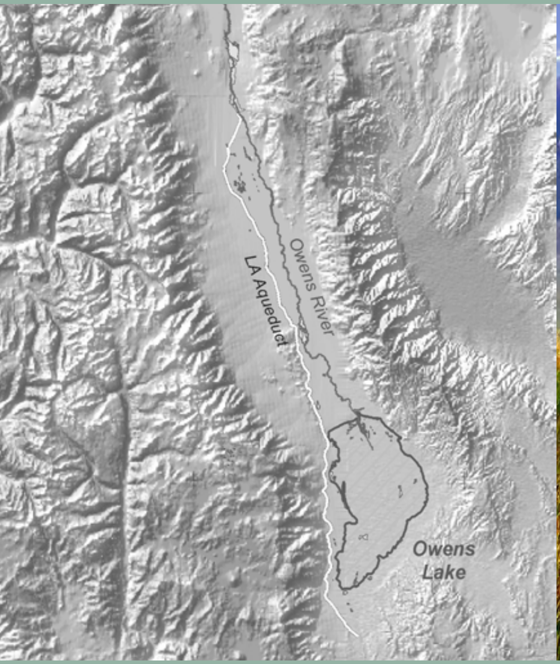
Lower Owens River Project

Monitoring, Adaptive Management and Reporting Plan



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April 28, 2008

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Preface

Ecosystem restoration is a relatively new and evolving field of scientific and practical knowledge that still lacks some basic information and understanding of subtle ecological functions and interactions. Consequently, ecosystem restoration must begin at scales where our knowledge base is better understood, and then we are able to set the pathways for natural forces to follow and organize around over time. To achieve success in the restoration of the Lower Owens River, there are three basic requirements: (1) to understand ecosystem function; (2) to give the system time; and (3) to appreciate self-design.

Even though currently there is little hard scientific backing in the discipline of rebuilding and restoring whole ecosystems, what works and doesn't work in different types of ecosystems is learned and relearned every time we rehabilitate nature's processes. Subtle ecosystem interactions are better understood when we allow nature the time to respond to the reintroduction of natural resources. Through careful monitoring of the effects of macro-scale interventions, we can then adaptively manage with confidence and use more subtle interventions at micro-scales to influence the direction of restoration efforts toward a functional and sustainable ecosystem.

Management of the Lower Owens River ecosystem will emphasize the "self-designing" or "self-organizing" capacity of nature to recruit species and to make choices from those species that have been introduced. Self-design emphasizes the development of natural habitat. Scientific knowledge in the field of ecology verifies that natural forces do ultimately self-design around habitat by choosing the most appropriate species to fill niches and establish rates of recruitment, production and growth. Self-design allows the natural colonization of plant and animal species to attain balance and optimum biodiversity with minimal human manipulation of materials or processes. In other words, sustainable ecological restoration should not rely upon a human-built and artificially maintained ecosystem. We emphasize instead, to the greatest extent possible within the constraints of continued multiple uses, to give nature back what it needs to function and then take a hands-off approach that adapts management interventions to what nature is teaching us about what it needs to achieve a healthy balance.

Regulators and interested parties who are monitoring and measuring restoration success often make the mistake of not allowing adequate time for natural self-designing processes to develop before passing judgment. Legal, political and economic human priorities too often demand unnatural and mechanistic interventions for "quick-fixes" that usually do not allow the time necessary for nature to find balance, and actually can often be undermining or even destructive to ecological restoration efforts. Because of the stochastic nature of hydrologic events, and the naturally slow and progressive development of ecosystems, sometimes in spurts and sometimes in the slow process of recruitment and growth, a five year horizon is arbitrary and probably too short a time period. Ecological models show that the further initial conditions are from a steady state, the more time is required for that system to reach, or even approach, steady state. The Lower Owens River ecosystem is currently very far from a balanced steady state; regulators should assume a time horizon of 15 to 20 years before evaluations are made about restoration success.

This LORP Monitoring, Adaptive Management and Reporting Plan is the culmination of nine years of reviews, meetings, and workshops with the Los Angeles Department of Water and Power (LADWP) and the Inyo County Water Department (ICWD) and other MOU (Memorandum of Understanding) parties. This document represents the seventh iteration of the plan as shown in the chronology below.

Chronology of LORP Monitoring, Adaptive Management and Reporting Plan

May 1999	Ecosystem Sciences' Initial Monitoring and Adaptive Management Plan presented in the draft LORP Ecosystem Management Plan.
Sept. 11, 2001	ICWD requests modifications to the Monitoring Plan.
Sept.28, 2001	ICWD presents tabulated modifications to the original plan.
Apr. 23, 2002	ICWD revisions and additions to plan.
June 7, 2002	ICWD revisions for the EIR.
July 5, 2002	ICWD revisions for the EIR.
July 12, 2002	ICWD revisions for the EIR.
Aug. 2002	Final LORP Ecosystem Management Plan with revised Monitoring and Adaptive Management (Chapter 7) that synchronized with the EIR.
Sept 2004	Second draft of Monitoring and Adaptive Management Plan with more detailed methodologies and protocols requested by MOU parties.
Dec. 1, 2004	Meeting with MOU parties (SC, OVC, CDFG) for consultation and discussion of second draft plan.
Aug. 11, 2006	Third Draft to include MOU Party requests for more detailed thresholds, loop-back mechanisms and refinement of methods and protocols.
Oct. 11, 2006	First joint workshop with ICWD and LADWP to revise the plan in response to MOU party lawsuit.
April 12, 2007	Fourth draft of the plan with major reorganization into three stand-alone sections, improved statistical analysis, quantified thresholds.
June 27, 2007	Second joint workshop with ICWD and LADWP to review and revise previous draft.
July 11, 2007	Stipulation and Order issued which dictates flow monitor methods.
Sept. 28, 2007	Fifth draft of plan incorporating the Stipulation and Order and second workshop outcomes with input from ICWD and LADWP.
Feb. 8, 2008	Sixth draft of plan prepared. This final draft will be used to prepare the final document once comments are received from all MOU parties.
March 13, 2008	Third joint workshop with ICWD, LADWP and all MOU Parties to review and revise final draft.
March 31, 2008	Seventh draft of Section 3.0 'Adaptive Management' prepared and sent to all MOU Parties for review.
April 28, 2008	Seventh and final LORP Monitoring, Adaptive Management and Reporting Plan completed.

Inyo County has played a major role in the development of the monitoring and adaptive management plan since the first iteration in 1999. The MOU obligates Inyo County to share the cost of post implementation work including monitoring. Inyo County made their position clear from the beginning that monitoring could not be open-ended and the program must be least-cost yet still be scientifically credible and meet other MOU objectives. To this end, Inyo County Water Department staff painstakingly reviewed and commented on various iterations. Additionally, the monitoring and adaptive management plan was revised to reflect the LORP FEIR, as much as possible, to create detailed protocols and methodologies, comply with the Stipulation and Order for Baseflow Compliance, and to attempt to develop a consensus plan with the city and county.

This current version of the plan reflects the independent judgment and recommendations of Ecosystem Sciences and is intended to supersede all previous monitoring and adaptive management plan iterations; it is produced as a final document to allow LORP monitoring, reporting and adaptive management to proceed.

Executive Summary

This Monitoring, Adaptive Management and Reporting Plan describes the methods used to collect baseline data and conduct future monitoring of environmental conditions in the Lower Owens River Project (LORP) area. This document describes the management objectives and actions, scientific background, concepts and studies, baseline data, monitoring methods, data management, data analysis and reporting, quality control, and adaptive management methods for the LORP. The LORP is divided into four management areas: the riverine-riparian area, Blackrock Waterfowl Management Area, Delta Habitat Area, and off-channel lakes and ponds. Monitoring will occur for 15 years upon implementation of the LORP.

Ecosystem Sciences, in drafting this document, has made every effort to integrate the complex components of this project into a useable plan. However, this is not entirely a stand alone document. This monitoring and adaptive management plan is based on several additional LORP documents, plans and agreements. This monitoring and adaptive management plan is fundamentally integrated with many additional plans and studies, to the extent feasible. These documents and their relationships are described in Section 1.0 of this document, and the scientific background and studies are described in Section 2.0. This document can be used to comprehensively manage the LORP, and all immediately relevant project criteria have been included and/or referenced. Although not necessary, for further information or to more fully understand the context and relevance of this LORP monitoring plan, the other associated project documents should be consulted and reviewed.

This document consists of the following sections:

Section 1.0: Describes the historical context of agreements and plans that direct the implementation and management of the LORP. It also provides a discussion of the project goals and guidance.

Section 2.0: Describes the LORP scientific background, concepts, hypothesis, studies, modeling, data collection, reports and relevant criteria that informed the design of the LORP. Much of this information is included to provide context of the lengthy planning and design stages of the LORP, and to bring all of the related documents together (as much as is feasible). LORP planning began in 1993; as a consequence of the lengthy planning and design phases some of the information in Section 2.0 has been superseded since its inception. LORP information databases are expected to continue to evolve as scientific understanding and the project body of knowledge increases through time.

This section also describes the baseline monitoring areas of the LORP and relates them spatially for a comprehensive look at the scales and locations of LORP data collection (quantitative and qualitative).

Section 3.0: Describes the adaptive management process for the LORP. Each criterion that is monitored through time is evaluated and described to illustrate comprehensive approaches to adaptive management understanding, knowledge sharing, feedback mechanisms and decision making.

Section 4.0: Describes the detailed LORP monitoring methodologies for data collection, and reporting for all ecosystem components.

Appendices:	Describe a range of project information that is relevant to the management and understanding of the LORP.

The LORP is a very complex project. Not only is the restoration and ecology of the project multifaceted, but the LORP legal agreements that direct, and often dictate, the procedures to be followed for the future management of the LORP are limiting factors that define the boundaries of management and monitoring. This monitoring and adaptive management plan has grown directly from the constraints and opportunities afforded it by the legal agreements, and existing documents. To understand LORP monitoring and adaptive management it is essential to recognize the MOU directions and limitations. These limiting factors are described in Sections 1.0, 2.0 and 3.0 of this plan.

Notwithstanding these constraints, the LORP Monitoring, Adaptive Management and Reporting Plan strives to use the best available science, collection of the most pertinent data that describes evolving ecological conditions, and efficient use of manpower and budgets to effectively observe and manage the area resources into the future.

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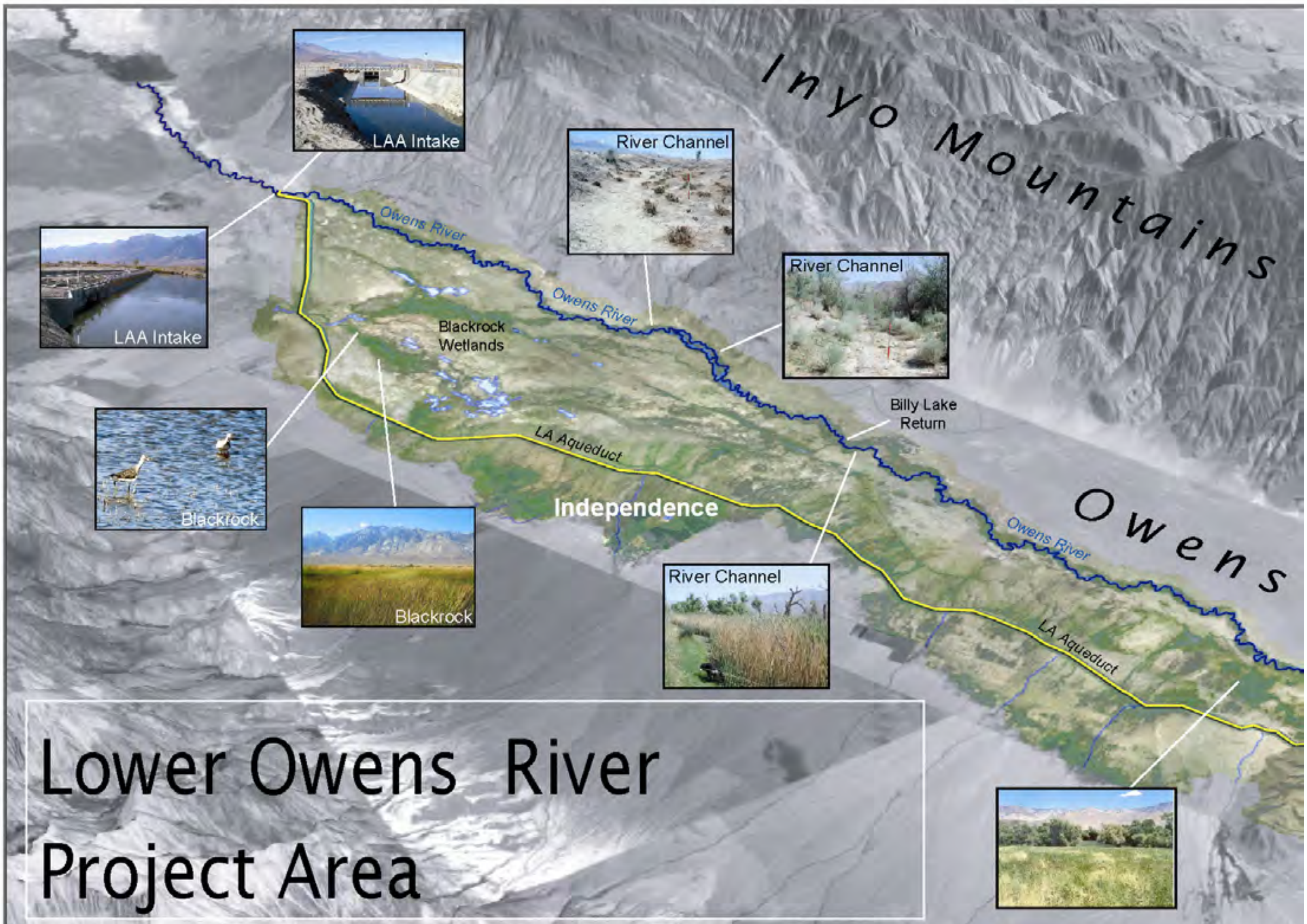
Section 4 Monitoring Methods 4-1

Abbreviations List

AUM’s- Animals units per month
AVG- average
BBS- Breeding Bird Survey
BLM- Bureau of Land Management
BMPs- Best Management Practices
BOD- biological oxygen demand
BWMA- Blackrock Waterfowl Management Area
CDFG- California Department of Fish and Game
CEQA- California Environmental Quality Act
CFS- cubic feet (per second)
CWHR- California Wildlife Habitat Relationship
DAM- Dry Alkaline Meadow
DBH- diameter at breast height
DBMS- database management system
DHA- Delta Habitat Area
DO- dissolved oxygen
EC- electrical conductivity
ET- evapotranspiration
FEIR- Final Environmental Impact Statement/Report
EIR- Environmental Impact Report
EMP- Ecosystem Management Plan
EIS- Environmental Impact Statement
FAC- facultative
FACW- facultative wetland
FACU- Facultative upland
FPS- feet per second
GBUAPCD- Great Basin Unified Air Pollution Control District
GIS – Geographic Information System
GPS- Global Positioning System
HCP- Habitat Conservation Plan
HGM- Hydrogeomorphic model
HSI- Habitat Suitability Index
HU- habitat units
ICWD- Inyo County Water Department
IFIM- Instream Flow Incremental Methodology
LADWP- Los Angeles Department of Water and Power
LORP- Lower Owens River Project
LRWQCB- Lahontan Regional Water Quality Control Board
MAM- marsh alkaline meadows
MORP- Middle Owens River Project
MOU- Memorandum of Understanding
NFIP- North Flood Irrigation Project
NI- Not indicator
NPDES- National Pollutant Discharge Elimination System
NRC- National Resource Council
NRCS- Natural Resource Conservation Service
OBL- obligate
PHABSIM- Physical Habitat Simulation Model
QC- Quality Control
RHJV- Riparian Habitat Joint Venture
RWQCB- Regional Water Quality Control Board
SI- suitability index
STD- standard deviation

SWPPP- Storm Water Pollution Prevention Plan
T&E- threatened and endangered
TL- Task Leader
USDA- United States Department of Agriculture
USFWS- United States Fish and Wildlife Service
UTM- Universal Transverse Mercator
WDR- Waste Discharge Requirements
WHA- White Horse Associates
WSE- water surface elevation



Lower Owens River Project Area

The northern reaches of the LORP are recently rewatered, and fish can already be found swimming in many areas of this reach. This reach of the Lower Owens River had been completely dry for decades.

The 78,000 acre LORP area, consisting of the Owens River channel and its adjacent floodplains, follows 55 miles of the Owens River from the Los Angeles Aqueduct (LAA) intake in the north to the Owens Lake bed in the south. The LORP area consists of a diverse mix of riparian, wetland, and upland vegetation, as well as open water, riverine-channels, and seeps and springs found primarily along the 1872 fault line. Pertinent features in the northern portion of the LORP include the Blackrock Waterfowl Management Area (BWMA), and several Off-Channel Lakes and Ponds.

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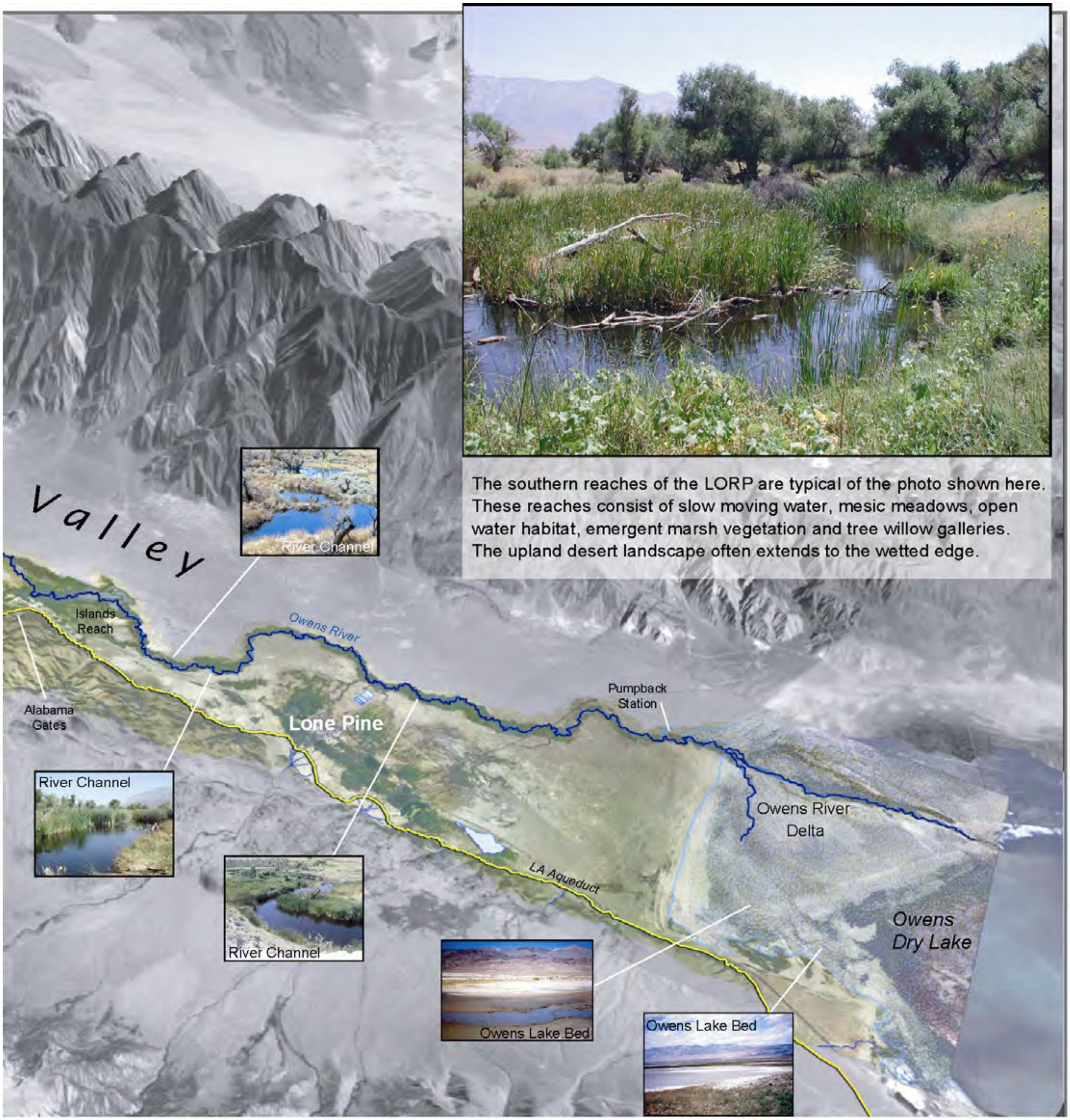

The southern reaches of the LORP are typical of the photo shown here. These reaches consist of slow moving water, mesic meadows, open water habitat, emergent marsh vegetation and tree willow galleries. The upland desert landscape often extends to the wetted edge.

The 20,461 acre Blackrock Waterfowl Area is a seasonally flooded, man-induced wetland supporting open water, wetland, riparian and upland habitats. Goose Lake and the Upper and Lower Twin Lakes are the dominant open water areas in the northern portion of the LORP. Directly downstream of the LAA Intake the Owens River channel is wet, as it is supported by ground water movement from the BWMA and the LAA. Further south, in the central portion of the LORP, a once dry river channel is now rewatered and flowing. The northern portion of this reach begins near the Blackrock return ditch's intersection with the Owens River. This area is dominated by upland vegetation and has experienced significant Tamarisk invasion. The southern portion of the LORP begins at the Billy Lake (an Off-Channel Lake and Pond) Return, just upstream of Mazourka Canyon Road. From this point south to Owens Lake the Owens River channel supports a dynamic floodplain community of riparian trees and shrubs, wetlands, mesic grass communities and open water habitats. The most southerly feature of the LORP is the 3,578 acre Owens River Delta which consists of riparian, wetland, and brine pool habitats.

Section 1

Introduction

MOU Direction and Planning

Lower Owens River in winter, near Lone Pine.

Lower Owens River Project

Monitoring, Adaptive Management and Reporting Plan

April 28, 2008

SECTION 1.0

1.1 Introduction

This Monitoring, Adaptive Management and Reporting Plan describes the methods used to collect baseline data and conduct future monitoring of environmental conditions in the Lower Owens River Project (LORP) area. Environmental conditions in the LORP will change in response to water and land management activities. The collection, evaluation, and reporting of environmental data is central to the monitoring program and will determine the effectiveness of adaptive management actions in meeting project goals and objectives. This document describes the management objectives and actions, baseline data, monitoring methods, data management, data analysis and reporting, quality control, and adaptive management methods for the LORP. The LORP is divided into four management areas: the Riverine-Riparian Area, Blackrock Waterfowl Management Area, Delta Habitat Area, and off-channel lakes and ponds.

The driving tool of adaptive management is environmental monitoring. Monitoring data is used to measure progress toward a desired management objective over time. Data provides the necessary information to allow managers to adapt actions and methods to on-the-ground circumstances and unforeseen events. Successful adaptive management is dependent upon a monitoring program that provides a reliable measure if change occurs in ecosystem components. The LORP monitoring program focuses on primary, macro-scale environmental components such as water flow, water quality, vegetation, habitat, range condition and fisheries.

Monitoring will occur for 15 years upon implementation of the LORP. The degree, frequency and timing of monitoring activities are determined by project goals and objectives. Monitoring will be conducted frequently during the first years of the project and less frequently after trends have been determined.

1.2 LORP Planning Area

The LORP is located in Eastern California in the southern portion of the Owens Valley. The LORP area begins at the Los Angeles Aqueduct Intake and follows the course of the Owens River south, terminating at Owens Lake (Figures 1.1 and 1.2). The LORP planning area encompasses 77,657 acres of riverine, riparian, wetland, and upland habitats. The four management areas that constitute the LORP (Riverine-Riparian, Blackrock Waterfowl Management Area [BWMA], the Delta Habitat Area [DHA], and off-channel lakes and ponds) are managed and monitored differently. The Riverine-Riparian Area is managed to restore a functional river system and is subject to flow changes. The BWMA is a “human-controlled” wetland and is managed to promote wetland vegetation through scheduled flooding and subsequent dry periods. The Off-River Lakes and Ponds are managed to keep an agreed upon water surface elevation that promotes open water habitat, which is a limited habitat type in the Owens Valley. The Delta Habitat Area is managed to preserve and enhance the unique Owens River Delta, where the Owens River once flowed into Owens Lake. There are more detailed descriptions and maps of each geographic area in Sections 2.2 and 4.1.

Lower Owens River near Lone Pine, CA.

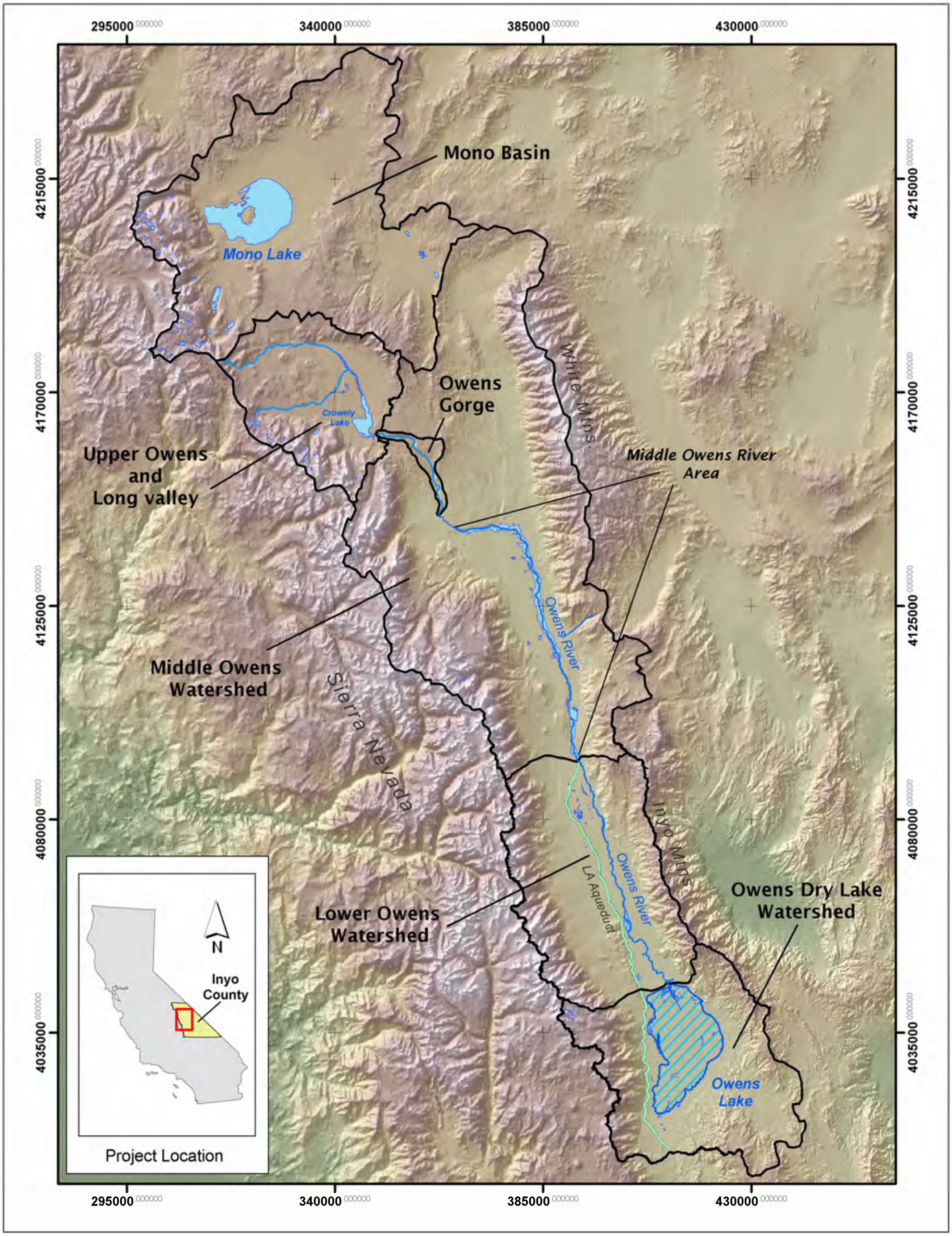

Figure 1.1 Owens River Watershed

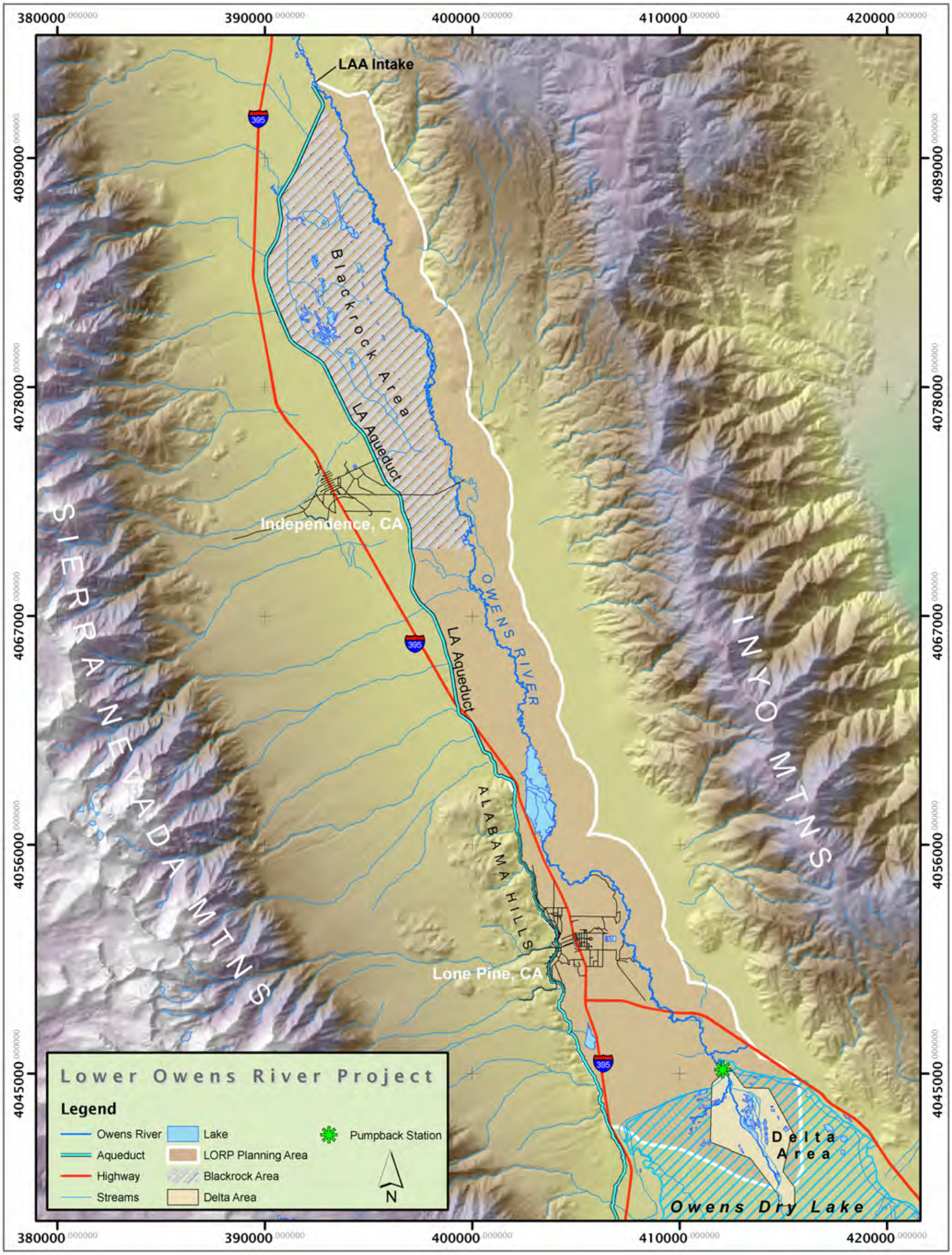

Figure 1.2 LORP Planning Area

1.3 Mandatory Documents

There are many legal and scientific documents that guide the LORP. This subsection summarizes how these documents are related and how each defines the conditions and directives for managing and monitoring the LORP. Section 2.0 describes the in-depth scientific background and studies of the LORP.

In the 1980s, Inyo County and the Los Angeles Department of Water and Power (LADWP) collaborated to develop a cooperative water management plan. An interim agreement was executed in 1984 between Inyo County and LADWP, which called for more cooperative studies, certain environmental enhancement projects, and continued negotiations on a long-term agreement. In 1989, a draft long-term agreement was released to the public. In October 1991, the County and LADWP approved the Inyo County/Los Angeles Long Term Water Agreement (Agreement). The overall goal of the Agreement is to manage the water resources within Inyo County "*…to avoid certain described decreases and changes in vegetation and to cause no significant effect on the environment which cannot be acceptably mitigated while providing a reliable supply of water for export to Los Angeles and for use in Inyo County*."

Subsequently, an Environmental Impact Report (EIR) was completed in 1991 by LADWP and Inyo County. It addressed the impacts of all water management practices and facilities associated with the second Aqueduct from 1970-1990, and the impacts of projects and water management practices that would occur after 1990 under the Agreement. The Agreement committed LADWP and the County to implement the Lower Owens River Project (LORP). The LORP was identified in the 1991 EIR as compensatory mitigation for impacts related to groundwater pumping by LADWP.

The evolution of the LORP from the mid-1980s, through the Agreement, the 1991 EIR, the Memorandum of Understanding (MOU), the Ecosystem Management Plan and the 2004 LORP EIR is summarized below.

Lower Owens River Rewatering Project. The Lower Owens River Rewatering Project was initiated in 1986 by LADWP and Inyo County. The project was one of 25 Enhancement/Mitigation Projects jointly implemented by the agencies between 1984 and 1990. Under the project, 18,000 acre-feet of water per year was to be released from the Blackrock spillgate to maintain a continuous flow in the Lower Owens River from the Blackrock area to the Owens River Delta. The objective of the project was to improve habitat for waterfowl, shorebirds, and fish in the river corridor and at the Delta. In addition, water was supplied to the project through various spillgates along the Aqueduct to support Upper and Lower Twin Lakes, Goose Lake, Thibaut Ponds, and Billy Lake.

Agreement. The LORP, as specified in the 1991 Agreement includes: the rewatering of the Lower Owens River below the Aqueduct Intake with an unspecified flow of water; maintenance of Off-River Lakes and Ponds; and a pumpback system near Keeler Bridge with a pumping capacity of up to 50 cubic feet per second (cfs) to recover water released to the river and return it to the Los Angeles Aqueduct (average annual pumping is not to exceed approximately 35 cfs). The Agreement provided that a management plan be developed by LADWP, the County, and California Department of Fish and Game to set the amount of river flows and water releases to the southern end of the river and the Owens River Delta, maintain existing Off-River Lakes and Ponds, and establish management guidelines to maintain the project elements.

1991 EIR. The 1991 EIR identified the LORP as a mitigation measure for impacts resulting from activities associated with LADWP's water gathering operations in the Owens Valley from 1970 to 1990. The 1991 EIR clarified and expanded upon the description of the project contained in the Agreement. The pumpback station was intended to return water to the Aqueduct so a substantially larger flow could be placed in the river without requiring additional groundwater pumping in the valley, to make up for the loss and to prevent excessive flows through the Delta Habitat Area onto the Owens Lake dry lake bed.

The 1991 EIR provided that a 56-mile reach of the Lower Owens River from Blackrock to Lone Pine be rewatered with an average flow of 35 cfs annually. Seasonal releases of water to wetland areas near Blackrock and the Delta to supply two major waterfowl management units consisting of approximately 850 acres were added to the project. The 1991 EIR stated that the project would be managed by LADWP, the County and the California Department of Fish and Game in accordance with a Habitat Management Plan that would be developed for the project. The 1991 EIR stated that the LORP would be the subject of a separate EIR.

MOU. The 1997 MOU augmented the Agreement and the 1991 EIR. The MOU states that "*[E]xcept as it modifies the scope of the Lower Owens River Project as described in the Inyo County/Los Angeles Long Term Water Agreement approved in October 1991…nothing in this MOU affects any other provision of that agreement*." Therefore, to the extent that the MOU modifies the scope of the LORP as described in the Agreement and 1991 EIR, the modifications of the MOU must be implemented. The MOU added specific goals for the LORP, provided a timeframe for the development and implementation of the project, and required that certain actions be undertaken, including the preparation of a LORP Ecosystem Management Plan to guide the implementation and management of the project. The MOU also established certain minimum requirements for the LORP related to flows, locations of facilities, and habitat and species.

The overall goal of the LORP, as stated in the MOU, is as follows:

> "*The goal of the LORP is the establishment of a healthy, functioning Lower Owens River riverine-riparian ecosystem, and the establishment of healthy functioning ecosystems in the other elements of the LORP, for the benefit of biodiversity and threatened and endangered species, while providing for the continuation of sustainable uses including recreation, livestock grazing, agriculture, and other activities.*"

The MOU provides that natural habitats be created and maintained consistent with the needs of certain habitat indicator species through flow and land management in the project area. The MOU identifies the four physical features of the LORP: (1) Lower Owens River Riverine-Riparian Ecosystem; (2) Owens River Delta Habitat Area; (3) Blackrock Waterfowl Habitat Area; and (4) Off-River Lakes and Ponds. A summary of the four physical features of the LORP is provided below:

- <u>Riverine-Riparian Habitats</u>. The MOU specifies that a base flow of 40 cfs be established throughout the river, an increase from the 35 cfs specified in the Agreement. The MOU also specifies a seasonal habitat flow of up to 200 cfs. The annual amount of the seasonal habitat flow will depend on the runoff amount in Owens Valley each year. The MOU includes goals for certain habitat indicator species associated with the river. This element of the LORP also includes the pumpback station designed to capture water released to the river, and to convey the water to the Los Angeles Aqueduct and/or the Delta.

- <u>Owens River Delta Habitat Area.</u> The MOU specifies that an average annual base flow of approximately 6 to 9 cfs be released from the pumpback station to the Delta to enhance and maintain approximately 325 acres of existing habitat, and to establish and maintain new habitats in the Delta. This base flow does not include any flows that by-pass the pumpback station during the seasonal habitat flows in the river. The MOU includes goals for certain habitat indicator species associated with the Delta.

- <u>Blackrock Waterfowl Habitat Area.</u> The MOU specifies that a 1,500-acre off-river area with a mixture of pasture and wetlands be enhanced through flow and land management to benefit wetlands and waterfowl. Approximately 500 acres of the habitat area are to be flooded at any given time when runoff is forecasted to be average or above average, with reductions in water supplies in less than average runoff years. The MOU includes goals for habitat indicator species associated with the Blackrock Waterfowl Habitat Area.

- Off-River Lakes and Ponds. The MOU specifies that existing Off-River Lakes and Ponds near the Blackrock Waterfowl Habitat Area be maintained for fisheries, waterfowl, shorebirds, and other animals through flow and land management. The Off-River Lakes and Ponds are: Billy Lake, Goose Lake, Thibaut Ponds, and Upper and Lower Twin Lakes. The MOU includes goals for habitat indicator species related to actions at the Off-River Lakes and Ponds.

LORP Action Plan and Concept Document[1] is Attachment A (and all Appendices) to the 1997 MOU and is incorporated into the MOU by reference ("Action Plan"). The Action Plan is based upon the LORP Phase I and LORP Phase II scientific studies (see Section 2.0).

In 1993, a detailed ecological study of the Lower Owens River was conducted as described in Section 2.0. The outcome of these scientific studies and the results is the LORP Action Plan and, subsequently, the MOU.

Ecosystem Management Plan 2002.

The MOU includes a requirement that a LORP Ecosystem Management Plan be prepared following the procedures outlined in the Action Plan[2], which is contained in the MOU. Background scientific studies were conducted to identify and determine river flow requirements for fish, wildlife, and riverine-riparian habitats, which are now the agreed upon flows for the LORP.

The Action Plan/MOU specified the scope of the various plans that would comprise the overall LORP Ecosystem Management Plan, including plans for river management, wildlife and wetlands management, habitat conservation, land management, and monitoring. A draft LORP Ecosystem Management Plan was issued in May 1999 for review and comment by the MOU parties. A final LORP Ecosystem Management Plan was completed in 2002.

The LORP Ecosystem Management Plan is based on scientific research, documentation and data. However, parties to the MOU specified that the plan be written as an *action plan*, which non-scientist or laymen could more easily follow. Technical, scientific studies supporting the actions were referenced throughout the LORP Ecosystem Management Plan. This is summarized in Section 1.3.1 below, and described in detail in Section 2.0.

LORP FEIR 2004.

The LORP FEIR is an informational document designed to *"…inform public agency decision-makers and the public generally of the significant environmental effects of a project, identify possible ways to minimize the significant effects, and describe reasonable alternatives to the project*".[3] The focus of an EIR is to identify significant environmental effects of the proposed project.[4] The significant effects are discussed with emphasis in proportion to their severity and probability of occurrence.[5]

The LORP FEIR must also *"… describe a range of reasonable alternatives to the project … which would feasibly attain most of the basic objectives of the project but would avoid or substantially lessen any of the significant effects of the project, and evaluate the comparative merits of the alternatives"*.[6]

California Environmental Quality Act (CEQA) Guidelines Section 15151 state that: *"An EIR should be prepared with a sufficient degree of analysis to provide decision-makers with information which enables them to make a decision which intelligently takes account of environmental consequences. An evaluation of the environmental effects of a proposed project need not be exhaustive, but the sufficiency of an EIR is to be reviewed in the light of what is reasonably feasible. Disagreement among*

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[1] MOU 1997, Attachment A: Action Plan. Lower Owens River Project Ecosystem Management Plan Action Plan and Concept Document

[2] MOU 1997, Attachment A: Action Plan. Lower Owens River Project Ecosystem Management Plan Action Plan and Concept Document

[3] CEQA Guidelines 15121

[4] CEQA Guidelines 15126.2

[5] CEQA Guidelines 15143

[6] CEQA Guidelines 15126.6

experts does not make an EIR inadequate, but the EIR should summarize the main points of disagreement among the experts. The courts have looked not for perfection but for adequacy, completeness, and a good faith effort at full disclosure."

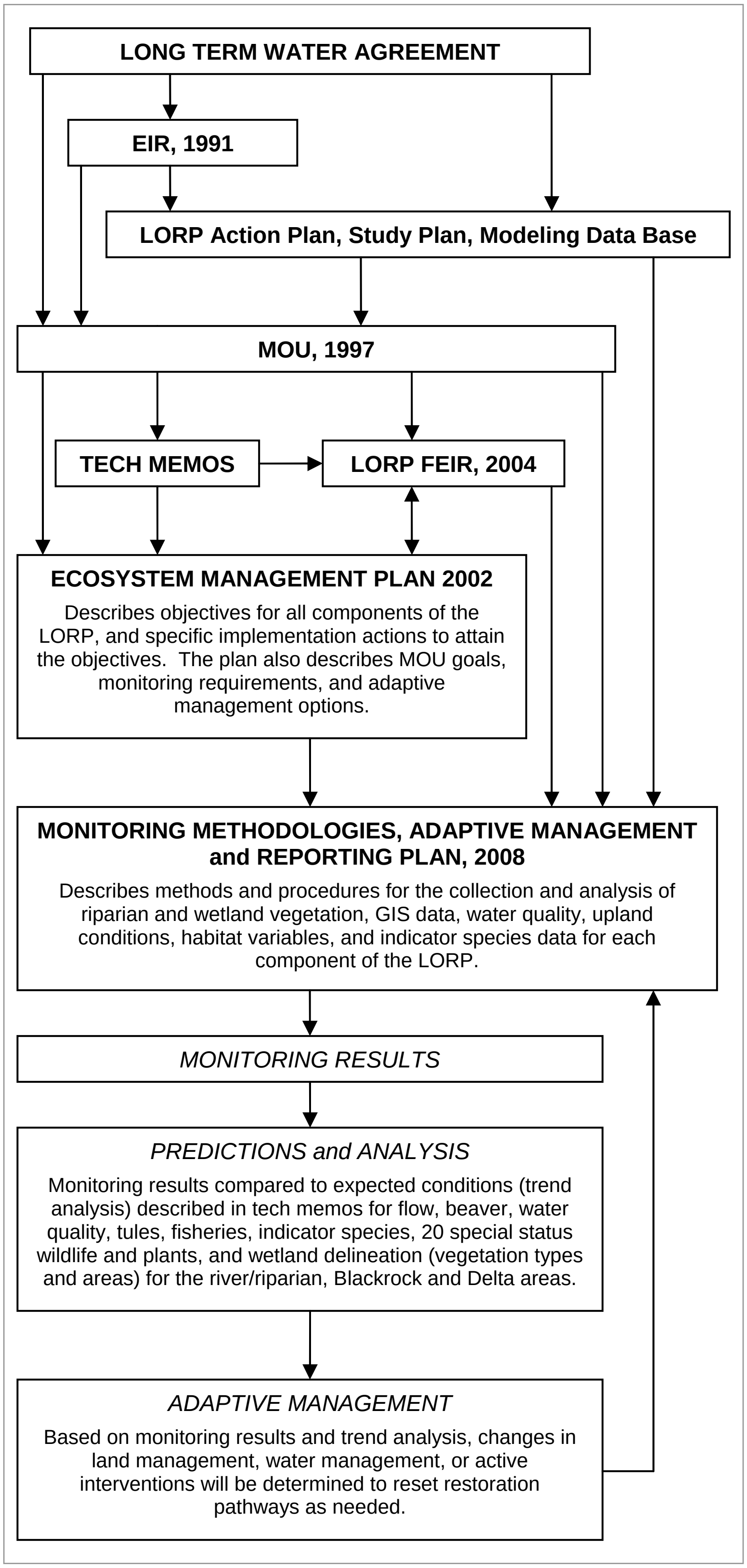
The LORP is designed to improve environmental conditions, but may cause incidental and unintended adverse environmental impacts, many of them temporary. The objective of the EIR is to evaluate the impacts of the proposed LORP in order to allow LADWP and Inyo County to make informed decisions on how to minimize impacts of the project.

The LORP FEIR 2004 is based on the MOU, the MOU LORP Action Plan, LORP Technical Memorandums, and the Ecosystem Management Plan. The LORP FEIR sets out obligations with regards to monitoring and reporting that, in part, direct the conditions described in this document. The LORP FEIR directions with regards to monitoring are described in Section 1.5 below.

1.3.1 Relation of LORP Scientific Documents

This information and these documents are discussed in detail in Section 2.0 of this plan, and only briefly discussed here.

The scientific foundation for managing the LORP is based on: (1) the LORP Action Plan, Study Plan, Controlled Flow Study and Modeling Database; (2) the collection of more than 20 Technical Memoranda (tech memos) and addendums; (3) the LORP Ecosystem Management Plan; and (4) the LORP Monitoring, Adaptive Management and Reporting Plan. Understanding the linkages between these documents is fundamental. Each of these guiding documents is briefly described below. The diagram of Figure 1.3 summarizes how all project documents interrelate. Section 2.0 details the scientific basis and decision making for the LORP.



Describes objectives for all components of the LORP, and specific implementation actions to attain the objectives. The plan also describes MOU goals, monitoring requirements, and adaptive management options.

Describes methods and procedures for the collection and analysis of riparian and wetland vegetation, GIS data, water quality, upland conditions, habitat variables, and indicator species data for each component of the LORP.

Monitoring results compared to expected conditions (trend analysis) described in tech memos for flow, beaver, water quality, tules, fisheries, indicator species, 20 special status wildlife and plants, and wetland delineation (vegetation types and areas) for the river/riparian, Blackrock and Delta areas.

Based on monitoring results and trend analysis, changes in land management, water management, or active interventions will be determined to reset restoration pathways as needed.

Figure 1.3 Mandatory Plans and Documents

Relation of documents to the Monitoring and Adaptive Management Plan

LORP Action Plan (Scientific Concepts, Studies and Models; Combined Documents): The LORP Action Plan is Attachment A to the 1997 MOU and is incorporated into the MOU by reference ("Action Plan").

The Action Plan is based upon the LORP Phase I and LORP Phase II scientific studies (described in Section 2.0), which were designed and performed by Ecosystem Sciences under the direction of Mr. Mark Hill, Dr. Bill Platts, lead project scientists.

In 1993, under the direction and design of Ecosystem Sciences, the detailed ecological study of the Lower Owens River from the DWP's aqueduct intake to Owens Lake - approximately 65 miles of river channel and wetland habitat were conducted (see Figure 1.2). The outcome of these studies and results is the LORP Action Plan and, subsequently, the MOU.

Technical Memoranda: Tech memos were produced over the course of the planning phase and provide information and data analyses about specific components of the LORP ecosystem. Tech memos describe and quantify existing conditions and predict future conditions. All decisions on how to proceed with restoration of the ecosystem were based on recommendations given in each tech memo. Qualitative, and some quantitative, thresholds that are predicted/expected for the LORP are described in these reports.

Ecosystem Management Plan[7]: Decisions from the tech memos were incorporated into the Ecosystem Management Plan as specific goals, objectives, and actions required to establish and maintain a healthy, functioning ecosystem. The Ecosystem Management Plan does not reiterate or display all of the information, data, and analysis from the tech memos and is not intended to be a detailed methodology for monitoring and adaptive management. The range of adaptive management actions and triggers for adaptive management decision making are also described in the Ecosystem Management Plan.

Monitoring, Adaptive Management and Reporting Plan: This plan describes the methods and criteria (objective and subjective) that will measure trends in response to ecosystem restoration. The results of monitoring over time will direct adaptive management decisions. Ecosystem criteria that will inform adaptive management decisions are described. This plan is directed and informed by the 1997 MOU (and LORP Action Plan, Attachment A and Appendices to the MOU), the LORP FEIR, the LORP Technical Memoranda, and the Ecosystem Management Plan. This monitoring plan integrates MOU requirements, LORP actions, LORP scientific analysis and direction, and EIR commitments into one document. The combined project documents, studies, plans and reports are far too complex and lengthy to include in total or even in part with this document. The essence of each of the project documents have been integrated into this plan to the extent feasible and reasonable.

1.4 MOU Requirements

For Monitoring and Adaptive Management

The 1997 MOU requires a monitoring, adaptive management, and reporting plan as one of the plans that will comprise the overall LORP planning. Monitoring, adaptive management, and reporting are described in the LORP Ecosystem Management Plan (Chapter 7). This plan relates the monitoring methods to the LORP objectives and actions, and provides detailed methodologies, data analysis techniques, data management, reporting, and adaptive management.

Section C, 4E of the MOU describes the “Monitoring and Reporting Plan – Adaptive Management” as follows:

> *“Monitoring sites and water flow gaging stations will be identified and a program for data collection, analysis, and reporting (which will identify pathways to allow feedback to indicate where adaptive modifications to management are necessary) will be described as part of this plan. Should*

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[7] Ecosystem Sciences 2002

> *the reported information reveal that adaptive modifications to the LORP management are necessary to ensure the successful implementation of the project, or the attainment of LORP goals, such adaptive modifications will be made."*

The MOU defines adaptive management as a method for managing the LORP that provides for modifying project management to ensure the project's successful implementation and/or the attainment of the project goals, should ongoing data collection and analysis reveal that such modifications are necessary. The MOU requires that data and information be collected and evaluated so that recommendations and decisions can be made, and changes implemented (adaptive management procedures) to ensure that LORP goals are achieved or, conversely, determine if any LORP goals are not achievable.

Data collection, analysis, and reporting (over a 15 year period) will provide information feedback through pathways that will indicate what and where adaptive modifications to management of resources is necessary. This analysis will also determine if the expectations are reasonable, feasible or unrealistic. Based on monitoring information and the evaluation of monitoring results, recommended changes in land and water management can be determined. If expected ecological changes are not acquired from an applied benefit, the scientific team will recommend management changes or additions. Adaptive management conditions and procedures are described in Section 3.0.

1.5 LORP FEIR Requirements

For Monitoring and Adaptive Management

The Technical Group, Standing Committee, and the governing boards of LADWP and the County will make the ultimate decision on implementing adaptive management actions after reviewing the annual report and any other relevant monitoring data. [8]

The LORP FEIR references monitoring and adaptive management decision making. Section 2.1.4 of the FEIR[9] states:

If monitoring results indicate that the changes in environmental conditions are inconsistent with the LORP objectives, LADWP and the County will implement feasible adaptive management measures. The adaptive management approach is described in Section 2.10.5. Under the proposed project, the effects of altered river flows, changed flooding patterns in wetland areas, and modified land management practices will be monitored on an ongoing basis to determine if the desired goals are being achieved, and if not, the adaptive management actions will be considered and implemented as necessary and to the extent consistent with the MOU. This approach contrasts with alternative habitat restoration approaches that involve active planting of vegetation and/or introduction of wildlife species.

The LORP FEIR further defines roles and responsibilities for monitoring and adaptive management decision making. Section 2.2.1 of the FEIR[10] states:

The LORP will be implemented through a joint effort by LADWP and the County. The other MOU signatories will not have any direct management responsibilities for the LORP…. Regulatory agencies including the CDFG, Lahontan Regional Water Quality Control Board, and Corps of Engineers, will influence the LORP through various permits and approvals.

The County and LADWP will conduct the monitoring associated with the LORP, provide analysis of technical data, and prepare an annual report that includes monitoring data, analysis and recommendations on the need for adaptive management actions.

The Inyo/Los Angeles Technical Group ("Technical Group") was formed in 1982, and is comprised of staff from LADWP and the County. It will meet to review the annual report prepared by LADWP and the County,

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[8] LADWP 2004. LORP FEIR, Section 2.10.5

[9] LADWP 2004, LORP FEIR

[10] LADWP 2004, LORP FEIR

and will meet as necessary to review other monitoring data and recommendations, to determine if management actions need to be modified within the framework of the adaptive management approach in order to better achieve the LORP goals.

If the Technical Group is in disagreement over the need to implement an adaptive management measure or over the content of a work program, the disagreement will be submitted to the Inyo County/Los Angeles Standing Committee ("Standing Committee") for resolution. The Standing Committee was formed in 1982 and consists of both managers and elected and appointed officials from the County and LADWP. Its meetings are open to the public. If the Standing Committee is unable to resolve a disagreement, the disagreement will be submitted to the governing boards of each entity for resolution. If the governing boards are unable to agree on all, or any part, of a work program, the portion of the program in disagreement will not be implemented. Further, if the governing boards are in disagreement over the need to implement an adaptive management measure, the measure will not be implemented. The dispute resolution process, including mediation/facilitation and litigation, is detailed in the MOU (Sections VI and VII).

The LORP FEIR references monitoring and adaptive management. Section 2.2.2.2 of the FEIR[11] states:

The Agreement provides that, once the LORP has been implemented, LADWP and the County will each be responsible for one-half of the annual operation costs of the LORP that are not related to the pumpback system, and that LADWP will pay all operation and maintenance costs of the pumpback system.

These post-implementation costs are for activities related to operation and maintenance, monitoring and reporting, adaptive management, and mitigation measures. Both the County and LADWP intend to fully fund their share of the post-implementation costs of the LORP in accordance with the Agreement and the more recent provisions of the Stipulation and Order entered in Inyo County Superior Court Case Number S1CVCV01-29768 (Sierra Club and Owens Valley Committee v City of Los Angeles et al., February 13, 2004; see also Section 1.1, LORP EIR). The stipulation calls for LADWP to provide matching funds to Inyo County for saltcedar control as detailed in Mitigation Measure V-3 (Section 10.4.4, LORP EIR). Except for LADWP funding to be provided to the Inyo-Mono County Agricultural Commissioner as described in Mitigation Measure V-2 (Section 10.4.4, LORP EIR; non-saltcedar noxious weed control), all mitigation measures identified in the EIR/EIS are considered post-implementation costs to be shared equally by LADWP and Inyo County.

After adoption of the LORP, the governing bodies of the County and LADWP will adopt a policy that sets forth each entity's responsibilities for LORP funding during the implementation and post implementation periods. The policy will also describe the procedures for managing the LORP during the post-implementation period. Although not finalized, a working draft copy of the post-implementation policy that will be considered by the governing bodies is provided in Appendix C, LORP EIR. As required by law, decisions about the availability of funding for the LORP will be made annually by the Inyo County Board of Supervisors and the LADWP Board of Water and Power Commissioners. In the event that one or both governing boards determine that there are insufficient funds available to cover the entity's share of the costs of the LORP, each entity will evaluate the situation and take such action as deemed appropriate under the existing applicable laws.

Intensive monitoring and implementation of adaptive management measures to better achieve the goals of the LORP are expected to only be necessary during the initial 15 years of the project.[12] *It is anticipated that the goals of the project will largely be achieved within a 15-year time period. Therefore, estimates of monitoring, operation and maintenance*

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[11] LADWP 2004

[12] Ecosystem Sciences, LORP Ecosystem Management Plan, 2002

activities are based upon this 15-year period. Since the future needs for adaptive management and, to some extent, mitigation, are unknown, it is not possible to accurately estimate these post-implementation costs.

It is estimated that the cost of operating and maintaining the project (including the maintenance of project flows, maintenance of certain ditches, levees, spillgates, flow measuring devices, beaver control, and certain grazing fences – but not including the operation and maintenance of the pumpback station) will be approximately $4.2 million during the 15-year period following the implementation of the LORP. LADWP developed estimates of the costs of project operation and maintenance by estimating the amount of time it would take LADWP staff to maintain the project's facilities; the estimates do not include the costs of materials. The 15-year operation and maintenance estimate includes a 3 percent annual inflation adjustment. It is anticipated that LADWP staff will perform the maintenance and operation activities and that the County will reimburse LADWP for one-half of LADWP's costs. Over the long term, County staff may perform some of this work.

The costs of implementing the monitoring program identified in Section 2.10 of the LORP EIR during this 15-year period are estimated to be approximately $2.6 million. The cost estimates for project monitoring were developed by LADWP, the County, and Ecosystem Sciences by estimating the staff and time required to conduct each monitoring component identified in Section 2.10 of the LORP EIR. Hourly and daily costs were assigned to each staff position (e.g., hydrologist, biologist, field technician) based on a range of hourly costs for similar positions charged by a sample of consulting firms. The annual cost of each monitoring component was estimated as the staff costs multiplied by the estimated time to perform a given monitoring component plus a daily vehicle charge. The estimated total cost for implementing the 15-year monitoring program includes a 3 percent annual inflation adjustment. It is anticipated that the LORP monitoring responsibilities will be shared equally by staff from the County's Water Department and LADWP. The overall costs of the LORP for operation, maintenance, monitoring and mitigation during the 15 years following implementation are estimated to be approximately $13.4 million (see Table 1.1).

TABLE 1.1
ESTIMATED LORP POST-IMPLEMENTATION COSTS*

Post-Implementation Item	***Estimated Cost***
Operation and Maintenance	*$4,200,000*
Monitoring	*$2,600,000*
Mitigation	*$6,600,000*
Total	***$13,400,000***

** Does not include the following post-implementation costs: adaptive management costs (which are unknown at this time) and maintenance, operation or other related costs associated with the pumpback station (which are funded by LADWP as provided in the Agreement).*

1.6 Additional Directions

For Monitoring and Adaptive Management

A long-term environmental monitoring program must be attentive to, and is dependent upon, funding. Monitoring must be commensurate with the monies available while providing the data needed for making appropriate adaptive management decisions. LADWP and Inyo County are currently negotiating final monitoring costs. These costs include division of labor assignments, person-day costs and expense distribution. A final monitoring budget is based upon the distribution of labor for each of the monitoring, analysis, reporting, and decision-making tasks as shown in the appendices in Table A.7. The initial budget shown in this table connects the monitoring tasks in this plan to effort, timing and expenses. While details are still being determined, it is expected that this budget is close to the initial estimate given in the EIR and described previously.

The 15-year environmental monitoring program for the LORP could be extensive and very expensive unless it is finely tuned to measure the goals and expectations outlined in the MOU. Budgetary funds for monitoring are limited and there is no allowance for research or collection of data that is not directly related to evaluating change in order to make appropriate adaptive management decisions. This monitoring plan describes the data collection and information necessary to answer the questions posed in the MOU, while reflecting the basic funding agreement between the LADWP and Inyo County.

As adaptive management actions are implemented over time, monitoring will also change with those decisions. Thus, monitoring efforts and responsibilities must be revisited throughout the life of the project. The budget can change in response to these modifications. While it is impossible to accurately predict all costs over the next 15 years, the estimates given here are a strong starting point and allow decision-makers to adjust for change with some certainty that monitoring will be affordable through time.

1.6.1 Stipulation and Order for Baseflow Compliance

The July 11, 2007, Stipulation and Order[13] from the Superior Court of the State of California, County of Inyo serves to establish certain data reporting requirements, provide criteria as to what constitutes a permanent baseflow of approximately 40 cfs in the LORP, and provides a mechanism for enforcement of the provisions stated in the Stipulation and Order. The following is a summation of the Stipulation and Order as it applies to the monitoring and reporting requirements for the LORP baseflow. The full Stipulation and Order is included in the appendices as A.7.

Baseflows shall be deemed in compliance with the Stipulation and Order as long as each of the following conditions in the Lower Owens River exists:

1. *A minimum flow of 40 cfs is released from the Intake at all times;*
2. *None of the 10 in-river flow measuring stations described in Section F (of the Stipulation and Order) has a 15 day running average of less than 35 cfs;*
3. *The mean daily flow at each of the 10 in-river flow measuring stations must be equal or exceed 40 cfs on at least 3 individual days per any continuous 15 day period, except that this requirement shall not apply to the following measuring stations at Reinhackle Springs and Lone Pine Narrow Gage Road between November 1 and April 30 of each runoff year;*
4. *The 15-day running average of the 10 in-river flow measuring stations is no less than 40 cfs.*

The mean daily flow shall be the 24-hour mean of the flow data from midnight to midnight at each measuring station or a current meter measurement if the automated gauge is not functioning. For the purpose of the Stipulation and Order, the 15-day running average is the mean of the mean daily flow for 15 consecutive days up to the date of calculation. Running averages shall be calculated daily, beginning on the 15th day after the entry of the Stipulation and Order as an order of the Court.

The MOU calls for at least 4 permanent flow monitoring stations; therefore, the Parties recognize that up to six of the 10 in-river flow measuring stations are temporary. Except as provided in this Stipulation and Order, the temporary flow monitoring stations will be maintained and operated for at least 24 months after the entry of this Stipulation and Order as an order of the Court and after the 24 month period until the Standing Committee designates the permanent flow measuring stations as provided in the July 11, 2007, Stipulation and Order.

Electronic measuring devices shall be used at all temporary and permanent flow measuring stations.

LADWP will perform routine current metering at all the in-river flow measuring sites (except the pumpback station) on at

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[13] Sierra Club and Owens Valley Committee vs. City of Los Angeles, et. al. (July 11, 2007). *Stipulation and Order*. Superior Court of the State of California, County of Inyo. Case No. S1CV01-29768.

least a monthly basis to insure that the measuring devices are properly calibrated.

Daily LORP flow reports showing mean daily flows and summary statistics (in-river station average and running average at each station) at all in-river flow measuring stations and all augmentation stations will be posted on the LADWP website.

Within 2 years of the entry of this Stipulation and Order as an order of the Court, real time flows will be added and posted to the current LADWP real-time website for Intake, Owens River at 2 Culverts, Owens River at Reinhackle Springs, Keeler Bridge and Pumpback Station flow measuring stations.

Monthly data reports will be generated and provided to all the Parties by the last workday of each month unless al the Parties agree to another schedule. The monthly data reports will report data from the month ending approximately 60 days prior to the data report.

The monthly reports will include final archived data for the flow measuring stations (both in-river and augmentation ditch stations), current meter measurements, stage data, mean daily flow values, and other routinely collected data, as well as a synopsis of events for the month. Monthly reports will identify data indicating possible noncompliance with the baseflow criteria.

During the first year, outflow from the Delta will be recorded hourly and collected biweekly from continuous recorders at temporary gauging stations established where the vegetation ends in the channel of the lower west branch and lower east branch.

During the first year following the completion of the pump station, LADWP will post the outflow data from the two temporary gauging stations on the LADWP website within 5 workdays following the biweekly collection of data.

Within 210 days of the entry of this Stipulation and Order as and order of the Court, the Standing Committee will adopt a reporting program for hydrologic data for the Blackrock Waterfowl Area and Off-River Lakes and Ponds.

The County and LADWP will prepare an annual report that includes data collected during the habitat and flow compliance monitoring, results of analysis and recommendations on the need for adaptive management actions. The annual report will be reviewed by the Inyo/Los Angeles Technical Group and will also be made available to the public.

The Technical Group, Standing Committee and the governing boards of LADWP and the County will make the ultimate decision on implementing adaptive management actions after reviewing the annual report and any other relevant monitoring data.

1.6.2 California Regional Water Quality Control Board[14]

Water Quality Certification, Waste Discharge Requirements, and National Pollutant Discharge Elimination System Permit

The California Regional Water Quality Control Board issued an order July 14, 2005 that provides Water Quality Certification, Waste Discharge Requirements (WDR), and a National Pollutant Discharge Elimination System (NPDES) Permit for the LORP. The certification and permits operate under a single order that incorporates water quality certification and other requirements. The permits regulate all discharges associated with the LORP and set conditions for discharging, identify discharge points and monitoring locations. Discharges include those associated with dewatering excavated areas of construction sites, disposal of waste earthen material and dredged spoils, and stream diversion activities associated with construction of a gaging station weir and reintroduced flows.

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[14] July 14, 2005, CRWQCB Board Order No. R6V-2005-0020

This order also implements the requirements of the *Water Quality Control Plan for the Lahontan Region (Basin Plan)*, which designates beneficial uses, establishes water quality objectives, and contains implementation programs and policies to achieve those objectives. The order also regulates project discharges and certifies that discharges will comply with applicable provisions of the Clean Water Act (Sections 301, 302, 303, 306, and 307). Certification actions are contingent on (a) the discharges being limited and all proposed mitigation being completed in strict accordance with the applicant’s project description, and (b) on compliance with all applicable requirements of the Basin Plan and this order. Narrative water quality objectives are included for ammonia, bacteria/coliform, biostimulatory substances, California Toxics Rule Constituents, chemical constituents, color, dissolved oxygen, floating materials, non-degradation of aquatic communities and populations, pH, sediment, settleable materials, suspended materials, taste and odor, temperature, toxicity, and turbidity. Numerical water quality objectives are described for boron, chloride, fluoride, nitrogen, nitrogen as nitrate, sulfate, dissolved orthophosphate, and total dissolved solids.

To reduce impacts to water quality, the Order requires LADWP to implement various mitigation measures, including implementation of a 200 cfs partial flushing flow from the Alabama Spillgate in conjunction with the first winter habitat flow.

The Order describes the *Statewide General Waste Discharge Requirements for Discharges to Land with a Low Threat to Water Quality*, with which LADWP must comply for disposal of waste earthen materials and dredged spoils. Exemptions to waste discharge prohibitions in the Basin Plan were granted for implementation of the LORP (for the Lower Owens River and Owens Lake delta) - this exemption period begins when base flows are initiated and expires July 14, 2015.

The NPDES permit covers several specific discharges associated with dewatering excavated areas of construction sites and for stream diversion activities associated with construction of a gaging station weir. Water quality-based effluent limitations will be established, if necessary, once LORP flow regimes have been implemented to attain and maintain applicable numeric and narrative water quality criteria (described above) and to protect beneficial uses of the receiving waters. The Order requires that LADWP comply with the Monitoring and Reporting Program described in Attachment E. The plan contains monitoring requirements for influent, effluent, whole effluent toxicity testing, land discharge, receiving waters, ambient surface water, wetland functions and values, and reclamation monitoring. It also describes monitoring requirements for the first winter habitat flow, Alabama Release, and the initial two spring seasonal habitat flows. It describes monitoring locations and details the monitoring reporting requirements.

The *NPDES General Permit for Storm Water Discharges Associated with Construction Activity* describes the discharges that are eligible for coverage (dredged or fill material that have received State Water Quality Certification pursuant to the Clean Water Act section 401- see Attachment H for more information). Any activity that may result in a discharge of pollutants to a water of the U.S. must obtain certification that the proposed activity will comply with state water quality standards.

This Order requires LADWP to develop and implement a Storm Water Pollution Prevention Plan[15] (SWPPP) to regulate storm water discharges associated with construction activities. Attachment L of the Order describes the information required in a SWPPP. The SWPPP (September 29, 2005) outlines activities to minimize storm water runoff contamination and prevent contaminated storm water runoff from being discharged into surface waters. It also specifies the Best Management Practices (BMPs) to be implemented to reduce the discharge of pollutants in storm water and non-storm water to the maximum extent practicable.

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[15] Storm Water Pollution Prevention Plan for Construction Activities (LORP). September 29, 2005.

1.7 MOU LORP Goals

The MOU describes goals for the LORP once the mandated changes in land and water management have been applied over a sufficient period of time.

The overall goal of the LORP, as stated in the MOU, is as follows:

> *The goal of the LORP is the establishment of a healthy, functioning Lower Owens River riverine-riparian ecosystem, and the establishment of healthy functioning ecosystems in the other elements of the LORP, for the benefit of biodiversity and threatened and endangered species, while providing for the continuation of sustainable uses including recreation, livestock grazing, agriculture, and other activities.*
>
> *The goal of the LORP includes:*
>
> 1. *Establishment and maintenance of diverse riverine, riparian and wetland habitats in a healthy ecological condition. The LORP Action Plan identifies a list of "habitat indicator species" (Table 1, Attachment A) for each of the areas associated with the four physical features of the LORP. Within each of these areas, the goal is to create and maintain through flow and land management, to the extent feasible, diverse natural habitats consistent with the needs of the "habitat indicator species." These habitats will be as self-sustaining as possible.*
>
> 2. *Compliance with state and federal laws (including regulations adopted pursuant to such laws) that protect Threatened and Endangered Species.*
> 3. *Management consistent with applicable water quality laws, standards and objectives.*
>
> 4. *Control of deleterious species whose presence within the Planning Area interferes with the achievement of the goals of the LORP. These control measures will be implemented jointly with other responsible agency programs.*
>
> 5. *Management of livestock grazing and recreational use consistent with the other goals of the LORP.*

LORP objectives include:[16, 17]

1. The LORP will create and sustain a healthy warm water recreational fishery, create a healthy habitat for native fish species, and benefit Threatened and Endangered Species.

2. Off-River Lakes and Ponds will sustain diverse habitat for fisheries, waterfowl, shorebirds, and other animals.

3. The BWMA will provide the establishment of resident and migratory waterfowl populations. Approximately 500 acres within the BWMA will be flooded when annual runoff is forecasted to be average or above average. The water supply to the acreage will be reduced in general proportions to the forecasted runoff on below average runoff years.

4. The LORP should provide for continued and sustainable uses including recreation, livestock grazing, agriculture and other activities.

5. The habitat flow (up to 200 cfs) should create a natural disturbance regime that produces a dynamic equilibrium for riparian habitat, fisheries, water bank storage, water quality, animal migration, and biodiversity resulting in resilient and productive ecological systems.

6. The habitat flows should fulfill the wetting, seeding and germination of riparian vegetation (particularly willow and cottonwood), muck removal, ground water discharge into streambanks and the flood plain, control tules and cattails to the extent possible, maintain water quality, and enhance the river channel.

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[16] LADWP 2004. LORP FEIR

[17] Ecosystem Sciences 2002, LORP Ecosystem Management Plan

7. Diverse natural habitats should be created in the Delta, to the extent feasible, consistent with the needs of habitat indicator species. Existing and new habitat, consisting of riparian areas and ponds suitable for shorebirds, waterfowl, and other animals, should be enhanced and maintained.

8. Deleterious plant species interfering with the achievement of LORP goals will be controlled.

9. Livestock grazing and recreation will be consistent with LORP goals.

1.8 Project Constraints

The MOU provides benefits and possible constraints and/or limitations to land and water management that have been agreed to by the MOU parties. Whether all LORP goals are realistic under these potential constraints is yet to be determined. The constraints and limitations mandated by the MOU are:

1. A base flow of approximately 40 cfs will be maintained year-round from the Los Angeles Aqueduct Intake to the pumpback system.

2. A 200 cfs flow will be released at the Los Angeles Aqueduct Intake on average or above average precipitation years. Years with below average precipitation will have flows reduced from 200 cfs to as low as 40 cfs.

3. An annual average flow of between 6 to 9 cfs will be released below the pumpback station into the Delta Habitat Area
4. Sustainable uses including recreation, livestock grazing, agriculture and other activities will continue.

5. Continuation of LADWP’s primary mission to provide water to the citizens of Los Angeles will continue.

6. The costs of monitoring will be shared equally between LADWP and Inyo County and monitoring must be commensurate with (a) available funding and (b) reasonable and feasible adaptive management interventions.

In summary, the constraints and limitations established by the parties in the MOU set the boundaries, or limitations for the environmental monitoring program. Monitoring and management must be synergistic. Data collection for monitoring programs that do not directly inform management decisions is a misuse of limited resources. Monitoring environmental conditions for which there are no management interventions is also a misuse of resources.

1.9 Monitoring and Adaptive Management Implementation

In addition to flow compliance and water quality conditions, habitat is the focus of monitoring efforts in the LORP area. Habitat is directly responsive to changes in ecosystem management; therefore, it is a descriptive and reliable indicator of change over time. Furthermore, management of the LORP ecosystem is keyed to adaptive actions aimed at interventions at the habitat level, and not at the species population level.

It is financially and physically impossible to monitor the entire river corridor, wetlands, transition zones, and upland areas. In addition, changes in habitat will be quite variable from one area to another. In order to detect and quantify habitat changes, or no changes, in some areas, and make decisions on appropriate interventions, managers must recognize ecosystem response to re-watering and land management holistically, but also have reliable, quantifiable information and discrete data and analyses to support decisions.

LORP monitoring relies upon habitat mapping from remote imagery and reconnaissance surveys at the macro-scale to observe major habitat changes. Monitoring also relies on rapid assessments of the entire riverine-riparian system for early detection of problem areas or areas of interest. Specific habitat features for riparian vegetation, wetlands, fish and wildlife habitat, flow and water quality are measured at the micro-scale that are spatially representative of key ecosystem types (i.e., river, riparian, wetland, and upland habitats). An adequate number of sites are monitored so that data analysis identifies biologically significant changes.

Macro-scale monitoring can confirm whether changes measured at the micro-scale are indeed representative of the entire LORP area; conversely, trends measured at the macro-scale are correlated with and substantiated by micro-scale monitoring. Managers will thereby have a good picture of how the ecosystem is responding through time, and where and what interventions are most effective.

LORP monitoring will span 15 years. The primary monitoring years include years 2, 5, 7, 10, and 15 in which more intensive, micro-scale monitoring will be performed. Rapid Assessments will be performed every year for the first 10 years. In this manner, trends in the LORP are monitored each year for the first 10 years.

Specific and detailed monitoring methodologies, analysis and reporting protocols are set out in Section 4.0 of this plan. Additionally, Section 2.2 describes the baseline LORP data collection effort and relates the monitoring areas (both macro and micro) spatially for reference.

The following is a list of the different monitoring methods used to detect changes in each management area (See Section 3.7.1 for detailed list of monitoring):

1. RIVERINE-RIPARIAN HABITAT

Base Flows
- River Flow Measurements
- Water quality

Seasonal Habitat Flows
- River Flow Measurements
- Flooding extent
- Water quality

Habitat
- Rapid assessment surveys
- Riparian habitat development
- Vegetation mapping
- Site Scale Vegetation Assessment/Mapping
- Fish habitat surveys

2. BLACKROCK WATERFOWL HABITAT AREA
- Wetland compliance monitoring
- Wetland habitat development
- Vegetation mapping

3. DELTA HABITAT AREA
- Delta flow compliance
- Wetland habitat development
- Vegetation mapping
- Seasonal habitat flow and aerial surveys

4. OFF-RIVER LAKES AND PONDS
- Lakes/Ponds WSE

5. LAND USE
- Utilization
- Pasture Scoring
- Range Trend

1.9.1 Adaptive Management

Adaptive management uses monitoring data and information to evaluate whether MOU goals for the LORP are, or are not being met. If expectations are not being accomplished, adaptive management devises reasonable and feasible management changes to correct it. Adaptive management provides a process for continually improving management practices by learning from the outcomes of previously applied management practices. Instead of seeking precise predictions of what future conditions will be, adaptive management recognizes the uncertainties associated with forecasting what future conditions will be.[18]

Adaptive management allows for a range of possible outcomes or expectations. The adaptive management direction implemented for the LORP must be reasonable and feasible and within the constraints of the MOU. The effects of the recommended actions must also consider how the implementation will affect the other resources (i.e., grazing, recreation, habitat indicator species, riparian habitat, etc).

A specific and detailed narrative on adaptive management for the LORP is discussed in Section 3.0 of this plan.

1.10 Indicator Species

A goal of the LORP is to provide habitat conditions suitable for indicator species. Table 1.6 shows the habitat indicator species and their current status. While monitoring does not focus on enumerating populations of indicator species, habitat will be used to infer the suitability of the habitat for the indicator species.

In an effort to obtain accurate, cost-effective data, management of indicator species is frequently used as the basis for environmental assessment and monitoring programs.

Guild	Grassland	Wetland-Open Water	Successional-Scrub	Woodland
Species	Northern Harrier	Belted Kingfisher	Blue Grosbeak	Long-Eared Owl
	Swainson's Hawk	Great Blue Heron	Willow Flycatcher	Nuttal's Woodpecker
		Marsh Wren	Yellow-Breasted Chat	Red-Shouldered Hawk
		Sora	Yellow Warbler	Warbling Vireo
		Virginia Rail		Yellow-Breasted Chat
		Western Least Bittern		Tree Swallow
		Wood Duck		

Table 1.5. Breeding habitat guilds for avian indicator species.

However, habitat assessments and population monitoring that focus on all species in a given area is neither time nor cost effective. As a means to avoid these difficulties, Severinghaus (1981) and Verner (1984) proposed alternative approaches to monitoring using the guild indicator species concept.

A wildlife guild is a group of species that exploit the same class of environmental resources and respond to changes in their environment in similar ways.[19] The entire group of species is considered a guild unit, in contrast to a single member of the group, or guild indicator species. Guild units are grouped based on similarities in feeding and breeding strategies, habitat preferences, behavior, and species size.[20] Because all species in the guild are affected similarly by habitat changes, one guild member, or indicator species, can be used to assess the impacts on other members.

Using the needs of guild indicator species to guide LORP habitat assessments represents a compromise between a detailed approach that attempts to enumerate all local wildlife populations and one that optimizes time and financial resources for the greatest ecological benefit.

1.11 LORP Discussion

Ecosystem restoration is a relatively new and evolving field of scientific and practical knowledge that still lacks some basic information and understanding of subtle ecological functions and interactions. Consequently, ecosystem restoration must begin at scales where our knowledge base is better understood, and then we are able to set the pathways for natural forces to follow and organize around over time.

The LORP is a very complex project. Not only is the restoration and ecology of the project multifaceted, but the LORP legal agreements

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[18] Walters 1986

[19] Verner 1983

[20] Short and Burnham 1982, Neimi and Pfanmuller 1979, Severinghaus 1981, Crawford et al. 1981, Rice et al. 1984

that direct, and often dictate, the procedures to be followed for the future management of the LORP are limiting factors that define the boundaries of management and monitoring. This monitoring and adaptive management plan has grown directly from the constraints and opportunities afforded it by the legal agreements, and existing documents. To understand LORP monitoring and adaptive management it is essential to recognize the MOU, and other documents, directions and limitations.

Notwithstanding these constraints the LORP Monitoring and Adaptive Management and Reporting Plan strives to use the best available science, collection of the most pertinent data that describes evolving ecological conditions, and efficient use of manpower and budgets to effectively observe and manage the area resources into the future

Even though currently there is little hard scientific backing in the discipline of rebuilding and restoring whole ecosystems, what works and doesn’t work in different types of ecosystems is learned and relearned every time we rehabilitate nature’s processes. Subtle ecosystem interactions are better understood when we allow nature the time to respond to the reintroduction of natural resources.

Management of the Lower Owens River ecosystem will emphasize the “self-designing” or “self-organizing” capacity of nature to recruit species and to make choices from those species that have been introduced.

This Monitoring, Adaptive Management and Reporting Plan describes the methods used to collect baseline data and conduct future monitoring of environmental conditions in the LORP area. This document describes the management objectives and actions, scientific background, concepts and studies, baseline data, monitoring methods, data management, data analysis and reporting, quality control, and adaptive management methods for the LORP.

Common Name	**Scientific Name**	**Status**[21]
Fishes		
Large mouth bass	*Micropterus salmoides*	
Small mouth bass	*Micropterus dolomieu*	
Bluegill	*Lepomis macrochirus*	
Channel catfish	*Ictalurus punctatus*	
Owens sucker	*Catostomus fumeiventris*	CSC
Owens pupfish*	*Cyprinodon radiosus*	FE, SE
Owens tui chub*	*Gila bicolor snyderi*	FE, SE
Owens speckled dace*	*Rhinichthys osculus ssp.*	CSC
*The LORP Action Plan states, “Other species that will receive proper consideration are Owens pupfish, Owens tui chub, and Owens speckled dace” (MOU Attachment A).		
Birds		
Great blue heron	*Ardea herodias*	W
Western least bittern	*Ixobrychus exlilis hesperis*	C2, CSC
Swainson's hawk	*Buteo swainsoni*	ST
Northern harrier	*Circus cyaneus*	CSC
Red-shouldered hawk	*Buteo lineatus*	
Virginia rail	*Rallus limicola*	
Sora	*Porzana carolina*	
Marsh wren	*Cistothorus palustris*	
Wood duck	*Aix sponsa*	
Western yellow-billed cuckoo	*Coccyzus americanus occidentalis*	SE
Long-eared owl	*Asio otus*	CSC
Willow flycatcher	*Empidonax traillii*	SE, CSC
Yellow warbler	*Dendroica petechia brewsteri*	CSC
Yellow-breasted chat	*Icteria virens*	CSC
Blue grosbeak	*Guiraca caerulea*	
Warbling vireo	*Vireo gilvus*	
Belted kingfisher	*Ceryle alcyon*	
Nutall's woodpecker	*Picoides nuttallii*	
Tree swallow	*Tachycineta bicolor*	
Mammals		
Owens Valley vole	*Microtus californicus vallicola*	C2, CSC
Code	**Conservation Status**	
FE	Listed as Endangered by the U.S. Fish and Wildlife Service	
FT	Listed as Threatened by the U.S. Fish and Wildlife Service	
FSS	Listed as a Sensitive Species by the U.S. Fish and Wildlife Service	
C2	A Category 2 Candidate for listing by the U.S. Fish and Wildlife Service under the former Category 2 Classification System	
SE	Listed as Endangered by the State of California	
ST	Listed as Threatened by the State of California	
CSC	Listed as a Species of Special Concern by California Department of Fish and Game	
W	A watch species- A species that is biologically rare, restricted in distribution, declining throughout their range, or at a critical stage in their life cycle when residing in California	

Table 1.6. LORP indicator species

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[21] Ibid.

Section 2

Scientific Background and Baseline Monitoring

Lower Owens River Project

Monitoring, Adaptive Management and Reporting Plan

April 28, 2008

2.0 Introduction

To achieve success in the restoration of the Lower Owens River, there are three basic requirements: (1) to understand ecosystem function; (2) to give the system time; and (3) to appreciate self-design.

Ecosystem restoration is a relatively new and evolving field of scientific and practical knowledge that still lacks some basic information and understanding of subtle ecological functions and interactions. Consequently, ecosystem restoration must begin at scales where our knowledge base is better understood, and then we are able to set the pathways for natural forces to follow and organize around over time.

Even though currently there is little hard scientific backing in the discipline of rebuilding and restoring whole ecosystems, what works and doesn't work in different types of ecosystems is learned and relearned every time we rehabilitate nature's processes. Subtle ecosystem interactions are better understood when we allow nature the time to respond to the reintroduction of natural resources. Through careful monitoring of the effects of macro-scale interventions, we can then adaptively manage with confidence and use more subtle interventions at micro-scales to influence the direction of restoration efforts toward a functional and sustainable ecosystem.

Management of the Lower Owens River ecosystem will emphasize the "self-designing" or "self-organizing" capacity of nature to recruit species and to make choices from those species that have been introduced. Self-design emphasizes the development of natural habitat. Scientific knowledge in the field of ecology verifies that natural forces do ultimately self-design around habitat by choosing the most appropriate species to fill niches and establish rates of recruitment, production and growth. Self-design allows the natural colonization of plant and animal species to attain balance and optimum biodiversity with minimal human manipulation of materials or processes. In other words, sustainable ecological restoration should not rely upon a human-built and artificially maintained ecosystem. We emphasize instead, to the greatest extent possible within the constraints of continued multiple uses, to give nature back what it needs to function and then take a hands-off approach that adapts management interventions to what nature is teaching us about what it needs to achieve a healthy balance.

The concept, or specifically the ability of the Lower Owens River to "self-design" or "self-organize," has been questioned due to the amount of disturbance and manipulation that has occurred and will continue to occur into the future. Biotic and abiotic components will adjust with adequate time, and then will be able to naturally self-design to the Lower Owens River macro-scale flow regime of 40/200 cfs. Unless natural conditions are continuously reset with excessive and proactive human interventions to attempt to *force* nature and the restoration process along an inappropriate path, nature can and will organize by way of natural ecological processes toward a functional condition.

Regulators and interested parties who are monitoring and measuring restoration success often make the mistake of not allowing adequate time for natural self-designing processes to develop before passing judgment. Legal, political and economic human priorities too often demand unnatural and mechanistic interventions for "quick-fixes" that usually do not allow the time necessary for nature to find balance, and actually can often be undermining or even destructive to ecological restoration efforts. Because of the stochastic nature of hydrologic events, and the naturally slow and progressive development of ecosystems, sometimes in spurts and sometimes in the slow process of recruitment and growth, a five year horizon is arbitrary and probably too short a time period. Ecological models show that the further initial conditions are from a steady state, the more time is required for that system to reach, or even approach, steady state. The Lower Owens River ecosystem is currently very far from a balanced steady state; regulators should assume a time horizon of 15 to 20 years before evaluations are made about restoration success.

From one of the earliest river restoration projects on the Colorado River, Anderson and Ohmart[1] cautioned against using findings from a 2-year study to make predictions about growth and mortality of vegetation after 4 to 10 years. They stated that results should be considered preliminary until the site is at least 15 to 20 years old. Two years is not enough time from which to draw any conclusions beyond that time or beyond the range of variables studied. There is no reason to expect the LORP to exceed these time frames; however, it is advisable that at the end of the 15-year monitoring and adaptive management period, managers should review ecosystem development and attainment of MOU objectives to decide if additional time is warranted or whether further monitoring is needed. [2]

Short term and long-term management plans for the LORP are not written in stone. LORP management plans are written in a flexible manner so as to be altered and revised when necessary through adaptive management decisions and interventions. Management plans must be amenable to change and the documents must not become an impediment to frequent revisions. Management plans must be developed and presented in such a way that strategies can be implemented quickly to respond to changes in the evolving ecosystem.

2.0.1 Section Summary

Scientific Plans, Documents and Studies discussed in this section include:

- *Action Plan*. Ecosystem Sciences, 1996. *Lower Owens River Project Ecosystem Management Plan, Action Plan and Concept Document*.
- *Watershed Management Concepts.* Ecosystem Sciences, 1993.
- *Study Plan, Identification of River Flow Requirements for Fish, Wildlife, and Riverine-Riparian Habitats in the Lower Owens River, California.* Ecosystem Sciences, 1993.
- *Lower Owens River Project Data Base for the Determination of Stream Flows for Fish and Wildlife*. Ecosystem Sciences, 1994.
- *LORP Scientific Technical Memorandums (Selected) #1-#20.* Ecosystem Sciences.
- *Predicted future vegetation types: lower Owens River (40/200 cfs scenario).* Ecosystem Sciences. 1997
- *LORP Ecosystem Management Plan.* Ecosystem Sciences, 2002.
- *LORP Riparian Inventories and Mapping for the Riverine-Riparian, BWMA, and DHA.* Ecosystem Sciences and Whitehorse Associates.
- *LORP Final EIR.* LADWP, et. al. 2004.
- *LORP Riparian/Wetland Delineation, Hydrogeomorphic Modeling Assessment and Predictions.* Whitehorse Assocaiates, 2004.

See figure 2.9 for a list and chronological timeline of these documents and studies.

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[1] Anderson, B.W., and R.D. Omart. 1982.

[2] Anderson, B.W., and R.D. Omart. 1982.

2.1 LORP Physical Environmental Features

The LORP is located in the southern portion of the Owens Valley in eastern California. The LORP area begins at the Los Angeles Aqueduct Intake and follows the course of the Owens River south terminating at Owens Lake (Figure 2.1). The LORP planning area encompasses 77,657 acres of riverine, riparian, wetland, and upland habitats.

Four geographic areas identified in the MOU constitute the LORP:

1. Riverine-Riparian Area,
2. Blackrock Waterfowl Management Area (BWMA),
3. Delta Habitat Area (DHA), and
4. Off-River Lakes and Ponds.

In addition to these four areas, the area within the LORP planning boundary, but outside these management areas is termed and managed as Land Use and Upland Areas for grazing lease management.

Each area is managed and monitored differently. The Riverine-Riparian Area will be managed to restore the river system to a functional state and will be subject to baseflow and seasonal habitat flows. The BWMA is a constructed wetland, which is managed to promote wetland vegetation through scheduled flooding and subsequent dry years. The Off-River Lakes and Ponds are managed to keep an agreed upon water surface (wse) elevation that promotes open water habitat, which is a limited habitat type in the Owens Valley. The Delta Habitat Area is managed to preserve and enhance the unique Owens River Delta, where the Owens River once flowed into Owens Lake. Uplands are managed for grazing and livestock use. The following are descriptions of each geographic area.

2.1.1 Riverine-Riparian Area

The LORP Riverine-Riparian Area follows the Owens River from the Los Angeles Aqueduct Intake in the north to the DHA on the Owens Lake bed to the south. The LORP riparian area is 6,437 acres and includes 53.3 linear miles of the Owens River channel. The LORP Riverine-Riparian Area is displayed in three maps: Figures 2.2, 2.3, and 2.4.

The east and west boundaries of the LORP Riverine-Riparian Area generally correspond to transitions of stream terraces along the Owens River, where wetland/riparian habitat is present to higher terraces with upland habitat.

2.1.2 Blackrock Waterfowl Management Area

The Blackrock Waterfowl Management Area (BWMA) is located south of the Los Angeles Aqueduct Intake and lies between the aqueduct and the Lower Owens River riparian corridor (Figures 2.1 and 2.5). The BWMA encompasses 1,987 acres, of which the majority is constructed wetland that is sustained by managed water releases from the aqueduct and Blackrock Ditch. The southern boundary of the area is south of Mazourka Canyon Road, near Independence, California, where drainage through the BWMA and the 1872 fault line intersect the Owens River riparian corridor. The BWMA is divided into four management units: Drew, Waggoner, Winerton, and Thibaut.

The BWMA has been used for water spreading for over 40 years.[3] When runoff exceeds the capacity of the Los Angeles Aqueduct, it is spread over dry playas and basins in the BWMA. Dikes, levees, ditches, culverts and basins have been constructed to facilitate the

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[3] LADWP et al. 2002

spreading and diffusion of excess runoff. Continuous dikes and levees generally correspond with roads; scattered, isolated dikes divide shallow basins. Historically there were some natural wetlands in the Blackrock Area. These wetlands were probably associated seeps and springs located in old lava flows and along the 1872 fault.

The management goal of the BWHA is to maintain the existing waterfowl habitat area to provide the opportunity for the establishment of resident and migratory waterfowl populations as described in the FEIR and to provide habitat for other native species. Diverse natural habitats will be created and maintained through flow and land management, to the extent feasible.[4]

2.1.3 Delta Habitat Area

The Delta Habitat Area (DHA) is in the mouth of the Lower Owens River on the Owens Lake bed and includes the area between the Dust Control Project on the Owens Lake bed and pipeline corridors of the Dust Control Project, and north of the brine pool.[5] The north boundary of the DHA is just south of the pumpback station. The elevated corridors and dikes along the perimeters of the Dust Control Project zones confine the north, east, and west boundaries of the DHA (Figure 2.6). The southern boundary corresponds with a subtle transition from vegetated wetland confined by shallow dunes and playa to the broadly depressed, unconfined brine pool. The DHA is 3,578 acres.

In contrast to many of the Owens Lake wetlands, the Owens River Delta wetlands are not isolated islands on the expansive playa.[6] Delta wetlands are physically and functionally connected to the Lower Owens River.

2.1.4 Off-River Lakes and Ponds

The Off-River Lakes and Ponds are a series of small lakes and ponds (Figure 2.7) situated along the 1872 earthquake fault. These lakes and ponds include Upper and Lower Twin Lakes, the Coyote/Grass Lakes complex, Upper and Lower Goose Lakes and Billy Lakes.[7] The Off-River Lakes and Ponds are contained within the BWMA, but are subject to different management prescriptions.

2.1.5 Land Use and Upland Areas

Rangelands, grazing allotments or leases in the LORP are managed primarily for cattle grazing (Figure 2.8 and the lease maps shown in Appendix A.4). Rangelands are limited to LADWP lands within the LORP, stretching from the Los Angeles Aqueduct Intake south to Owens Dry Lake, and all lands east of the LA Aqueduct to the Inyo-White Mountains.[8] The total area governed by land use plans is approximately 79,000 acres. The driest (xeric) leased lands are in higher elevation terraces and uplands east and just west of the river. Mesic lands are commonly closest to the aqueduct and near internal ditches and active springs, such as Reinhackle.

The overarching LORP management objective, to develop a healthy, functioning Owens River riparian ecosystem, will be met while still ensuring that lessees are able to sustain ranching operations in a multiple use plan. Therefore, monitoring of rangelands will focus on the grazing strategies outlined in each lessee's grazing management plan.

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[4] Ecosystem Sciences 1998

[5] White Horse Associates 2004b

[6] Great Basin Unified Air Pollution Control District (GBUAPCD) 1998

[7] Ecosystem Sciences 1998

[8] Ecosystem Sciences 2002

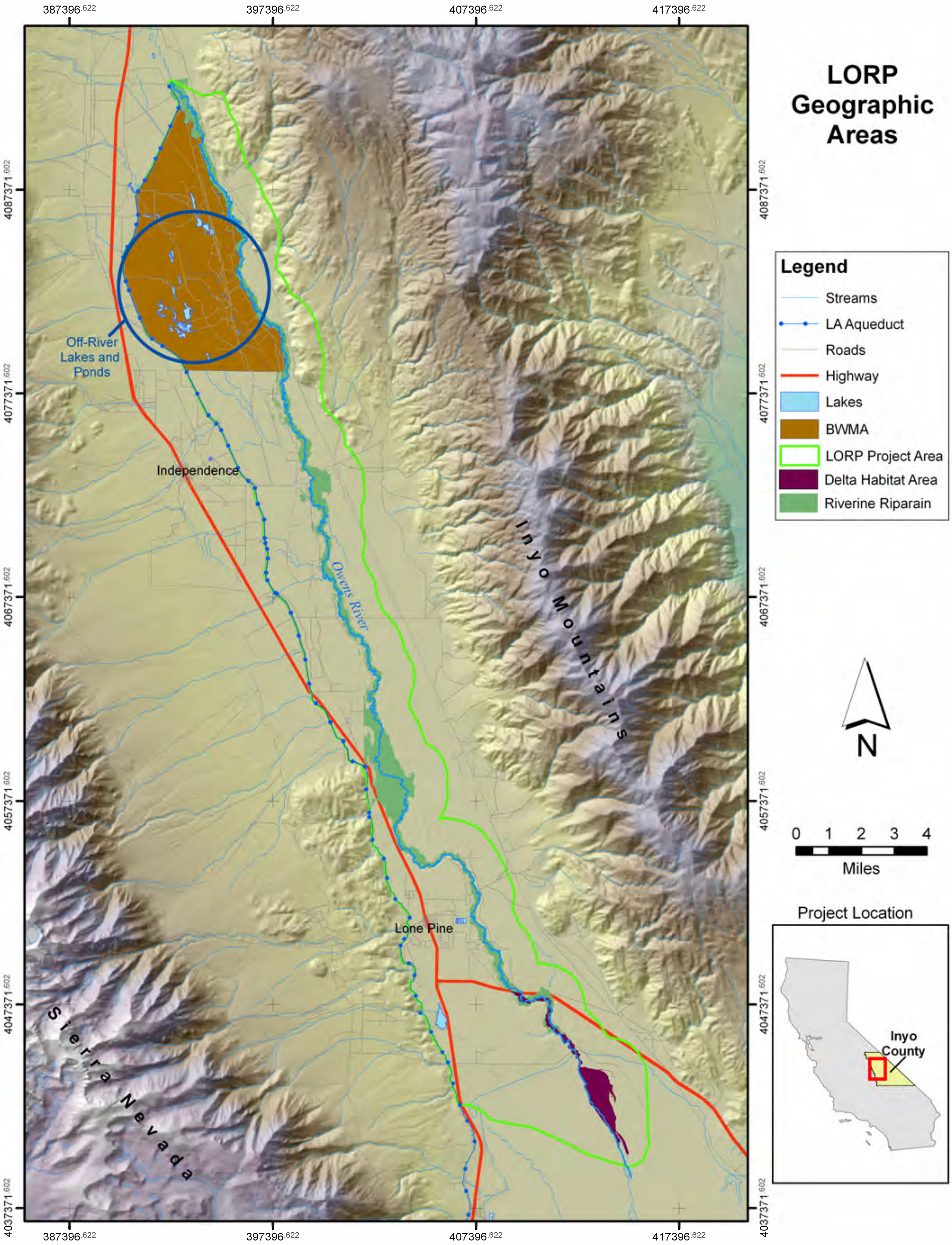

Figure 2.1. LORP Area Geography

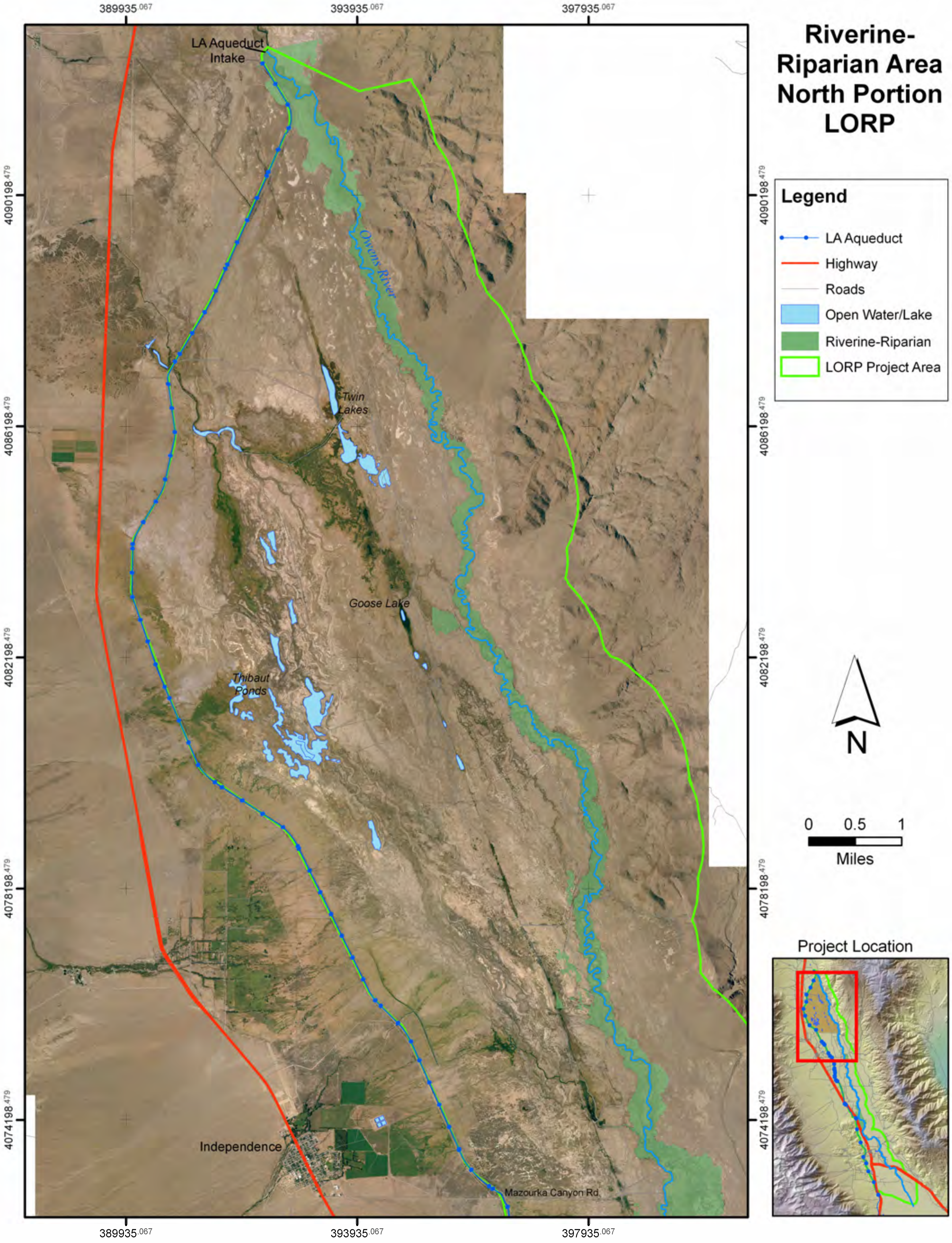

Figure 2.2. LORP Riverine-Riparian Area; North Portion

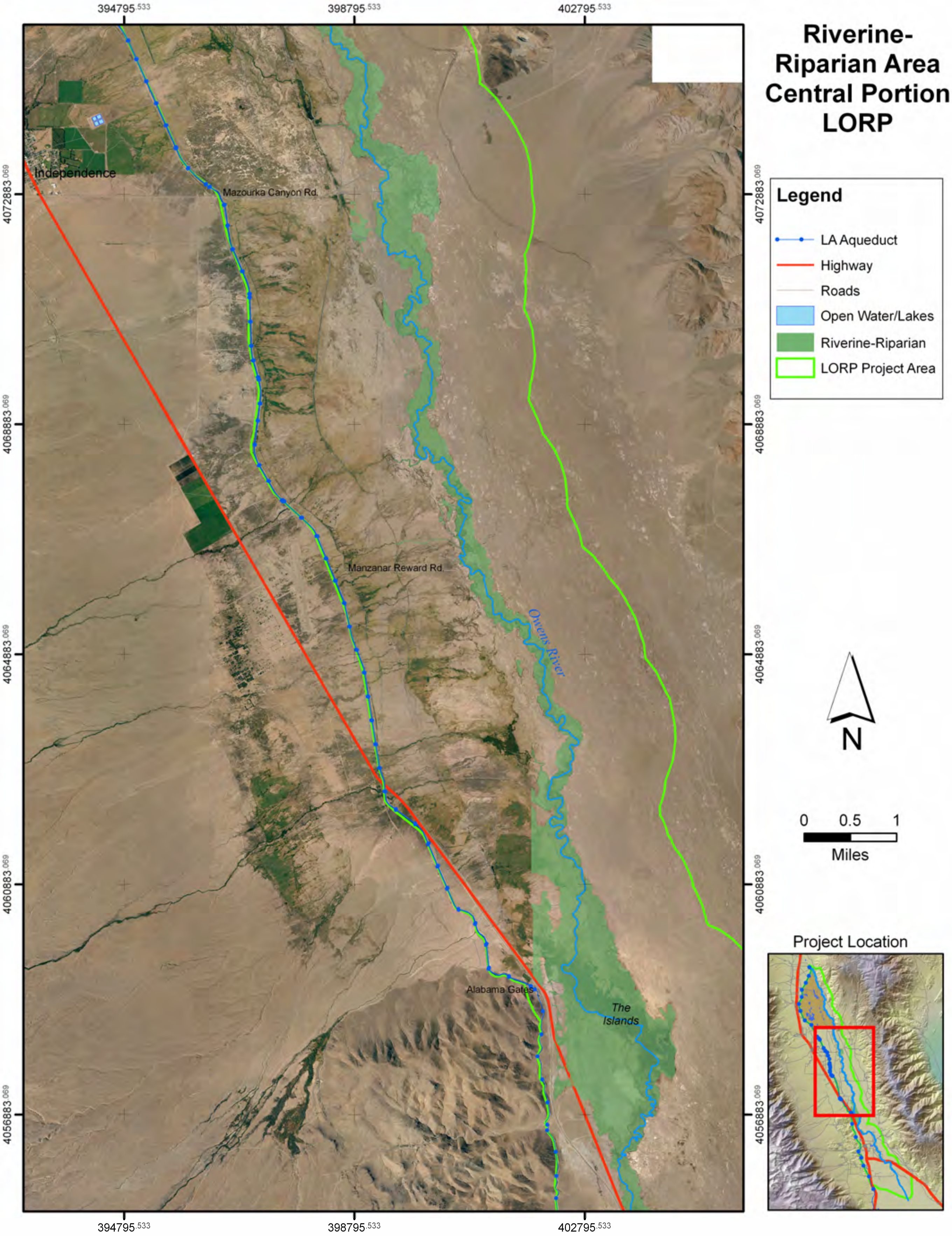

Figure 2.3. LORP Riverine-Riparian Area; Central Portion

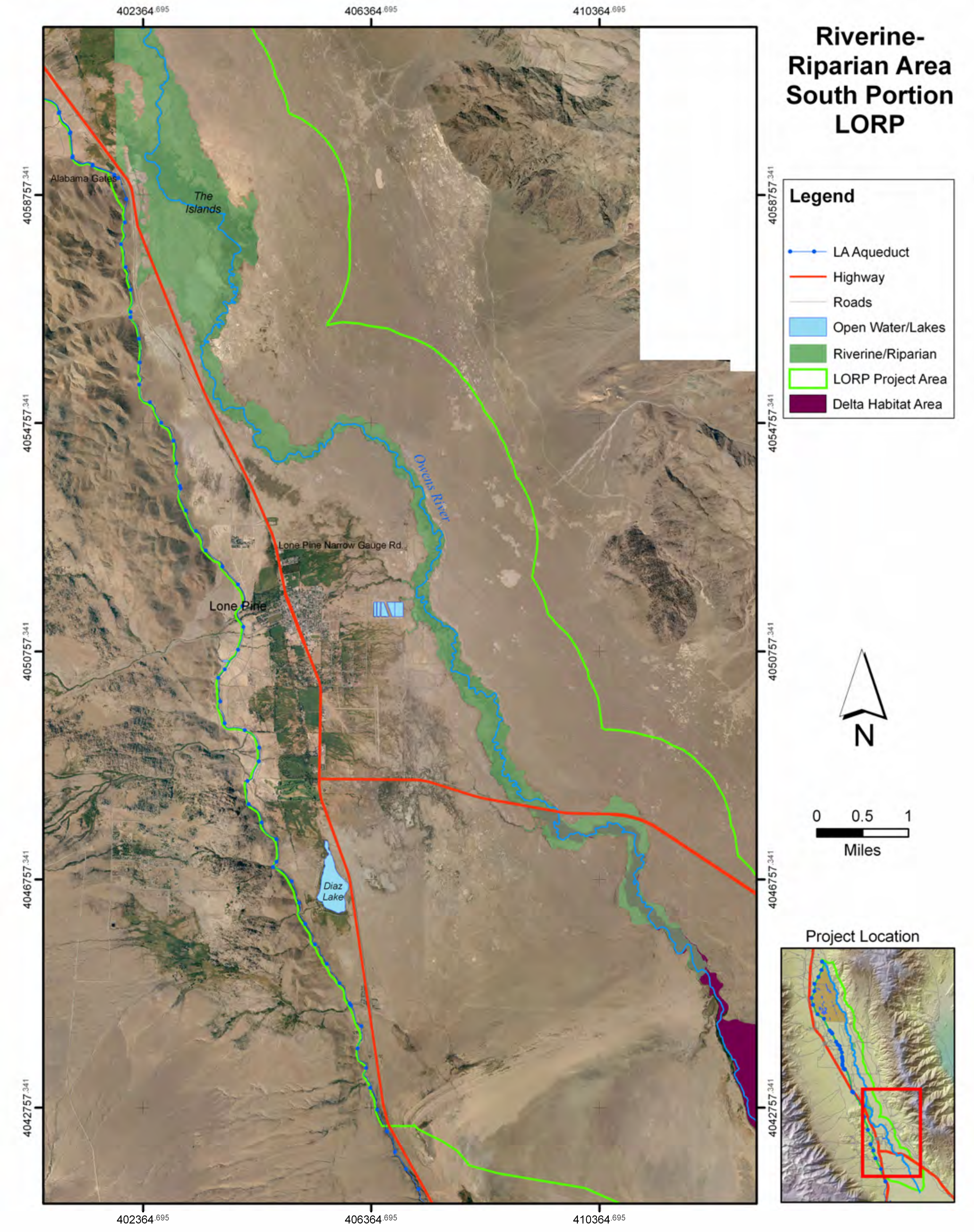

Figure 2.4. LORP Riverine-Riparian Area; South Portion

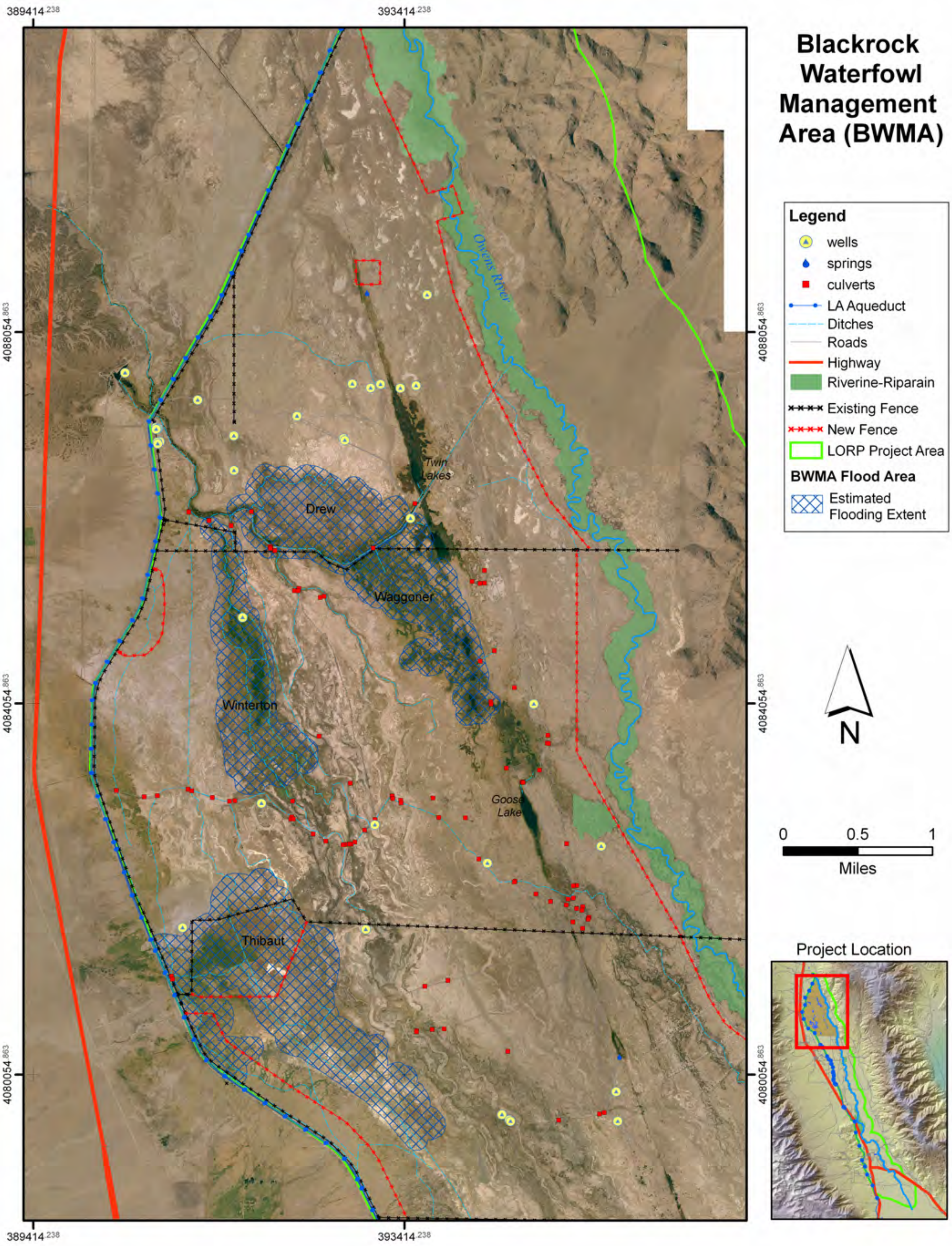

Figure 2.5. Blackrock Waterfowl Management Area

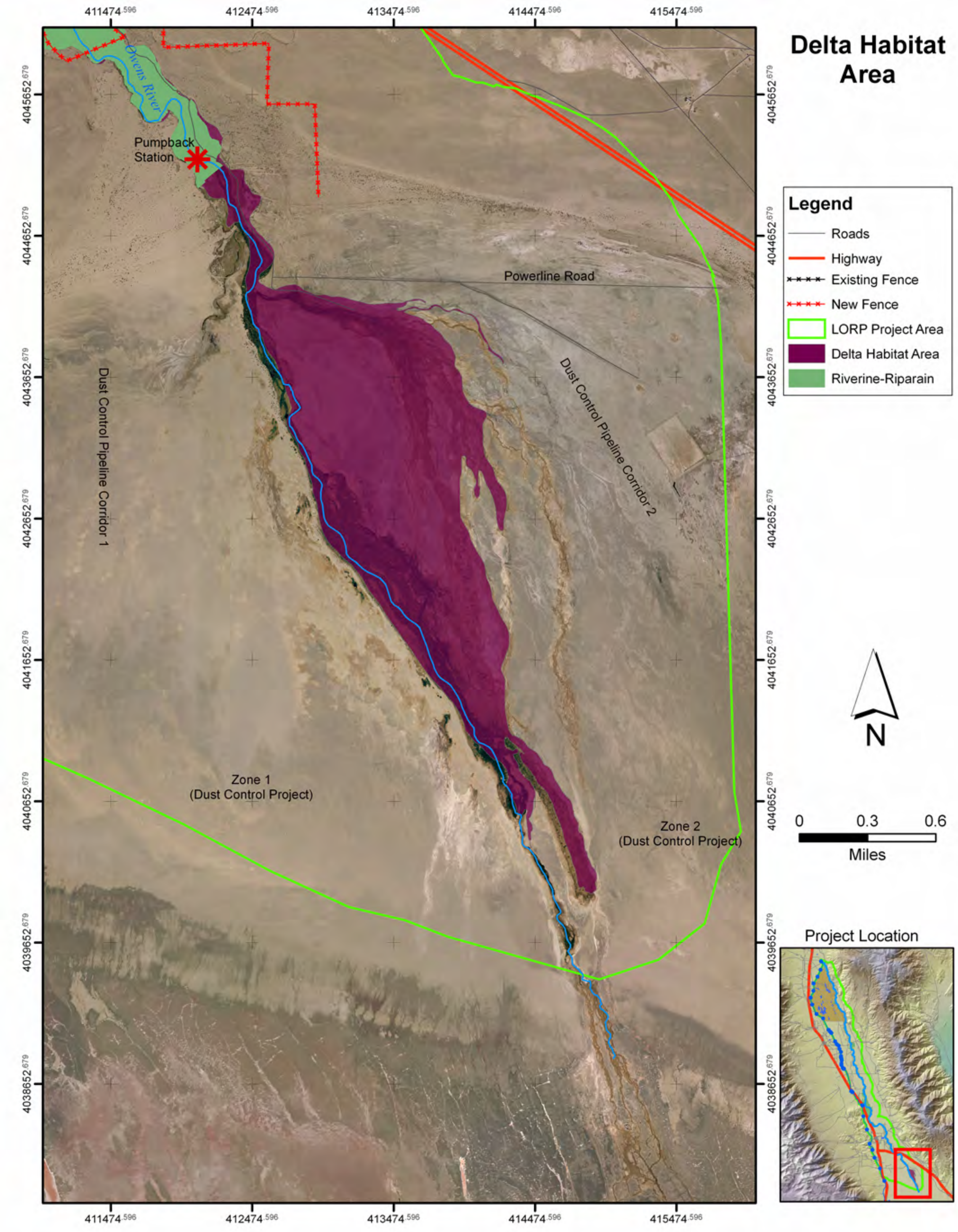

Figure 2.6. Delta Habitat Area

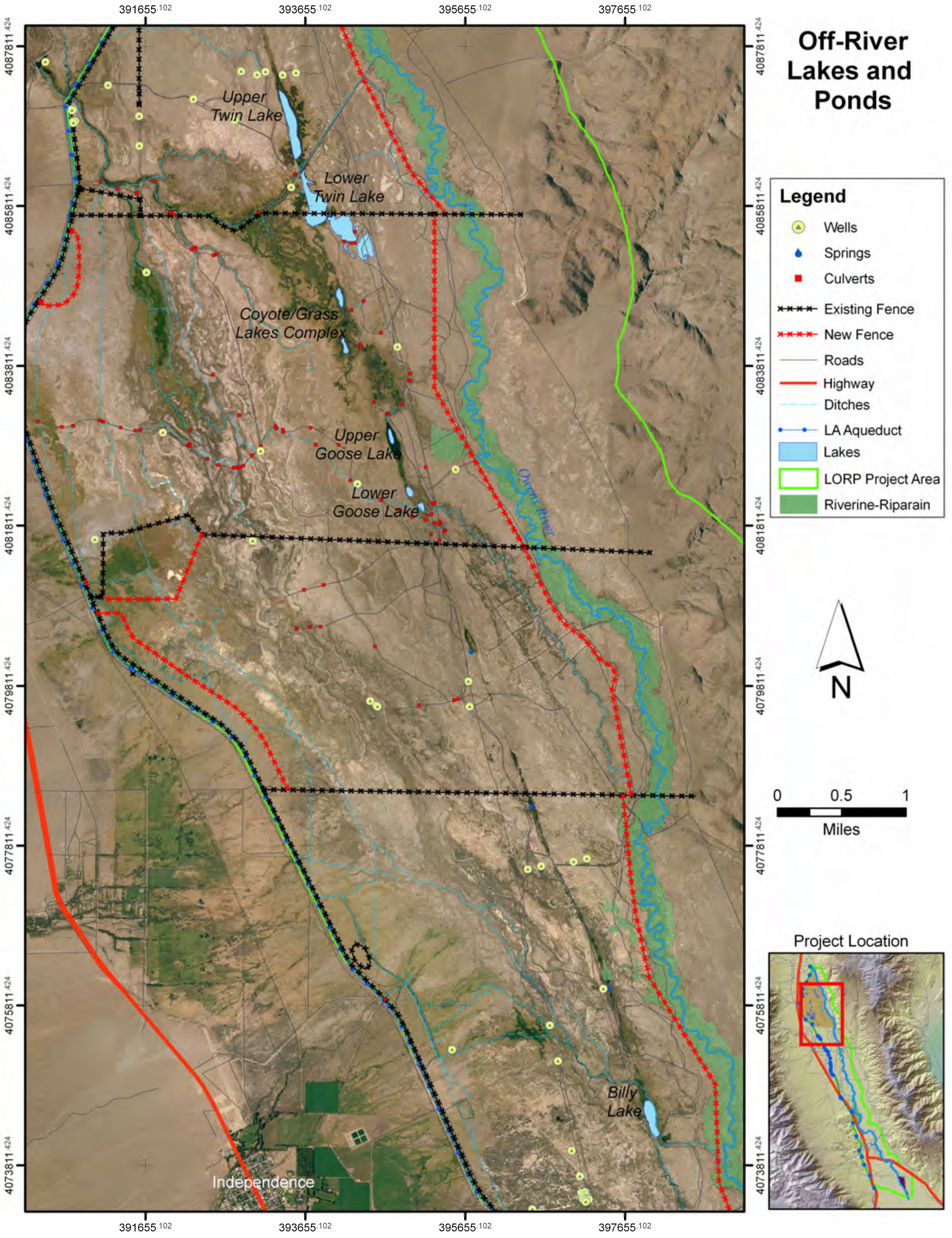

Figure 2.7. Off-River Lakes and Ponds

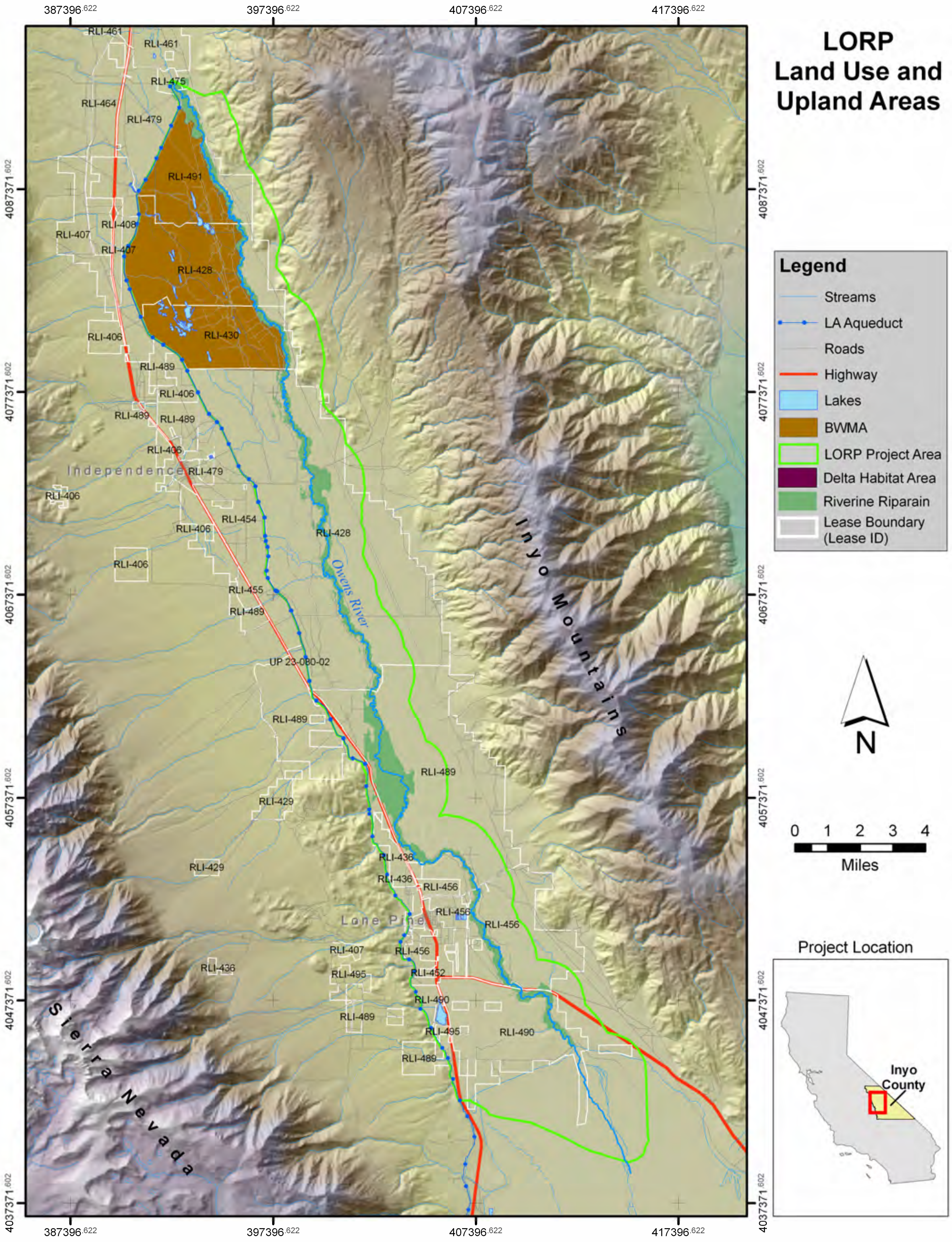

Figure 2.8. Land Use and Uplands; Leases

2.2 LORP Scientific Background

In 1993, under the direction and design of Ecosystem Sciences, the Los Angeles Department of Water and Power and Inyo County, in cooperation with the California Department of Fish and Game implemented a detailed ecological study of the Lower Owens River from the LA Aqueduct Intake to Owens Lake - approximately 60 miles of river channel and wetland habitat (see Figure 1.2).

The original purpose of the study was to develop an EIR and mitigation plan for the LORP, which included establishing minimum streamflows for fish and wildlife values. The primary focus of the original LORP was on developing a healthy warm water fishery and on improving wetland habitat.

The study, which was conducted in two phases, consisted of extensive data collection (Phase I) and controlled-flow modeling (HEC-2, HEC-6, HEP, PHABSIM, QUAL2E), resource mapping, GIS database development, and associated biological (fish, wildlife, vegetation) and hydrological studies (Phase II). The protocol for Phase I of the study and the executive summary for Phase II of the study are summarized in this section and are detailed in the 1997 MOU (as attachments to the MOU Appendices). The results of these studies set the stage for decisions on rewatering the Lower Owens River to achieve fish and wildlife goals and served as the basis for the MOU, the Ecosystem Management Plan, the LORP FEIR and other project documents.

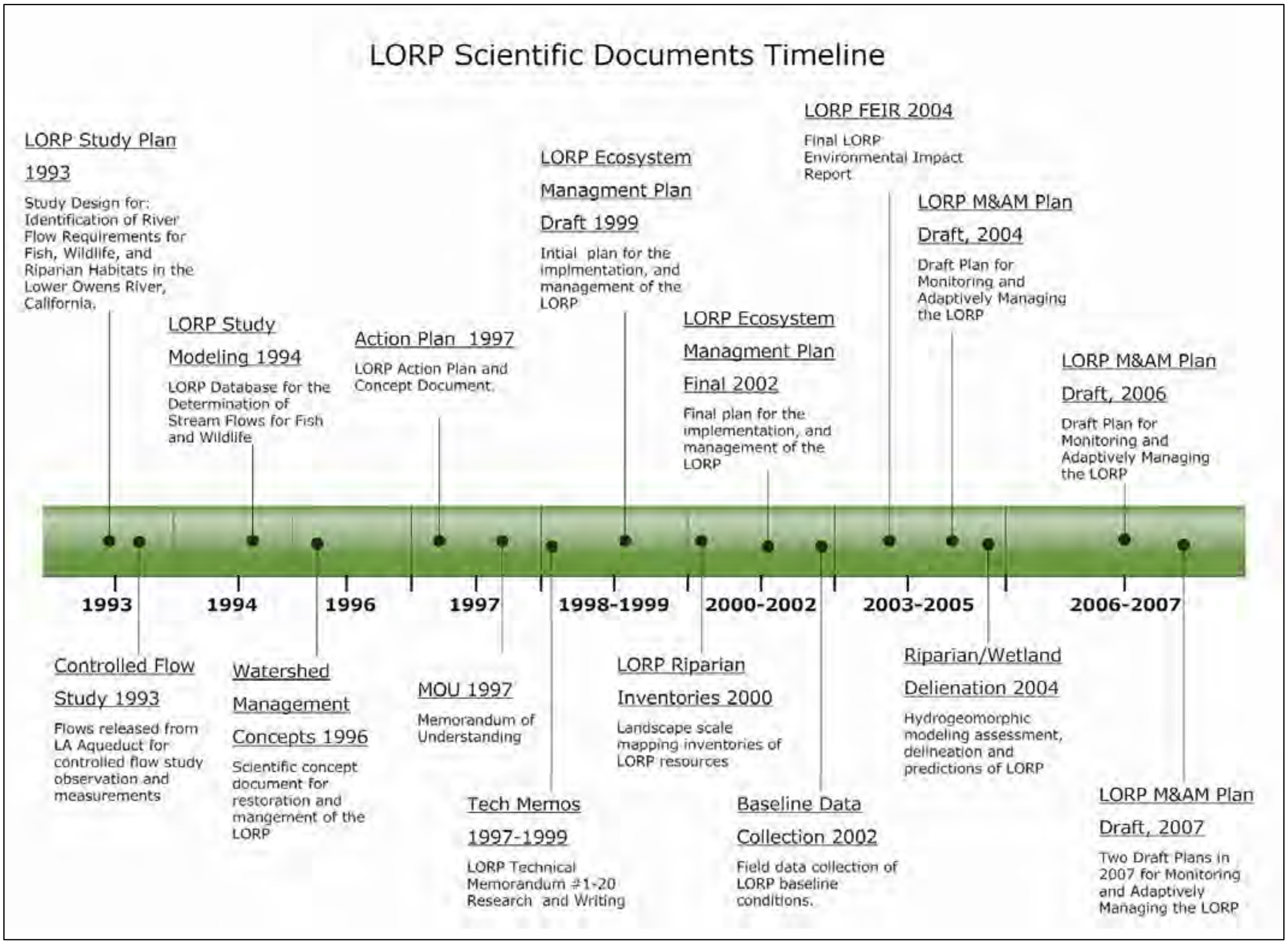

Figure 2.9. LORP Scientific Studies and Document Timeline.

One outcome of these initial studies was the recognition that the goal of simply achieving a healthy fishery and improving wetland habitat was too narrow. The studies showed that a unique opportunity existed to reestablish a functioning riverine ecosystem throughout the Lower Owens River. This length of river and associated wetland areas throughout the Lower Owens Valley could provide substantial ecological benefits and sustainable development to all users (recreation, livestock, agriculture, diversion) if a holistic approach was taken.

It was apparent that the benefit of establishing a holistic ecosystem management program on the Lower Owens River represented a wise investment of time, money, and energy. In the Lower Owens River watershed, streamflow can be matched to groundwater and riparian habitat development, which can be connected to wetland habitats, threatened and endangered habitat conservation areas can be consolidated, biodiversity can be enhanced and recreational fish and wildlife values can be created that are unavailable anywhere else in the Owens Valley.

The scope and goals of the LORP were therefore expanded to include sustainable development through a large-scale ecosystem management program that incorporates a variety of resource values and reestablishes the riverine-riparian ecosystem for the benefit of biodiversity, threatened and endangered species, recreational opportunities, and user groups. The Memorandum of Understanding (MOU), which is largely based on these studies, scientific hypothesis and ecological understanding, sets forth the goals and commitments for the implementation and management of the LORP.

2.2.1 Project Intent and Purpose[9]

The goal of the LORP is to establish a functioning ecosystem (i.e., an ecologically healthy watershed). The heart of an ecologically healthy watershed is the riparian habitat[10] (see Section 2.2.2, Watershed Management Concepts). The riparian habitat is shaped by channel geomorphology, hydrologic pattern, spatial position of the channel in the drainage network, and the inherent disturbance regimes. Yet the riparian habitat affects, and is affected by, habitat dynamics, water quality, and the animal community. This strongly suggests that maintenance of riparian habitat in a healthy ecological condition is of fundamental importance for long-term ecological and socioeconomic vitality of the Lower Owens River watershed.

The available evidence suggests that ecologically healthy watersheds are maintained by an active natural disturbance regime operating over a range of spatial and temporal scales.[11] Ecologically healthy watersheds are dependent upon the nature of the disturbance (e.g., fire, landslides, channel migration) and the ability of the system to adjust to constantly changing conditions. This natural disturbance regime imparts considerable spatial heterogeneity and temporal variation to the physical components of the system. In turn, this is reflected in the life history strategies, productivity, and biodiversity of the biotic community.[12]

The natural disturbance regime in the Lower Owens River consists of multiple streamflows emulating natural water-year events (wet, moderate, dry years). This natural disturbance regime will produce a dynamic equilibrium for riparian habitat, water storage, water quality, animal migration, and biodiversity resulting in resilient and productive ecological systems. The net result is an ecological system at the watershed scale which possesses a biotic

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[9] MOU 1997, Attachment A: Action Plan. Lower Owens River Project Ecosystem Management Plan Action Plan and Concept Document

[10] Decamps and Naiman 1989, Naiman and Decamps 1990

[11] Naiman et al. 1992

[12] Naiman et al. 1992

integrity strongly valued for its long-term social, economic, and ecological characteristics.

Achieving the goal of an ecologically healthy Lower Owens River watershed is dependent upon rewatering the channel from the intake to the pumpback station with a multiple flow regime with a base flow of approximately 40 cfs and variable habitat flows of up to 200 cfs, as specified in the MOU, which will flood riparian areas. Groundwater (streambank storage and hyporheic zones under the floodplain) is an essential element in establishing an ecologically healthy watershed. Maintenance of the interaction of surface-groundwater for the benefit of the biotic community is particularly important in the development and maintenance of the wetlands associated with the LORP (Blackrock, Twin Lakes, Goose Lake, the Delta, etc.) within the watershed.

Development of a habitat conservation plan for indigenous threatened and endangered species (fish, wildlife, and plants) is another feature of the project planning process. (The definition of "threatened and endangered species" contained in the MOU shall also apply in this plan.) To the extent feasible, such a plan will include all such indigenous species and will consolidate and/or provide linkages and corridors between critical habitats in the Planning Area to reduce gaps and habitat discontinuity. The Owens Valley Habitat Conservation Plan is currently in development.

Inherent in the overall management of the watershed will be the promotion of biodiversity and sustainable uses. Inclusion of non-native species will provide fishing opportunities. Diverse recreational activities such as hiking, bird watching, boating, swimming, and hunting will be anticipated. To the extent feasible, land management plans will consider these and other recreational uses, as well as livestock grazing and irrigation strategies.

2.2.2 Watershed Management Concepts[13]

In the United States, the term *watershed* is often misused in the context of river basin research and management. By proper definition the watershed is the ridgeline, or elevation contour, that delimits drainage basins or catchments. The catchment is bounded by the watershed, and since water flows downstream from the watershed through the catchment, we use the watershed as the natural ecosystem boundary.

Obviously, in these terms, an ecosystem may be very small (such as a first-order catchment)[14], or it may be very large, encompassing entire river systems (e.g., the 671,000 km² catchment of the Columbia River). Choice of ecosystem dimension (i.e., catchment size) is logically determined by the question being examined or the resource being managed. In the case of the Lower Owens River the boundary is from the LA Intake to the Owens Lake because the stream flow is managed at the intake and the lake is the terminus of stream flow. The east-west boundaries of this watershed are determined by the Eastern Sierra Nevada and the White-Inyo Mountain ranges.

The time encompassing the research question or management problem is, of course, also important. In geologic time, as a result of orogeny and erosion, watersheds were bisected and catchments via transwatershed diversions of rivers in many areas[15], allowed differently adapted organisms to commingle[16] or greatly accelerated immigration of non-native biota introduced by other means.[17]

2.2.2.1 Ecosystem Complexity

Given that catchments may be referred to as ecosystems, and that the ecosystem is dynamic in time and space as well as in its relation to

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[13] MOU 1997. Action Plan. Appendix 3, Watershed Management Concepts
[14] Strahler 1957
[15] Stanford and Ward 1979, Davies and Walker 1986
[16] Guiver 1976
[17] Stanford and Ward 1986, Mooney and Drake 1986

environmental problem solving, it is fundamentally important to recognize the major structural features and dimensions of river ecosystems. Ecologists have appreciated for many years the importance of microhabitats encompassed by the run-riffle-pool sequence as influencing the distribution and abundance of biota within the river channel. Zonation of the biota within the longitudinal continuum has long been recognized as a fundamental feature of the lotic environment[18], although explanations of specific distribution patterns often remain contentious.[19]

Over the last few decades, the connection between riparian zones, including the surficial floodplain dynamics, and ecological structure and function have been clearly demonstrated.[20] The importance of microbial transformation and transport of solutes in groundwaters has been shown in relation to plant growth nutrients for channel biotopes in streams[21]; and penetration of groundwaters (i.e., hyporheic zone) by amphibiotic stream biota has been documented.[22] But the presence of large-scale hyporheic zones, and the critical importance of groundwater – surface water interchange as a major landscape feature of catchments, have only recently been demonstrated.[23]

These observations emphasize that the riverine ecosystem is truly four dimensional, with longitudinal (upstream-downstream), lateral (floodplain-uplands), and vertical (hyporheic-preatic) dimensions; since these spatial dimensions are transient or dynamic over time as a consequence of relativity, temporality is the fourth dimension.[24] Within a given stream reach distribution and abundance of organisms form a multivariate function of the structural and functional attributes of channel (fluvial), riparian (floodplain, shoreline), and hypohreic (groundwater) habitats as they interact within time and space with the geomorphology and hydrology of the catchment.

Clearly catchments may be characterized as patch-dynamic systems[25], and ecological connectivity of patches is a fundamental feature.

2.2.2.2 Ecological Benefits Provided by Riparian Environments

Riparian portions of watersheds provide numerous ecological links between uplands and the aquatic ecosystem.[26] Riparian vegetation controls much of the environmental regime of stream ecosystems; this is less true of larger streams and rivers which greatly influence the nature of the riparian vegetation. Quantity and seasonal timing of light levels are most often determined by type and amount of streamside vegetation along small and medium-size (up to fourth-order) streams. Light levels are critical to a variety of ecological processes as diverse as primary productivity (which is light-limited in heavily shaded streams)[27], and feeding by fish.[28] Stream temperature is also strongly influenced by riparian vegetation; shading to maintain stream temperatures below lethal levels for fish was an early justification for preserving forest corridors and remains an important factor in warmer environments.[29]

Riparian zones are the source of extremely important structural components of the aquatic ecosystem. Woody debris is often the dominant element in the physical structure of streams.[30] Specifically providing coarse woody debris for the stream channels is a particularly critical role of the riparian forest.[31] The structural complexity resulting from woody debris is important in determining such stream-reach characteristics as ability to retain allochthonous inputs, store sediments, and

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[18] Hynes 1970
[19] Alstad 1982, Thorp et al. 1986
[20] Descamps and Naiman 1989, Dodge 1989, Hill et al. 1990, Gregory et al. 1991
[21] Stanford and Ward 1988, Ford and Naiman 1989, Valett et al. 1991
[22] Stanford and Gaufin 1974, Williams and Hynes 1974, Danielopol 1984, Pugsley and Hynes 1986, Stanford and Ward 1988
[23] Stanford and Ward 1988, Danielopol 1989
[24] Ward 1989, Hill et al. 1990
[25] Pringle et al. 1988, Townsend 1989
[26] Gregory et al. 1991, Agee 1988, Heede 1985, Naiman 1990, Naiman et al. 1988, 1989; Platts 1988
[27] Gregory et al. 1991
[28] Wilzbach et al. 1986, Cummins 1974
[29] Hunt 1988, Agee 1988
[30] Bisson et al. 1987
[31] Maser et al. 1988, Swanson et al. 1976, 1984; Harmon et al. 1986

detain water.[32] Large woody debris can be directly responsible for the creation of stepped stream profiles and a variety of habitats, such as debris jams and sediment accumulations (sand or gravel bars); wood and wood-related materials may account for 50 percent or more of habitats in small densely forested stream reaches.[33] These materials are important invertebrate resources.[34] Furthermore, large woody debris can strongly influence habitat diversity in large streams and small rivers through its effect on their hydraulic characteristics.[35]

Riparian vegetation provides important nutritional substrate for aquatic ecosystems.[36] The allochthonous inputs that dominate small streams are the main source of energy, and an important source of nutrients for the aquatic ecosystem. Research is making us increasingly aware of the large variety of species and life-forms that are present, as well as the high degree of spatial heterogeneity in natural streamside and riparian vegetation.[37] One direct consequence of this richness is allochthonous inputs with higher levels of compositional and temporal diversity.[38] For example, herbaceous components of riparian vegetation typically senesce earlier in the season, contain higher nutritional content, and are more readily processed by the aquatic community than inputs from deciduous trees and shrubs which, in turn, are of higher quality and are more readily processed than needles and litter from coniferous trees.[39] Therefore, streamside zones that have a diversity of herbaceous, shrub and tree communities generate more diverse allochthonous inputs quantitatively and temporally than those dominated by a single vegetation type.

Streamside zones also provide important and specialized habitat for many elements of biological diversity, a function that is disproportionately high for the area they occupy. Many plant and animal species are known to have their primary habitat requirements met with riparian environments.[40] The existence of vascular plant species dependent upon the special moisture and temperature of the streamside zones is well known; some of these may be equally dependent upon the pattern of chronic disturbance associated with floodplain environments.[41] Many species of both vertebrate and invertebrates, divide their life cycles between riparian and upland habitats[42], and still others, including many species of bats, make essential daily use of both conditions.[43] In addition to direct use of riparian habitats, streamside corridors are hypothesized to be routes for the movement or migration of various animal species[44], although use has not been well documented.

Disturbance regimes in stream ecosystems are important in maintenance of both species and processes; furthermore, the roles of chronic events (e.g., annual flooding) and episodic ones (e.g., debris flows and high intensity floods) are quite different.[45] Episodic disturbances are most important in shaping the riparian zone and its vegetation. Substantial import, movement, and export of woody debris and sediments occur during major storm episodes. Shifts in channel morphology and woody debris are more limited with chronic flooding, although annual events do provide for the regular creation of freshly disturbed habitats for plant colonization. In any case, both chronic and episodic disturbances are important elements of riparian zones, and their unique roles need to be recognized in watershed management.

One conclusion based on existing ecological research is that the structurally and compositionally diverse streamside zones are well suited to produce the desired mixture of “ecological services” for the associated aquatic

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[32] Harmon et al. 1986, Sullivan et al. 1987, Bisson et al. 1987, Bilby 1981
[33] Franklin et al. 1981, Harmon et al. 1986, Gregory et al. 1991
[34] Anderson et al. 1978
[35] Bilby and Likens 1980
[36] Gregory et al. 1991, Triska et al. 1982
[37] Oliver and Hinckley 1987, Nilsson et al. 1989, Gregory et al. 1991
[38] Conners and Naiman 1984
[39] Gregory et al. 1991, Conners and Naiman 1984
[40] Raedeke 1988, Rochelle et al. 1988
[41] Conners and Naiman 1984
[42] Merritt and Cummins 1978
[43] West 1988, Cross 1988
[44] Raedeke 1988
[45] Gregory et al. 1991, Lamnberti et al. 1991

ecosystems (wetlands and uplands). It also appears that natural streams or reaches – those free of major human influences – are more likely to have high levels of complexity and result in more diverse, productive, and resilient ecosystems.

The expanding ecological knowledge of terrestrial and aquatic ecosystems, particularly in the West, is a major factor both in identifying problems with existing practices and in offering solutions. Therefore, a discussion of the scientific underpinnings of this "New Perspective"[46] is useful. Any proposed management practice, however, including most current approaches, must be considered a working hypothesis until its effectiveness is verified.

2.2.2.3 Reconnecting Ecosystems

Ecology as a science has evolved into an understanding of landscapes as interconnected patches that vary in scale from a single rock in a stream to whole catchments.[47] Research is focused on processes, time frames, and disturbances that control the transfer of materials and energy through catchment landscapes. Management in this context refers to actions that limit interference of human disturbances to the extent that catchment ecosystems are sustained in a natural quasi-equilibrium.

In many catchments, human disturbance has eliminated or severely compromised natural connectivity. Catchment management in the future may logically involve reconnecting patches into landscapes. One example might be reestablishing floodplain springs as functional patches (e.g., as important rearing areas for fish). This may involve removing revetments and allowing flood-pulse events to reconnect the channel and floodplain.

Threats to catchments usually manifest measurably in aquatic habitats as problems related to stream regulation, eutrophication, and other forms of water pollution, food web changes and accelerated sedimentation. These phenomena can be used as benchmarks that integrate the environmental health of the catchment if the data are gathered systematically over long periods. Analysis of trends in such data can reveal how leaky or unconnected the system may be, and provide clear insights where management actions can be effective in reconnecting the system. This effort can best be accomplished with insightful, integrated management.

2.2.3 LORP Scientific Hypothesis, Concepts and Studies[48]

In 1993, under the direction and design of Ecosystem Sciences a detailed ecological study of the Lower Owens River from the DWP's aqueduct intake to Owens Lake - approximately 65 miles of river channel and wetland habitat (see Figure 1.2) was conducted.

A continuous flow in the river channel from DWP's aqueduct intake to the Owens River delta was needed. An average annual flow of not less than 6 to 9 cfs (plus requisite flushing flows) will be released below the pumpback station to supply water to the delta habitat area.

The purpose of this study was to determine the flows to be implemented and maintained in the river channel from at or near the intake to the pumpback station and the water needed to supply off-river wetlands, lakes and ponds. Stream flows in the lower Owens River are intended to establish and maintain riverine-riparian habitats in order to sustain healthy populations of wildlife (mammals, shorebirds, and waterfowl) and warmwater fisheries (largemouth and small mouth bass).

The goal of the study was to develop a predictive model relating landform, fisheries, wildlife, wetland and riparian vegetation responses to different flow regimes and to

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[46] Naiman et al. 1992

[47] Gillis 1990

[48] MOU 1997. Action Plan. Appendix 1, Study Plan, Identification of River Flow Requirements for Fish, Wildlife, and Riverine-Riparian Habitats in the Lower Owens River, California

recommend streamflow patterns for the, approximately, 60 miles of river, off-river lakes and ponds (including the Blackrock waterfowl area, existing and new meadows and marshes), and warmwater fisheries and habitat.

Objectives of the study were to:

1. Predict the volume of fishery habitat that will be established and maintained by an incremental range of baseflows.
2. Predict flushing flows that will be needed to maintain stream channels and a productive fishery.
3. Predict the extent and type of riparian habitat that will evolve in response to an incremental range of baseflows.
4. Predict the amount of water needed to establish and/or maintain off-river aquatic/wetland developments planned for the lower Owens River area.
5. Predict the net increase in wildlife values resulting from an incremental range of baseflows and off-river aquatic/wetland developments.
6. Develop flow-based management plans for fisheries and wildlife; riparian, marsh, meadow, lake, and pond habitat; vegetation control, water quality; muck removal; and livestock grazing.

2.2.3.1 Concepts

Alteration of stream flow for power production, irrigation, flood control, water supply, and a host of other purposes adversely affects aquatic resources. The question of how much streamflow is required to protect aquatic resources has been examined from several positions over many years including fisheries, channel maintenance, and riparian zone positions. Instream flow requirements for fisheries have been extensively studied and numerous technical approaches have been advanced.[49] Instream flows to maintain channels and geomorphological processes have been investigated.[50] Other investigations have focused on out-of channel flows necessary for riparian vegetation and floodplain processes.[51] However, no models or approaches have been suggested that link the instream and out-of-stream flow requirements of all aquatic resource values rather than the simultaneous protection of multiple resources.

This study was to employ methods to evaluate both instream and out-of-stream flow requirements within a “holistic” streamflow management framework. A range of flows are needed to create and/or maintain healthy fisheries habitats, channel conditions, riparian habitats, and wildlife resources. Well-known streamflow approaches were combined into a unified methodology that recognizes flow requirements for fish, riparian habitat, floodplains, and channel morphology. Establishing streamflows only on the basis of fish needs may result in the degradation of stream channel, alteration of geomorphological processes, reduction or alteration of riparian vegetation, and cause changes in floodplain function.

The U.S. Fish and Wildlife Services’ Instream Flow Incremental Methodology (IFIM)[52] and the Physical Habitat Simulation Model (PHABSIM)[53] have many limitations as a habitat-based model of the instream flow needs of fish.[54] While it would be convenient for fish populations to be limited by three or four environmental factors, such situations are the exception rather than the rule. In the simplest example of limitations within IFIM, trout populations often fluctuate considerably and in a manner that is apparently independent of direct simultaneous environmental control.[55] Seldom do we measure variables that truly affect fish populations. Models that fail to account for the natural fluctuations in animal populations are destined to be only “coincidentally accurate”.[56] Broader thinking and more ecologically centered approaches are needed when managing streamflows. However, PHABSIM derived fish flows play a key role in overall flow evaluation.

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[49] Stalnaker and Arnette 1976, Wesche and Rechard 1980
[50] Rosgen et al. 1986, Beschta and Platts 1986, Reiser et al. 1989
[51] Franz and Bazzaz 1977, Harris et al. 1987, Junk et al. 1989, Stromberg and Patten 1991, Stromberg et al. 1991
[52] Bovee 1982
[53] Milhouse et al. 1984
[54] Annear and Condor 1984, Mathur et al. 1985, Orth 1987
[55] Platts and Nelson 1988
[56] Platts and Nelson 1988

Multiple flow regimes are needed to maintain biotic and abiotic resources within a river system. The four flow groups examined were: (1) flood flows that form floodplain features; (2) overbank flows that maintain surrounding riparian habitats, adjacent upland habitats, water tables and soil saturation zones; (3) in-channel flows that meet critical fish requirements. When natural flow patterns are altered, we must look beyond immediate fish needs to see how streamflows affect channels, transport sediments, and influence vegetation.

2.2.3.2 Stream Processes

Watersheds reflect the long-term influence of geology, climate, and topography as well as short-term influences of vegetation.[57] Flows resulting from climate conditions create and maintain stream forming processes. When natural flow patterns are changed, fluvial processes change, and condition of the valley, the stream, and all other ecological components must change as a consequence.[58]

To understand stream processes, one must first consider a watershed in four dimensions.[59] These are the longitudinal dimension from headwaters to mouth, the lateral dimension extending beyond the channel boundaries, and a vertical dimension resulting from out-of-channel flows moving downward into the soil and groundwater. Each of these dimensions must then be analyzed in a temporal dimension.

To determine which flow patterns are needed to maintain a stream system, one must match the respective valley bottom type, riparian type, floodplain and channel type, to the hydrologic processes that control form and function. Typically steep, high elevation streams flowing through V-shaped valleys lack floodplains or even riparian habitat. Other valley types create streams with riparian habitat but lack floodplains. The fluvial-geomorphic processes vary by valley type.[60]

An assemblage of geomorphic processes develop characteristic landforms as they construct the valley and its stream system.[61] Flowing water erodes, transports, and deposits sediment and controls vegetation species and growth in generally predictable ways.[62] Thus valley type can be determined through land classification, historical analysis, and hydrologic approaches.[63]

The temporal distribution of flow, interacting with geology, topography and vegetation, influences the form and condition of a stream system and valley. We can broadly describe watershed changes that occur when fluvial processes are altered by reducing natural flood flows: (1) valley floors no longer flood; (2) local water tables are no longer recharged; (3) stream bar and channel areas no longer become inundated and scoured; (4) sediment accretes on bars and channel edges and forms lower, narrower streambanks; (5) side channels and backwater areas become disconnected from the main channel or abandoned by the mainstream as they fill in; (6) tributary channel confluences with main stems locally aggrade and push out into the main channel; and (7) the ratio of pools to riffles is significantly altered.[64] These factors need to be considered in any analysis of flow alteration because biotic conditions such as riparian habitat or long-term fish community structure and fish populations may depend upon them.

Streams are generally going through an aging process. They are seldom at equilibrium because they adjust to a wide range of factors and processes within the watershed.[65] Once a stream approaches an equilibrium condition, the controlling factors may change. Such adjustments may occur daily, seasonally, or over long periods. Nevertheless, over time a channel and associated streamside vegetation will develop characteristics and features that balance the effects of a varied flow and sediment regime.[66]

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[57] Chorley et al. 1984
[58] Lotspeich 1980
[59] Ward and Stanford 1989
[60] Leopold et al. 1964
[61] Strahler 1957
[62] Morisawa 1968
[63] Lotspeich and Platts 1982
[64] Morisawa 1968, Platts 1979, Leopold and Emmett 1983
[65] Kellerhals and Church 1989
[66] Platts et al. 1985

Channel adjustments are a natural component of channel forming processes in all valley bottom types.[67] Hence, local channel dimensions and characteristics will change as a result of natural or altered flow regimes. For example, the removal of all peak flows will impair floodplain functions, which in turn alter streamside vegetation and channel conditions[68] that provide habitat for fish.

The morphology of streams, especially alluvial ones, is controlled by the interaction of flow regime with streamside vegetation and sediment input.[69] The magnitude and duration of the bankfull flows (and larger) are particularly important. Geology, climate, and resulting sediment supply (including quality and quantity) and size of channel bed materials, within the geomorphic setting, also provide for control.[70]

In sand-bed streams, bedload transport generally occurs over a wide range of flows.[71] However, in gravel-bed streams the channel materials are usually stable except during relatively high flows.[72] Therefore, if fine sediments that have become deposited between the gravels are to be removed by flowing water, sufficiently high flows must periodically occur to cause local scour and transport of bed materials.[73] Natural high flow events normally provide the necessary level of stream bed mobilization to flush fine sediments from the bed and the gravel and rubble.[74]

Regulated flows that occur downstream from water diversion and storage facilities can have positive and negative effects on channel substrates. For example, a positive effect is the reduction in availability of fine sediments from upstream sources that may deposit in spawning gravels. A negative effect is the reduction in gravel recruitment and loss of fines for bank-building processes.

Streambank form depends on a balance between erosive forces of flowing water and resisting forces of the bed, bank, and streamside vegetation.[75] Vegetation buffers the streambank from flowing water and flowing water in turn keeps vegetation from occupying the channel.[76] The duration of over-bankfull flow is also important to channel and floodplain characteristics. Flow duration determines the amount of time available for deposition of sediments, recharge of subsurface moisture, and other maintenance processes.

2.2.3.3 Floodplain Processes

Except in under-fit or deeply entrenched streams, floodplain size is generally related to the discharge of the stream and slope of the valley bottom.[77] Surface erosion and mass wasting of upstream slideslopes provide material for floodplain deposits. Low-gradient reaches of many streams, and especially large rivers, have geomorphic settings that often produce relatively large floodplains and valuable wetlands.

Floodplain habitats provide cover, nesting, spawning, and rearing for fish and wildlife. Floodplains also play an important part in the transfer of sediments and nutrients that maintain stream productivity.[78] If the stream and its associated floodplain are separated from water by improper flow management, both will change over time because the original dynamic balance between flows and floodplains has been altered.

For floodplain ecosystems, timing and duration of flooding is particularly important. Seasonal flooding affects seed dispersal, seedling survival, and growth of many plant species that occupy channel banks and floodplains (e.g., cottonwoods and willows).[79] Flooding during the growing season apparently has a greater effect on floodplain productivity than does an

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[67] Lotspeich and Platts 1982
[68] Platts 1979
[69] Hynes 1970
[70] Beschta and Platts 1986
[71] Leopold et al. 1964
[72] Beschta 1987
[73] Beschta and Jackson 1979, Beschta 1987
[74] Rosgen et al. 1986
[75] Platts 1979
[76] Rosgen et al. 1986
[77] Hack 1957
[78] Sedell et al. 1989
[79] Platts 1979

equal amount of flooding during the non-growing season.[80]

1. Average Annual Hydrograph	- Indicates timing of high and low flows. - Indicates slopes for rising and falling limbs. - Can be used to index daily drawdown rate.
2. PHABSIM	- Establishes minimum instream flow to maintain fish. - Late summer/fall flows are unusually set lower than base flows.
3. HEC-2 Analysis	- Used to estimate extent and elevation of riparian habitat in sampled reach. - Estimates elevation of bankfull conditions and floodplains in samples reach. - Estimates discharge (Q) needed to provide bankfull flows and to maintain riparian zones and floodplains.
4. Frequency of Occurrence Curve	- Indicates return period for peak flows (determined from historical records or from HEC-2 analysis). - Establishes the extent to which riparian and floodplain flow requirements exceed the average annual hydrograph.
5. Flow Duration Curve	- Demonstrates flow duration associated with specific exceedence values. - Demonstrates that recommended flows do occur in time.

Table 2.1 Summary of steps and concepts to develop multiple streamflow recommendations

Floodplains receive a wide range of nutrients, organic matter, and fine soil particles during overbank flows. Floodplain nutrients can, however, establish their own cycles because organisms and environmental conditions differ considerably from those of the main stream.[81] Floodplains also import, store, produce, and recycle materials used in downstream food chains, thus providing energy flow to detrital food webs.[82]

Riparian vegetation is a major factor affecting floodplains, fisheries habitat, and channel characteristics.[83] The fundamental importance of vegetation to the long-term channel stability and form is usually the weakest part of most flow analysis. Corridors of riparian vegetation along streams influence light and temperature, organic input, provide cover, and control bank morphology.[84] Natural flooding that maintains the riparian system in a productive growth stage, if reduced, can enable non-riparian species to invade riparian zones and floodplains. Although extreme events may play an important role in shaping channels, Wolman and Miller (1960) indicate that the less extreme and more frequent flooding events (considered as bankfull) are probably most influential. In high desert streams, Platts et al. (1985) found that large storm events dominated the channel forming process. Maintenance of stream ecosystems rests on streamflow management practices that protect physical processes which, in turn, influence biological systems. Consequently, multiple flow regimes are needed in most streams to protect multiple resources.

2.2.3.4 Stream Flow Determination Concept and Approach

Four potential flow types and procedural methodologies for evaluating these flows are discussed here. Flow magnitude increases from flow regime 1 (fish maintenance), flow regime 2 (channel maintenance), flow regime 3 (riparian maintenance), to flow regime 4 (floodplain process maintenance).

Fishery

PHABSIM, part of IFIM[85], is most appropriate year-round. The primary purpose of PHABSIM is to describe the relation between streamflow and usable quantities of physical water column space (discharge versus habitat). Such relationships represent the space in a stream that can be used by a specific species during its life stage. PHABSIM is necessary to determine base flow needs, particularly in late summer and fall. Thus, PHABSIM will adequately handle some phases of an instream flow assessment. However, other analytical methods are needed to address channel maintenance flows, and especially riparian and floodplain flows.

Channel

Channel maintenance flows consist of moderately high flows that are expected to prevent vegetation growth in the channel and remove sediments.[86] Most channel-maintenance flow methods suggest that

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[80] Junk et al. 1989
[81] Vannote et al. 1980, Minshall et al. 1983
[82] Vannote et al. 1980
[83] Platts 1979
[84] Larsen et al. 1986
[85] Bovee 1982
[86] Reiser et al. 1989

bankfull discharge is a simple discriminator for differentiating between channel-forming and floodplain-forming processes.[87] Leopold and Emmett (1983) suggest 1.5 year recurrence intervals for bankfull flows. However, Chorley et al. (1984), in studying 36 active floodplains, showed bankfull recurrence intervals vary between 1 and 32 years. Therefore, bankfull flow must be evaluated for a specific stream.

Rosgen et al. (1986) use simplified relationships to illustrate complex flow regimes. The relationships are based on the assumption that flows on the ascending hydrograph mimic the range of frequently occurring discharges that form and maintain channels over time. Rosgen et al. (1986) further assume that sediment loads are not changed appreciably by those factors controlling flows. Given these assumptions, Rosgen et al. (1986) indicate that in snowmelt streams three basic flow components are required: (1) a snowmelt peak flow which is defined as bankfull discharge; (2) a low flow which is defined as baseflow discharge; and (3) snowmelt rising and recession discharges (flow regimes over time).

Rosgen et al. (1986) indicate that an intermediate range of discharges transport most of the sediment load over the long term and thus determine channel form and condition. They utilized a sediment rating curve and a frequency curve of daily discharges, based on the work of Andrews (1980), to define an effective flow. Andrews determined that effective discharge was nearly equivalent to the discharge at bankfull stage. This simplifies the estimation of channel maintenance flows because only those measurements that determine bankfull flows are needed. In contrast, Platts et al. (1985) found that bankfull flows were not always an adequate indicator of channel form and condition. This was the case for certain types of basin-range streams, especially those that tend to experience lateral shifts in channel location when stressed by management activities. Overall, the intermediate range of discharges (i.e. approximately bankfull stage) is, in our opinion, an important hydrological benchmark that is related to the shape of many alluvial channels.

One of the commonly used hydraulic simulation models for evaluating flood flows is the HEC-2 model.[88] This model utilizes a step-backwater approach to determine the velocity and water surface elevation for specific stream discharges. For a specified discharge and channel configuration, the model calculates an initial water surface elevation. The interaction between hydraulic variables and channel dimensions can assist in evaluating the dynamic relationships between discharge and habitat characteristics over time and space.

Riparian

Riparian and floodplain flows are used synonymously in this discussion even though some floodplains could require higher flows than riparian vegetation. Floodplain landforms, which are generally considered to be represented by topographically flat areas, often include side channels, oxbow lakes, wetlands, swamps, and ponds.

The HEC-2 method can be used to estimate effects of flow changes on channels by predicting those velocities that disrupt bed armor and fines from gravel beds. We use HEC-2, however, to identify those out-of-channel flows that influence and maintain riparian and valley forming processes. HEC-2 predicts water surface at any given elevation. The upper and lower elevations of riparian habitat and the valley is measured and HEC-2 used to determine the discharge needed to reach those elevations. HEC-2 transects can be simple extensions of IFIM transects and, therefore, the required field effort for this model is very minimal.

Floodplain maintenance is dependent upon flooding at selected intervals if floodplain functions and vegetation are to be maintained.[89] These flows occur at the peak of the hydrograph and represent discharges within the Q_{15} and Q_{10} range (where Q_{15} and Q_{10} indicate flows that are equaled or exceeded, on average, once every 1.5 and 10 years,

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[87] Wesche and Rechard 1980

[88] USACE 1982

[89] Junk et al. 1989

respectively). HEC-2 modeling predicts the discharge needed to flood riparian habitat and the floodplain. High flow frequency of occurrence (or return period) identifies when, in time, those discharges occur.

Valley floor gradient and width, elevation, fluvial processes, and soil parent material govern riparian type and the extent of the riparian zone.[90] Kondolf et al. (1987) reported that in large U-shaped glacial valleys, the width of the riparian strip is highly variable, whereas on alluvial fan deposits the riparian strip is relatively uniform. Steep-sided, V-shaped valleys lack floodplains or even terraces that can support riparian habitat. Consequently, out-of-channel flows are not needed for riparian or floodplain maintenance in these types of valleys.

2.2.4 Study Design and Modeling[91]

The study of the Owens River was approached from an extensive sampling design to an intensive data acquisition program that allowed us to build an empirical, predictive model of landform response, and in turn, the resulting vegetation and fish and wildlife habitat response to different flows. The concepts described previously helped to bind the various components of the study into a unified procedure. The extensive phase of the study consisted of stratified random sampling to select specific sites. The intensive phase required detailed data collection at each site. ARCINFO, a Geographic Information System (GIS) is used as the database and mapping tool.

GIS is computer software similar to a relational database management system (DBMS) with the capability to manage, maintain, and manipulate spatially referenced data. In addition, GIS have the capacity to perform various types of enumeration, summarization, synthesis, and analysis of point, line, polygon (area), and volume based variables. For example, some of the more typical general types of analytical procedures include selectively overlaying various information layers, reclassification and generation of new information layers, Boolean attribute selection, mathematical modeling, proximity, contagion, contiguity, surface, network, corridor, and density analysis, and pattern recognition. The graphic subsystem of most GIS's allow the user to produce detailed maps and other graphic representations of spatial relationships of interest, in much the same way as a CAD reproduces a drawing or design.

GIS is a powerful tool for integrating interdisciplinary resource information and will facilitate analysis of the natural and anthropogenic environment of the Lower Owens Valley. Because this is a long-term project consistency is extremely important. GIS is used to track and update results of the monitoring program and provide some direct input for models.

GIS is used to expedite systematic documentation of resource inventory, characterization and monitoring data, wildlife and water management information, land ownership, and infrastructure facilities (i.e., levees, canals, roads, wells, springs and other water developments).

The GIS database is stratified into several information layers, including existing land use, areas already conserved or in public use, habitat types, and various physical environmental data such as slope, elevation, aspect, and soil types. Historic land use practices are also keyed into the database system. Additional information on quality of habitat for species and estimates of species abundance are added to the database. The GIS produces composite maps that integrate all the layered data. This graphics capability facilitates communication of simple and complex interrelationships, and provides valuable input for decision making.

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[90] Platts et al. 1985

[91] MOU 1997. Action Plan. Appendix 1, Study Plan, Identification of River Flow Requirements for Fish, Wildlife, and Riverine-Riparian Habitats in the Lower Owens River, California

2.2.4.1 Extensive Elements

The study focused on the Owens River from the LA Aqueduct Intake downstream to the delta and included off-river ponds, lakes, marshes, and meadows. The results of modeling discrete sections of the river were designed to be applicable to all of the Lower Owens River. In order to meet these criteria, a stratified random sampling design was used to select study sites. The assumption in a stratified random sampling approach is that representative sites are selected and that analysis of a specific site can be extrapolated to any other, similar site.

River Classification

The first step in the extensive portion of the study was to classify this reach of the Owens River. Classification provides the basis for extrapolation of results from one basin to another, from one landform or habitat to another, and from one biological assemblage to another. Classification, within a single basin, provides a cumulative framework for assessing abundance and distribution of habitat types as they would respond to flow alterations.

Platts (1974, 1979), Frissell (1986), Lanka et al. (1987), and Warren (1979) have demonstrated that terrestrial and aquatic systems can be integrated into one functioning system. Streams are open systems controlled by the watershed that, in turn, they help build. Streams reflect the hydrology, geomorphology, and biology of their drainage basin. Therefore, streams that drain similar lands formed by similar processes and climate will be similar in the natural state.[92]

Landform Stratification[93]

The next step in the extensive phase of this study was to use aerial photographs to identify all landforms. The LORP riparian area was divided into 4,072 parcels, each consisting of a dominant landtype. Four landtypes were identified based on soil, morphology and position relative to environmental gradients. The *floodplain landtype* includes land influenced by contemporary stream processes, including channels and ponds; surfaces were typically less than 2 feet above alluvial groundwater level. The *low terraces landtype* includes historic floodplains that have been left high-and-dry by channel incision; surfaces were typically 2 to 5 feet above alluvial groundwater level. *High terraces* are typically greater than 5 feet above alluvial groundwater level. *Eolian land* is characterized by a veneer of loose, wind-blown sand underlain by terrace or floodplain sediments. Hydric soil was evident throughout the floodplain landtype and in isolated depressions on low terraces. Hydric soil was generally not present on convex and even terrace surfaces, nor was it present in eolian land.

Sample Site Selection

The next step was to select from within each valley-bottom type and landform group a proportional number of sites to sample. The proportionality of site selection is a function of the size of the landforms in relation to the study reach and the number of landforms within a group at $P < .10$. Depending on the spatial distribution of landforms (random or clumped), the Poisson – or negative-binomial – based formula was used to determine the number of landforms to sample within a grouping with a 10 percent error. From each landform grouping, we randomly selected the requisite number of sites for sampling.

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[92] Lotspeich and Platts 1982

[93] WHA 2004c. WHA 2004b, 2004. WHA 2004a, 2004.

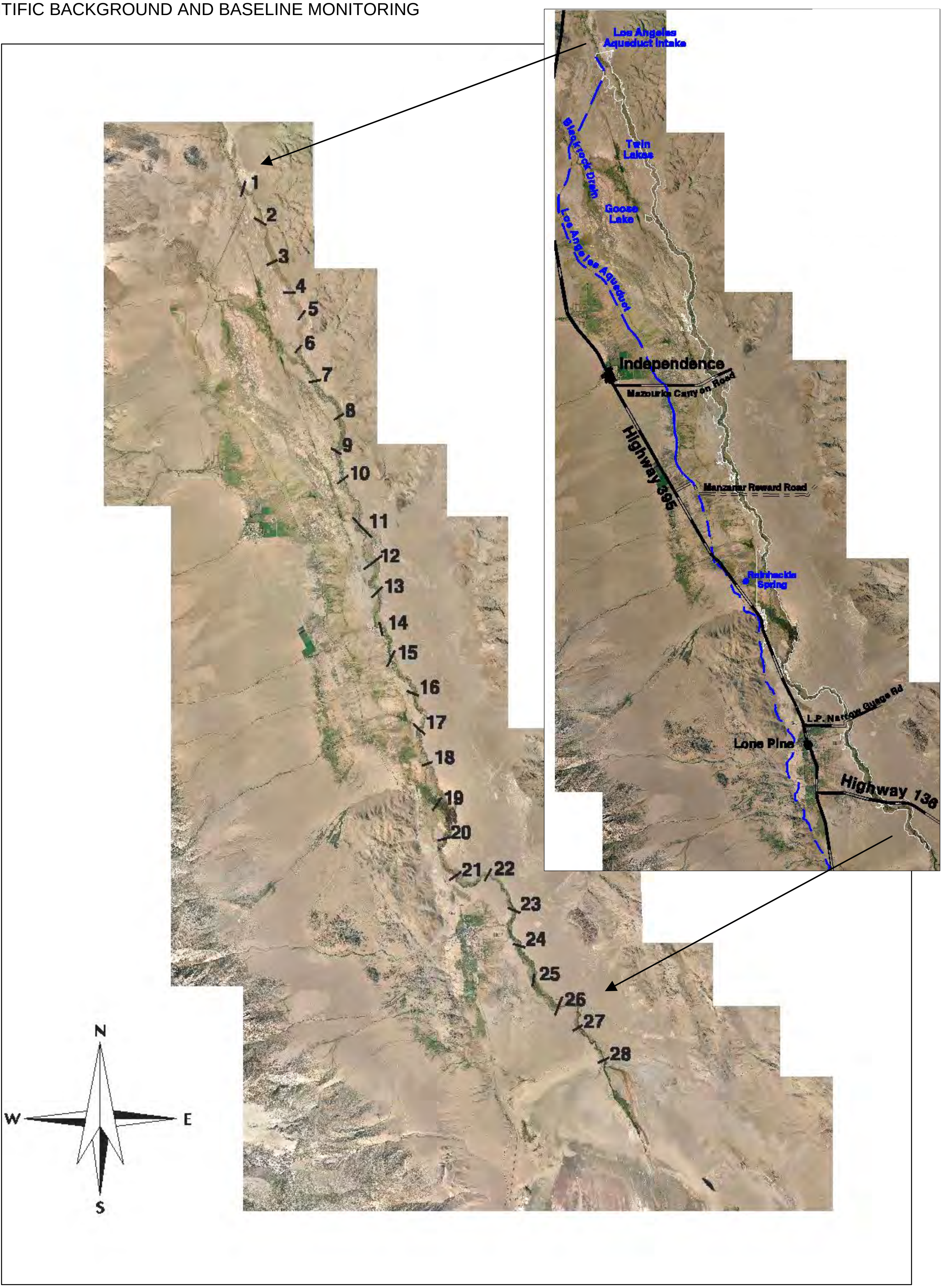

Figure 2.10. LORP Sampling / Study Sites for Controlled Flow Study.

After the proportional analysis was complete the needed number of landform sample sites was randomly selected within each valley-bottom type. Random selection, however, was tempered with accessibility. Sample sites that are more accessible, and therefore less costly to measure, were sometimes selected. Although this will inject some bias into the process, it is doubtful that selecting a few sites because of accessibility rather than randomness matters greatly. Figure 2.10 shows the location of the 28 sampling/study sites in the LORP.

These steps completed the extensive portion of the work. Specific, representative landforms were selected for intensive sampling. Also, during this phase, critical landforms which become evident during the photo analysis or from our common knowledge pool were included for intensive sampling.

2.2.4.2 Intensive Elements

Vegetation Mapping and Identification[94]

The existing vegetation along the river, as well as on landforms, were mapped. The dominant and subdominant riparian community or complex was identified related to slope and aspect and color coded on maps. In ARC GIS, mapping vegetation as simply a cover type limits the effectiveness of modeling or predicting the succession of riparian communities or complexes. Vegetation maps served as the backdrop for flow overlays so that we obtain a visual model of flow affects. This mapping included both xeric and upland vegetation that is included in the historical, existing or potential riparian zone. For example, some areas in this reach of the Owens River contain upland type habitat with transition and riparian habitat lower on the slopes. This habitat mix provides diverse habitat for a variety of birds and mammals. It became a goal of flow recommendations to maintain this habitat diversity while increasing the relative proportion of riparian habitat. In terms of real species succession within the riparian zones, we can expect to see historical and predicted shifts in relative abundance of those plant species now occurring in upland, transition, and riparian areas.

Soil Typing[95]

Vegetative response to different discharges will depend to a large degree on soil type. The composition of surface soil (sand, silt, clay) on landforms depends upon physical forces that deposit or scour materials with different flows. The nutrient concentrations within the soils are important for predicting vegetation response. The intensive sampling on each representative landform included soil typing and mapping. Soil maps of the river are available and this effort focused on identifying the dominant soil type and the percent composition of gravel, sand, silt, and clay in the surface layers.

Fluvial-Geomorphic Processes

Fluvial-geomorphic processes associated with different discharges in the Owens River will control riverine-riparian development. The effects of incising, deposition, scouring, aggrading, and degrading channels, will determine landform response and soil conditions. Consequently, we must be able to predict landform response to flow changes before we can adequately predict habitat responses. The fluvial-geomorphic processes that control existing, representative landforms were identified. To the degree possible, using historical records and historical flow conditions, fluvial geomorphic processes were determined. In the riverine-riparian system, environmental conditions are usually not stable. Therefore, a stream can change conditions over time depending on the stress or controls put upon it. A natural stream changes state in response to geo-climatic conditions. An artificially stressed stream like the Owens River can change states through both natural and artificial controls. The failure to identify a stream segment in an unnatural state can be the demise of any type of flow response methodology. Badly degraded streams like the Owens River will exhibit very different responses to changing flow conditions within reaches and its state can be radically altered. The change of state caused by a different flow

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[94] WHA 2004c. WHA 2004b, 2004. WHA 2004a, 2004.

[95] WHA 2004c. WHA 2004b, 2004. WHA 2004a, 2004.

regime in a particular segment of the Owens River may not be desirable.

The fluvial-geomorphic analysis included identification of muck accumulations (location and volume) and the most appropriate removal method, i.e., mechanical or natural. Relying on stream energy to redistribute the high organic material may cause an increase in the amount of dried material that could become fugitive dust in the Owens Lake area.

Hydrologic Curves

Several methodologies for determining the duration, magnitude, and timing of flushing flows (for channels only) have been developed. These are summarized by Reiser et al. (1985). These methods are not broad enough to work with flows needed for valleys, floodplains, terraces, and many streambank conditions. They are adequate for evaluating changes in substrate composition (fine sediment) with changes in flow regimes.

The value of step-backwater modeling (or hydraulic simulation) is to describe the velocity and water surface elevation for specified discharges. One can specify a discharge, knowing the energy slope, and the program calculates an initial water surface elevation. Thus, it is possible to know the condition within the channel and to calculate the discharge necessary to maintain and influence floodplains and side terraces. The HEC-2 program calculated valley and channel slope when known water surface elevation and discharge are put into the model at groups of cross sections. The physical habitat variables that result from HEC-2 analysis are velocities, depth, wetted perimeter, channel width and surface area. The interaction between these hydraulic variables and the structural features of the channel assist in the determination of the dynamics of habitat over time and space.

The HEC-2 program is not capable of directly calculating water surface profiles in the split channel. It can, however, come up with estimates by inputting energy slope at different discharges and carrying these profiles out and over the additional channels. Bank-channel discharges and side-channels must be estimated or measured separately. For the main channel, subcritical profiles are calculated form the most downstream to the most upstream cross section. The program calculates a water surface profile by solving the one dimensional energy equation with head losses evaluated by the Manning equation. Calculation proceeds with the standard step method. Initial conditions for subcritical profiles, the most downstream sections, are specified in two ways:

(1) Specify a known water surface elevation and a corresponding energy slope. The program calculates the energy slope to the next cross section.
(2) Specify a discharge and a corresponding energy slope. The program then calculates an initial water surface elevation.

The HEC-6 model has been developed to assist HEC-2 to better determine river channel response. This model simulates the change in channel form as a function of streamflow over time.

At this time HEC-6 can provide reasonable results in sand-bed controlled streams like the Lower Owens River. The HEC-2 methods and others (IFIM) can determine the effects of flow changes on channels and flows needed to remove fines from gravel beds. The real value in HEC-2, however, is if it can be adapted to predict those flows that are needed to maintain riverine-riparian and floodplain processes.

In addition to cross-section profiles for modeled transects, we created a median hydrograph for the Owens River and frequency of occurrences curves and flow duration curves for each of the sample sites. The median hydrograph showed “when and how much” flow levels are needed over time. The flow duration curve will display the annual duration time needed for each flow level recommended.

The results of HEC-2 measurements and calculations indicate the discharges necessary to meet channel and riparian flow needs. The average annual hydrograph indicates the time of year these flows are needed. The average annual hydrograph cannot tell us when these flows occur because most riparian flow requirements will exceed the average annual flows. The frequency of occurrence curve is based on the return period (years) of flows and indicates when the recommended flows will occur in time. This information verifies that our flow recommendations do occur in time – although not as average annual events – and that the current channel, riparian, and floodplain conditions are dependent upon these flow return periods.

Groundwater

In addition to flood flows, fluvial-geomorphic processes and the resulting soil type, the most critical environmental parameter for riparian plant succession and growth is the proximity of groundwater to the root zone. Groundwater levels in this reach of the Owens River are linked to surface water discharge. Generally, recharge to the groundwater occurs in the spring with flood flows and depletion occurs in the summer as surface flow declines. Other aquifer sources contribute to the water table of terraces adjacent to the river. Water withdrawal has an important effect on aquifers distant from the river which, in turn, influences water table levels available to riparian systems. Existing groundwater maps and study results (the *Green Book*[96]) were considered adequate to define the role groundwater plays in the maintaining riparian vegetation.

Percolation and Evapotranspiration Loss

Streamflow can be lost between channel reaches by percolation or seepage through the bed. Water levels in marshes, ponds, and lakes can be reduced throughout the summer by evapotranspiration particularly in water bodies supporting large plant biomass. We relied upon the *Green Book*[97] for evapotranspiration rates and losses from surface waters. Scientific literature is also a source of evapotranspiration rates for specific plant communities; however, literature derived rates are usually only valid for the specific climatic zone in which they are measured. Transition of such rates may not be reliable from one climatic zone to another. The amount of water lost in the summer in off-river ponds, lakes, and marshes may represent a significant volume of water to replace with streamflow into these water bodies.

Percolation loss through riparian soil and the Owens River streambed could also be a significant factor affecting streamflow requirements. The percolation rates of certain types of soil are well documented and these rates were examined for the soil types identified in this study. The most significant percolation losses in the river may occur between the LA Aqueduct Intake just below Goose Lake. The losses were measured during controlled flow studies.

Fisheries and PHABSIM

PHABSIM (Physical Habitat Simulation) is the modeling component of the Instream Flow Incremental Methodology developed by the U.S. Fish and Wildlife Service. Bovee (1982) describes site selection, field measurements, and computer analysis in detail. The representative reach approach was employed between each of the sampling sites. The sample site stratification separated the river into ecologically distinct zones and within each reach a “representative” section was selected following methods described in Bovee (1982). In this way, PHABSIM sites are more discrete and reflective of differences within the river rather than broad reaches which may or may not isolate true channel differences.

Flows identified with PHABSIM were used to establish minimum, low summer flows for the target fish species (smallmouth and largemouth bass plus other desirable Centrachits). PHABSIM flows were used to evaluate spawning and juvenile rearing flows with channel, riparian, and floodplain flows. It was also valuable to determine the relative size and structure of the target fish communities in order to identify possible limiting factors on recruitment or adult size distribution.

Habitat Evaluation Procedure

The Habitat Evaluation Procedure (HEP)[98] was performed on the landforms selected in the stratification procedure. Appropriate habitat suitability index models were selected for the

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[96] Inyo County and LADWP, 1991

[97] Inyo County and LADWP, 1991

[98] USFWS 1981

designated target wildlife species. These models were used to determine baseline habitat values, quantifying changes to wildlife habitat from different flow scenarios, determine the acreage of wildlife habitat at different flows, and assist in the development of wildlife management programs.

Wildlife-habitat relationships models such as habitat suitability models (HSI)[99] were used to quantify changes in wildlife values resulting from an incremental range of baseflows and off-river aquatic/wetland developments. Baseline wildlife habitat values were determined by assessing existing habitat conditions and land management programs. The direction and magnitude of changes in wildlife habitat values were assessed in terms of habitat quality and habitat quantity. HSI models and the resulting Habitat Evaluation Procedures (HEP)[100] analysis provided a basis for relative comparison of a variety of river flows, operational scenarios, and alternative management options. The project area was stratified into operational management units: 1) the Owens River channel and any new impoundments; 2) off-river ponds between Los Angeles Aqueduct and the Owens River channel; 3) the Owens River Delta; and 4) the Blackrock Waterfowl Area.

HSI evaluation models were selected for this process to reflect the riparian and wetland management goals and objectives. Wetland resources emphasize waterfowl and shorebird feeding and breeding habitat, and riparian areas are represented by a variety of species associated with different riparian habitats. Wildlife habitat management objectives and goals are incorporated into the evaluation species selection process and optimal habitat conditions to help address relevant management issues and concerns.

Water Quality

Changes in water quality (temperature, dissolved oxygen, pH, turbidity) were predicted with the QUAL2E model. This is a model developed by the U.S. Environmental Protection Agency and the U.S. Army Corps of Engineers for simulating water quality conditions under different flow regimes. This study assumes that the river system can be effectively simulated using a one-dimensional (longitudinal) analysis; steady-state flow conditions (inflow and withdrawal constant during the simulation period); daily average conditions; and specific diurnal fluctuations providing steady-state flow conditions – assumptions that consider interaction of the major water quality constituents using variable changes in environmental conditions such as temperature and sunlight. QUAL2E meets all of the required assumptions and is universally accepted in water quality simulations. It can be seen from the model assumptions that diurnal measurements of water quality parameters (especially dissolved oxygen and temperature) are required during summer months when plant biomass will have the greatest effect on oxygen conditions. Dissolved oxygen sag may occur in side-channels or off-river water bodies that might be ameliorated with streamflows.

Livestock Grazing

One of the tasks to be addressed in the management of the LORP is livestock grazing. A historical livestock grazing database, utilization record and rotation cycles were developed for the ranch leases in the LORP (based on lessees interviews as to their pattern of use and rotation cycles). Grazing strategies for livestock use of the Lower Owens River Valley were researched and detailed consultations were held between each lessee and LADWP. Grazing Management Plans are described in Section 2.2.11.

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[99] USFWS 1981
[100] USFWS 1980

2.2.5 Controlled Flow Study[101]

The mitigation plan for the LORP includes establishing minimum streamflows for fish and wildlife values. In 1993, under the direction and design of Ecosystem Sciences, the LADWP and Inyo County, in cooperation with the California Department of Fish and Game, conducted a controlled flow study throughout the river from the LA Aqueduct Intake to Owens Lake.

The controlled flow study consisted of the estimated release of 20 cfs, 40 cfs, and 80 cfs. These flows were used to calibrate hydrologic, fisheries, and wildlife models, which are used to recommend streamflows throughout the river.

All of the modeling was completed. In general, all of the models operated reliably and within their limits. Although the models are empirically based and the controlled flow data allows calibration of models to predict discharge and fish and wildlife habitat, there is no way to test the model results.

Thus the flows selected must be monitored through time to determine if goals and objectives of the LORP are being met.

Numerous tasks, many of which were performed concurrently, were required to fulfill the objectives of the study. Preceding each task a thorough literature search was performed to ensure that all available data, maps, photographs, and studies were collected. Target species (fish and wildlife) and habitat suitability criteria were developed in conjunction with the technical committee. The study effort was divided into two phases – data acquisition and data analysis.

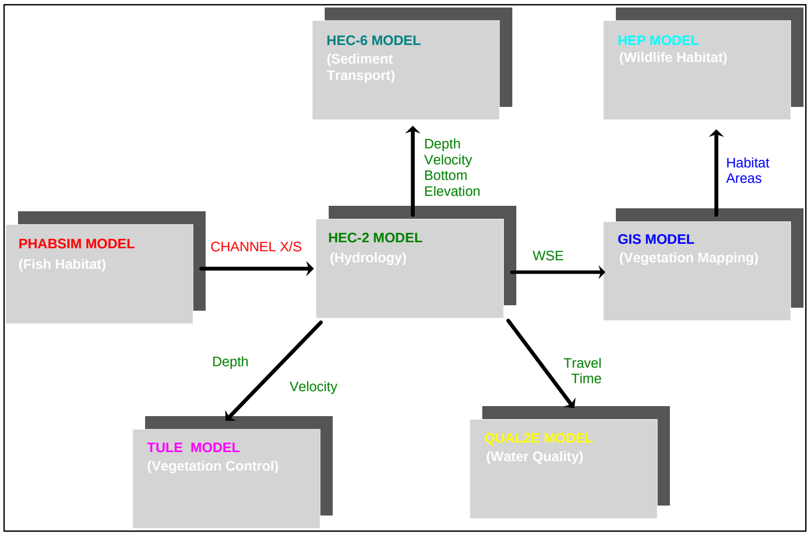

Figure 2.11 LORP Scientific and Data Models

During the summer of 1993, the controlled flow study focused on the collection of data for all of the resources categories. Mapping, modeling and analysis of this data was performed in Phase II, during the winter-spring of 1994.

Six different models were used in the analysis. These models are shown in Figure 2.11 and illustrate how they are linked together. The core model is the HEC-2 model. This defines the hydrology as determined from calibration data gathered during the controlled flow study.

The PHABSIM model predicts fish habitat but also defines channel configuration and geometry. That data is input to the HEC-2 model, which along with topographic evaluations simulates the stream at different flow conditions. We modeled the stream for simulated flows of 15, 30, 50, 80, 100, and 200 cfs. From the HEC-2 model, depth, velocity, and bottom elevations predicted by each of the simulated discharge regimes is used to perform HEC-6 modeling of sediment transport. Travel time from the HEC-2 model is input to the QUAL2E model to calibrate water quality conditions. Water surface elevation from the HEC-2 model is input to the GIS model to identify flow lines (elevation at a given discharge); this then predicts vegetation types that will develop within each ecological reach

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[101] MOU 1997. Action Plan. Appendix 2, Lower Owens River Project Data Base for the Determination of Stream Flows for Fish and Wildlife.

of the river. The GIS work and vegetation mapping defines the type and amount of habitat that will be available for different wildlife species at different flows. This information is input to the HEP model to predict habitat values for each target species. Inyo County developed the tule management model which uses HEC-2 derived depths and velocities necessary to control tules throughout the channel.

The river from the intake to Owens Lake consists of the five ecological reaches, and each of the twenty-eight sampling sites where data was collected during controlled flow studies. Each sample site is approximately two miles apart, and the ecological classification is based on the channel conditions prior to the initiation of the controlled flow study. The channel consisted of a dry reach which had not received water outside of flood years, a wet reach which had continuously received some flow, and an island reach, impounded reach, and delta reach, all of which had some flows throughout the year.

2.2.5.1 Model Calibration

The HEC-2 model showed cross-channel profiles for each of the sampling sites and water surface elevations for each of the simulated flows (15, 30, 50, 80, 100, and 200 cfs). One of the central problems we had in all the modeling was that a one-foot contour map was not developed from aerial photographs. Consequently, all of the elevations were taken from existing topographic maps, typically 7.5 minute quad maps. Therefore, the elevations are not as discrete as we would have liked, and models such as HEC-2 must extrapolate between elevations with a straight line. Therefore, the banks as shown in the cross-channel profiles are not really representative of the true declination or angle of the streambanks.

HEC-2 modeling is also performed under the conditions in which all hydrograph controls are removed and discharge is simulated. Removal of hydrologic controls simulated depth and velocity without the backwater effects from culverts, manmade obstructions such as dams, and beaver dams. This modeling did show an increase in velocities and, obviously, a decrease in depth. However, modeling without the hydrologic controls did not have a significant impact on predicted fish and wildlife habitat. Removal of hydrologic flow obstructions, however, did improve water quality to some degree and did provide greater tule control.

The HEC-6 model predicts scour or sediment transport, and essentially muck erosion at different discharges. The HEC-6 model simulates 80 cfs and 200 cfs. The results of HEC-6 modeling show that in some areas of the river there is a significant amount of scour. However, those areas are rare. The model also shows that as flows increase and scour increases, the amount of deposition also increases.

So, muck and other bottom materials are not transported out of the system at high flows; it is being picked up and redistributed. It is our professional opinion that we do not want to lose much from the Lower Owens River. This is high organic material free of toxicants, free of bacteria, which is essentially fertilizer of greater value for riparian plant growth. At higher flows, we anticipate that the stream will vortice-up the muck and lighter sediments onto the streambanks. This is essential in building streambanks and providing a growth base in the riparian zone. Consequently, the removal or flushing of muck out of the system is not desirable. But at the higher flows needed for riparian habitat, much will be deposited on banks, floodplains, and terraces where plants will reassimilate that material into the ecosystem. This reassimilation is of course a long term process and will take many years to reach equilibrium.

The QUAL2E model predicts water quality conditions at different discharges. The focus of the QUAL2E model is on simulating temperature, dissolved oxygen, and biological oxygen demand (BOD) loading throughout the stream. Water quality simulated at 20 cfs and 50 cfs mimics low flow conditions. The output shows that, initially, BOD loadings will be very high because of existing vegetation and the redistribution of muck throughout the stream, which will have an adverse effect on dissolved oxygen. QUAL2E could only model the short term water quality conditions. Long term conditions, however, are expected to reach equilibrium within the early years. Temperature will be modified by the canopy resulting in lower temperatures. Dissolved oxygen should remain high, certainly within the acceptable range for the fish species of interest in the Lower Owens River.

But, in the short term, one should anticipate that water quality conditions due to high BOD loading will result in detrimental conditions for fish. We anticipate that the initiation of streamflows could result in a fish kill from low dissolved oxygen, high ammonia concentrations, and overall BOD loading. This is simply an artifact of reestablishing flows in the Owens River and one must accept the fact that fish kills will occur, although we cannot predict to what magnitude. Upon implementation of LORP baseflows in December 2006, there were no fish kills, and to date there have been no fish kills.

Fish habitat is modeled with the PHABSIM model (Physical Habitat Simulation). We modeled the habitat in several different ways. The first is by individual habitat areas; weighted usable area for each species and life stage at each sample site. The second way is all the sites combined without the effects of tules or other hydrologic controls in the channel. The third way is the determination of weighted usable areas with all the sites combined into the five ecological reaches. Finally, all the sample sites are combined for one set of PHABSIM curves for each species and life stage representing the entire stream length.

Weighted usable area curves for each of the target species and eight fish species are presented. Smallmouth bass is the primary species of interest.

GIS and vegetation models are used to predict vegetation types associated with each of the water surface elevations at the simulated discharges. The difficulties with modeling and predicting vegetation became apparent without the accuracy of the one-foot contour map throughout the whole river reach. This is a work element that was not completed in the 1993 control flow study. Consequently, modeling relied upon topographic maps to determine elevations and to predict vegetation types in association with the water surface elevations and the topographic elevations. This resulted in an output that was not as discrete as one would like. This can be seen in the vegetation maps in which there is no visual difference between 15 and 30 cfs. There is a visual difference between 15 cfs and 50 cfs. Likewise, there is not a difference that can be seen between 50 cfs and 80 cfs, but one can be seen between 50 cfs and 100 cfs. The maps are therefore developed for 15, 50 and 100 cfs.

Vegetation modeling is also static. At 200 cfs, an out-of-channel flow that floods the riparian zone for a few days is not static. Managing the flow to allow the wetting, seeding, germination, and recharging of groundwater in the floodplain on a 2.5 to 5-year cycle is not the same as holding the flow at 200 cfs as an average annual flow. Consequently, at higher flows, vegetation modeling reflects standing water conditions. Because of this, greater amounts of wetland habitat, or tule habitat, and marsh habitat are predicted than for willow-cottonwood complex type habitats. Nevertheless, it is the professional opinion of the biologists that there will be a greater amount of willow and cottonwood habitat than is shown in these vegetation models.

Since the HEP models are dependent upon the qualification of vegetation types, predicting a greater amount of marsh wetland-habitat than willow-cottonwood habitat would have an obvious effect on the outcome of HEP modeling. However, in the HEP modeling, this is compensated for with greater quantities of willow-cottonwood habitat than is shown in the vegetation type modeling. Also, most of the wildlife habitat values are associated with the near stream corridor, and as a consequence, the inaccuracy of the vegetation modeling does not have a significant effect on HEP modeling. It is the opinion of the modeler that with more discrete vegetation typing coming from one-foot contour maps, there will be minor changes in the estimates of habitat from the HEP model. Re-analyzing the vegetation types based upon more discrete mapping and recalculating wildlife habitat and habitat values could be a work element in 1995 to provide definition and perhaps more discrete quantification of habitat areas and values.[102]

The HEP model was performed for approximately 15 species of wildlife, including guilds for shorebirds and waterfowl. HEP modeling performed very well. The output of the modeling shows that while habitat values are derived in the riverine corridor, flows necessary to optimize wildlife habitat are detrimental to fish habitat. These are higher flows than would provide the optimum fish habitat for smallmouth bass and their prey species. On the other hand, HEP modeling shows that habitat values are maximal in the Blackrock area as opposed to the riverine habitat. It is the conclusion of the biologists performing the modeling that the appropriate tradeoff is to optimize fish habitat in the Lower Owens River while still providing some quality wildlife habitat in exchange for optimizing the habitat in the Blackrock area.

The last modeling program is tule management or tule control in the Owens River. Relationships between tule growth and depth and velocities were examined by Inyo County. The outcome of the tule model shows that in many places tules can not be controlled at flows less than 200 cfs. At other places in the stream, flows of 30 or 50 cfs provide adequate tule control. The tule model incorporated two functions, depth and velocity, as controlling elements. A third function, light, is expected to have an even greater influence on tule growth than depth and velocity. However, the effects of light limitation on tules have not been investigated. Depth and velocities modeled under the conditions with and without hydrologic controls in the stream show that if beaver ponds, culverts and other obstructions are removed, then velocities increase while depth decreases. Nevertheless a greater amount of tule control is achieved with the removal of the obstructions that cause the backwater effect.

It is recommended that tule control as a function of discharge not be a part of the flow discussions and decisions. The effects of light in combination with depth and velocity will be a critical element in predicting at what point in the stream tules will not be controlled. In time, it is anticipated that a significant willow-cottonwood canopy will develop over much of the river that will be a major element in limiting tule growth. Future modeling that does incorporate depth, velocity, and light will show that there may be some points in the stream where canopy will not develop and depth and velocities are not of sufficient magnitude to control tule growth. It is at those points where management decisions can be made to alter the channel by deepening it, or employing mechanical approaches to limit tule growth at those specific points. On the other hand, tules do provide quality wildlife habitat and it may be decided that those points where tules will grow or are predicted to grow in the river should not be controlled.

2.2.6 Study Results and Project Decisions[103]

Riparian and Wetland Flows

The vegetation analysis indicates that as flows increase to about 50 cfs willow type habitat decreases and marsh type vegetation increases. The analysis failed to recognize that riparian-wetland flows, while out-of-channel, are not intended as base flows. In other words, high flows will be provided to meet germination and seeding needs of the riparian vegetation, particularly willow and cottonwood, but will not be a continuous flow. High flows will rise, flood the riparian and floodplain areas, then recede to the in-channel base flow. Such out-of-channel flows will be out of sufficient duration (less than two weeks) to allow willow-cottonwood seeding and germination and recharging of groundwater.

Since the vegetation modeling assumed that out-of-channel flows are constant then it is reasonable to predict a large increase in marsh

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[102] Vegetation mapping has been updated. See sections 2.2.10 and 2.2.11 for further information.

[103] MOU 1997. Action Plan. Appendix 2, Lower Owens River Project Data Base for the Determination of Stream Flows for Fish and Wildlife.

vegetation because standing water of less than a foot in depth would be extensive over the floodplain areas. However, since high constant flows will not be the case, variable out-of-channel flows of 200 cfs will result in extensive willow type vegetation not marsh vegetation. This is the maximum flow for the Lower Owens River. The frequency of occurrence of this high flow will be based on one of two approaches. One approach is to manage the intake flows so that 200 cfs are delivered annually. Another approach is to operate the intake as an algorithm of the upper Owens River flow that in a wet year 200 cfs is provided but in dry years high flows less than 200 cfs are provided in the freshet period.

The second approach is more in line with natural cycles because out-of-channel and lesser flows (but higher than base flows) occur on 1.5 to 5-year cycles. A high flow of 200 cfs occurring every 2.5 or 5-years will not measurably affect the Owens Lake level. The volume of inflow is insignificant, increasing lake level by less than .1 foot, and evaporation will remove this volume rather quickly. The vegetation model also shows that after establishment at 200 cfs, vegetation vigor, survival, and diversity is maintained at 30 cfs. Salt cedar growth is not increased at 30 cfs, alkali meadow vegetation is also held back but emergent wetland vegetation (tules) are not much affected by 30 cfs.

Channel Maintenance Flow

Channel maintenance flows are those flows which, in drier water years, allow for continued geomorphological processes of fine sediment transport, prevention of riparian vegetation encroachment, and maintenance of low-flow channel capacity. The "bankfull" levels indicated on each of the HEC-2 cross-section channel profile figures relate to the active channel, not the top-of-the-bank. This is the level at which discharge meets the minimum geomorphological processes but provides less water than is necessary for fisheries. At the sites in the "dry" reach (1 to 9) the bankfull level is 30 cfs: in the "wet" reach (sites 10-18) the bankfull level is 27 cfs: in the "island" reach (sites 21 and 22) the level is 15 cfs: in the "impounded" reach (sites 23-27) the level is 22 cfs; and 15 cfs in the "delta" reach (site 27). The overall average bankfull flow (all sites combined) is 22 cfs. We select a flow of 30 cfs to account for higher flow needed in the upper reach and to match with the flow needed for sediment transport described below.

Sediment Transport

HEC-6 modeling showed the bed elevation changes predicted at different flows. The model indicates that at high flows (>80 cfs) extreme deposition of material overcomes gains in scouring caused by the high flows. At lower flows it appears that the channel (on average) deepens or remains the same.

Consequently, it can be concluded that one cannot expect much scouring or change in bed elevation. This is because the gradient of the river is simply too shallow to produce high velocities necessary to scour and transport large amounts of material. At 30 cfs stream flow is high enough to provide some scour but low enough to avoid deposition.

Tule Management

From the model used to determine limiting conditions for tules, we can identify specific areas of the river where extremely high flows (200 cfs) will be necessary to control tules and cattails. However, flows in excess of 100 cfs may not be compatible with optimum fish and wildlife flows. In those reaches where model simulations excluded existing tule growth and other hydrologic controls, substantially lower flows adequately control tules and cattails because of the increased velocities. However, these lower flows are also probably not compatible with optimum fish and wildlife flows.

It can be seen that this approach allows us to pinpoint reaches of the river where tule control is unlikely and some form of intervention may be beneficial. However, we should not hasten such a decision to intervene or how to intervene with channel preparation for two reasons: (1) the final instream flow, the flow that tule control will depend upon, must be balanced with fisheries needs as well as riparian and/or wetland needs, thus a flow that simply controls tules could be deleterious to fish and wildlife, and (2) the effect of shading or light limitation on tules is a critical element and must be investigated so that river locations where tules are most likely to occur can be identified in the planning process.

Light magnitude could be a significant tule control mechanism as the overhead canopy expands to shade the river. As the river recovers to a healthy, functioning riverine ecosystem, shading by willows and cottonwoods and other trees and vegetation will increase over time. It is our belief that a dense canopy will develop over much of the river within a few years. This will create a very significant shading effect and, consequently, the three-way interaction of depth-velocity-light that limits tule encroachment may result in a reliable natural control mechanism at flows compatible with fish and wildlife. There is strong evidence of this in the Lower Owens now at Sites 24 to 26 where there is a dense cottonwood-willow canopy and very limited tule growth even though the water is shallow with very little velocity.

While it is necessary to delay a decision on tule control flows, this does not mean decisions cannot be made for instream flows for fish, channel maintenance, and riparian and wetland flows for wildlife. Flows for these resources will be large enough that they will provide tule control for many reaches. In those reaches where the agreed upon instream flow is not adequate to control tules, we can decide to (a) intervene with some kind of channel preparation method is light is shown to be a discriminator or (b) accept the presence of tules in those reaches as long as the tule stands do not significantly reduce fish habitat.

Water Quality

QUAL2E modeling indicated that there will not be much difference in dissolved oxygen and temperature between 20 and 50 cfs. However, this only reflects initial conditions of high BOD loading and as BOD decreases in time the shading increases and one can expect temperature and dissolved oxygen to be adequate at a flow of 30 cfs.

Fisheries

The stated objective for the Lower Owens River Project is to create a healthy fishery. Our objective in selecting fish flows was to balance bass flow needs with the needs of other species. PHABSIM modeling of eight fish species indicated the following (see the combined WUA curves for each species and life stage).

Smallmouth Bass: Juveniles are seldom limited at any flow but high flows (>100 cfs) begin to limit spawning and adult habitat; fry habitat is maximized at 8 to 15 cfs. Adult habitat asymptotes at about 40 cfs and habitat only increases 17 percent from 30 to 100 cfs. A flow of 40 cfs for smallmouth bass optimizes adult habitats while minimizing the loss of fry habitat.

Largemouth Bass: Habitat for all life stages is not limited by any flow. Adult habitat increases 50 percent from 30 to 80 cfs and juvenile habitat increases 23 percent. We select 80 cfs as the optimum flow for largemouth bass. However, this flow will conflict with flow requirements of other species including smallmouth bass. It should be noted that largemouth bass are more of a lake species than smallmouth bass. As flows increase to 80 cfs and above, the Lower Owens River takes on more of a lake than stream character (in terms of depths and velocities in the floodplain) and habitat suitability curves employed in the model for largemouth bass cause an increasing habitat response to this change in physical habitat.

Bluegill: The optimum flow for bluegill appears to be 40 cfs for all life stages. Bluegill production will provide an important food base for smallmouth bass and these flows balance well for each species life stage.

Brown Trout: This is not a serious target species but it is possible to have brown trout in the Lower Owens River. While 60 cfs seems optimum for brown trout some spawning and fry habitat is lost. We conclude that brown trout will not dominate the fishery but at 40 cfs it can be present as a game fish.

Catfish: At 40 cfs all the habitat that can be gained for catfish life stages is made available.

Sacramento Sucker: This species will also provide a forage base for smallmouth bass. However, a flow of 18-20 cfs would provide optimum habitat for this species. Consequently, Sacramento sucker production will be less at the 40 cfs necessary for smallmouth bass.

Speckled Dace: This is another forage species for smallmouth bass but, like the Sacramento sucker, optimum habitat for all of its life stages occur at a much lower flow; about 8 cfs. Thus, providing 40 cfs for smallmouth bass will reduce the total productivity of speckled dace.

Carp: This species was included as a target species in order to define flows that limit its presence. PHABSIM curves indicate that carp habitat might be limited at 8 cfs but at 40 cfs necessary for smallmouth bass, carp will not be limited. Nevertheless, carp fry and juveniles will provide a forage base for smallmouth bass.

Wildlife

River flows higher than those for aquatic resources seem to provide optimum habitat for wildlife. Meeting the flow needs for shorebirds, wintering waterfowl, and other bird species will result in reduced habitat for fisheries. Trading-off fish habitat for wildlife habitat in the Lower Owens River is not a fair proposition. Rather, we select flows that provide good fish habitat and aquatic resource conditions while, at the same time, provide some, but not optimum, wildlife habitat in exchange for maximum and high quality habitat at Blackrock. The HEP model established that wildlife habitat for species is maximized with water inflow to the Blackrock Units. It is our opinion that wildlife habitat should be maximized at Blackrock in exchange for optimizing fisheries and aquatic resources in the Lower Owens River.

2.2.7 Action Plan[104] and MOU

The *Action Plan and Concept Document* is Attachment A to the 1997 MOU and is incorporated into the MOU by reference ("Action Plan"). The Action Plan is based upon the LORP Phase I and LORP Phase II studies (described above) which were designed and performed by Ecosystem Sciences under the direction of Mr. Mark Hill, Dr. Bill Platts, lead project scientist.

In 1993, under the direction and design of Ecosystem Sciences the detailed ecological study of the Lower Owens River from the LA Aqueduct Intake to Owens Lake - approximately 65 miles of river channel and wetland habitat were conducted as previously described (see Figure 1.2). The outcome of these studies and results is the Action Plan and, subsequently, the MOU.

The MOU specifies the flow conditions for the LORP, based on the studies and results described in this section from the LORP Action Plan and Appendices, as follows:

b. The flow regime within the riverine-riparian system will be as follows:

i. A base flow of approximately 40 cfs from at or near the Intake to the pumpback system to be maintained year round.

ii. A seasonal habitat flow. It is currently estimated that in years when the runoff in the Owens River watershed is forecasted to be average or above average, the amount of planned seasonal habitat flows will be approximately 200 cfs, unless the Parties agree upon an alternative habitat flow, with higher unplanned flows when runoff exceeds the capacity of the Los Angeles Aqueduct. (The runoff forecast for each year will be DWP's runoff year forecast for the Owens River Basin, which is based upon the results of its annual April 1 snow survey of the watershed.) In years when runoff is forecasted to be less than

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[104] MOU 1997, Attachment A: Action Plan. Lower Owens River Project Ecosystem Management Plan Action Plan and Concept Document

average, the habitat flows will be reduced from 200 cfs to as low as 40 cfs in general proportion to the forecasted runoff in the watershed. The amount of the annual habitat flow will be set by the Standing Committee, subject to any applicable court orders concerning the discharge of water onto the bed of Owens Lake and in consultation with DFG, and be based on the Lower Owens River Riverine-Riparian Ecosystem element of the LORP Plan, which will recommend the amount, duration and timing of flows necessary to achieve the goals for the system under varying hydrologic scenarios.

iii. A continuous flow in the river channel will be maintained to sustain fish during periods of temporary flow modifications.

2. The Owens River Delta Habitat Area.

The goal is to enhance and maintain… existing habitat consisting of riparian areas and ponds suitable for shorebirds, waterfowl and other animals and to establish and maintain new habitat consisting of riparian areas and ponds suitable for shorebirds, waterfowl and other animals…

… the quantity of water that will be released below the pumpback station…will be an annual average of approximately 6 to 9 cfs (not including water that is not captured by the station during periods of seasonal habitat flows).

3. Off-River Lakes and Ponds.

The goal is to maintain and/or establish these off-river lakes and ponds to sustain diverse habitat for fisheries, waterfowl, shorebirds and other animals …

4. The 1500-Acre Blackrock Waterfowl Habitat Area.

The goal is to maintain this waterfowl habitat area to provide the opportunity for the establishment of resident and migratory waterfowl populations…

Approximately 500 acres of the habitat area will be flooded at any given time in a year when the runoff to the Owens River watershed is forecasted to be average or above average.

2.2.8 Ecosystem Management Plan

As stated in the MOU[105]:

The Lower Owens River Project ("LORP") was identified in the 1991 EIR as compensatory mitigation for impacts that were considered difficult to quantify or mitigate directly. The project described in the EIR includes the rewatering of the Lower Owens River channel below the aqueduct intake, the enhancement of several environmental features along and near the river, and the return of water to the aqueduct by means of a pumpback facility near the Owens River delta. The LORP will be augmented to include the development and implementation of an Ecosystem Management Plan for the Lower Owens River area as described below that incorporates multiple resource values and provides for management based upon holistic management principles.

DWP and the County will direct and assist Consultants in the preparation and implementation of the LORP ecosystem management plan ("LORP Plan"). The procedures to be followed in the preparation of the plan are described in the "Lower Owens River Ecosystem Management Plan--Action Plan and Concept Document" which is Attachment A to the MOU and is incorporated by reference ("Action Plan"). The Action Plan is based upon the LORP Phase I and LORP Phase II studies which were performed by Mr. Mark Hill, Dr. Bill Platts and others …. The Action Plan will be modified as necessary to be consistent with the goals for the LORP as set forth in this MOU. (The protocol for the Phase I study and the executive summary of the Phase II study are Appendices 1 and 2, respectively, to the Action Plan.)

1. The LORP Plan will apply to all lands owned by the City of Los Angeles in the Owens Valley located within the approximate area shown on [Figure 1.2 of this document] *("Planning Area"). The plan will address the four physical features of the LORP: (1) the Lower Owens River Riverine-Riparian Ecosystem, (2) the Owens River Delta Habitat Area, (3) Off-River Lakes and Ponds, and (4)*

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[105] MOU, 1997

the Blackrock Waterfowl Habitat Area. The plan will also include any other riparian areas, wetlands, marshes, meadows and springs and seeps within the Planning Area.

2.2.8.1 Plan Summary[106]

The two most important management tools for the Lower Owens River ecosystem are stream flow (i.e., the interaction of surface water and groundwater) and land use strategies. Water and land use management together exerts the greatest influence on the river's biotic and abiotic components and, ultimately, the degree of functional state attained by the total ecosystem. Whether the fishery reaches the desired goal of a healthy warm water community, T&E species recover, or land use activities are sustainable, depends to a large degree upon how successful water and land use management interventions are in restoring the river to a functional ecosystem.

Each ecological component has a distinct set of management objectives or desired outcomes and a set of actions that will attain the management objectives. Management objectives and actions have been determined by data analysis and decision-making that has been completed the last several years.

Numerous technical memoranda for each project component of the river ecosystem plan have been published, and these technical memoranda contain detailed analysis of data, describe options, present recommendations and establish decisions that are now the management objectives for each ecological component. Technical memoranda are referenced in footnotes in the Ecosystem Management Plan for the reader who wants more detailed information about how management objectives and actions have been set.

Adaptive management is described in the last section of the EMP and is the singular most important element for managing the river ecosystem to reach the desired goals. Management of the Lower Owens River requires a long-term commitment to allow for the evolution of natural processes to culminate in a functioning river ecosystem. Nature generally operates on an unpredictable time scale, and management must be able to adapt to subtle changes that occur over long periods of time. Achieving the goals of the LORP means using active management tools in innovative ways over time to adapt to changing ecosystem conditions.

Adaptive management can be defined in academic terms as a management intervention tool to strategically probe the functioning of an ecosystem with six main steps:
1) problem assessment,
2) design,
3) implementation,
4) monitoring,
5) evaluation, and
6) adjustment.

But adaptive management can also be defined in a broader context as a framework for management and decision-making at the watershed level. For practical purposes, the LORP has already completed steps 1 and 2. With the reintroduction of flows and implementation of this Ecosystem Management Plan, step 3 will be accomplished. Monitoring will complete step 4, and evaluation of trends will complete step 5. Decision-making, actions and changes that improve trends will complete step 6.

The principle tool of adaptive management is monitoring. Monitoring data is then used to measure progress toward a desired management objective over time. The data and information derived from monitoring of ecological components provides the necessary information to allow us to adapt actions and methods to real-time circumstances and unforeseen events. Details of monitoring activities are described in a separate chapter because monitoring is a distinct effort that supports management, but is not, in and of itself, management. The monitoring plan is comprehensive and includes monitoring of actions, methods and trends toward management objectives that are set in all management plans.

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[106] LORP Ecosystem Management Plan. Ecosystem Sciences, 2002.

The Ecosystem Management Plan consists of the following individual plans:

MANAGEMENT CONCEPTS
  Implementation, Maintenance and Operation Guidelines
RIVER MANAGEMENT PLAN
  SURFACE WATER
  WATER QUALITY
  RIPARIAN HABITAT
  TULES AND MUCK
  FISHERIES
  WILDLIFE
WETLAND MANAGEMENT PLAN
  BLACKROCK WATERFOWL HABITAT
  PROJECT IMPLEMENTATION
  OWENS RIVER DELTA HABITAT AREA
LAND MANAGEMENT PLAN
  LORP LEASES
LORP CONSERVATION PLAN
  FISHERIES
  WILDLIFE
  PLANTS
RECREATION PLAN
  EXISTING GUIDELINES
  FUTURE GUIDELINES
MONITORING AND ADAPTIVE MANAGEMENT PLAN
  MONITORING
  TREND ANALYSIS
  ADAPTIVE MANAGEMENT

By agreement with MOU parties, the LORP Ecosystem Management Plan was formatted and written to be a ‘user friendly’ document. The details and complexity of the scientific technical memoranda’s and the underlying ecological concepts could easily obscure the actions and objectives to be undertaken. Thus, the plan was designed to inform lay persons by presenting the key information clearly and succinctly and then referencing technical documents.

2.2.9 Technical Memorandums

Technical Memoranda’s (Tech memos) were produced over the course of the planning phase and provide information and data analyses about specific components of the LORP ecosystem. Tech memos describe and quantify existing conditions and predict future conditions. All decisions on how to proceed with restoration of the ecosystem were based on recommendations given in each tech memo. Relevant quantitative and qualitative thresholds that are predicted and/or expected for the LORP and scientific reasoning for actions or decisions are described in the following reports. Not all LORP Tech Memos are described in this document.

Tech Memo #1; Hydrologic Plan for Implementing Initial Maximum and Minimum River Flows[107]*:* Analyzes channel losses and flow conditions in the river.

Tech Memo #3; Distribution and Abundance of Beaver in the LORP[108]*:* Sets beaver numbers in relation to predicted amount of willow habitat.

Tech Memo #7; Water Quality[109]*:* Analyzes compliance with the State’s basin water quality control plan.

Tech Memo #9; Management of Tules and Organic Sediments[110]: Quantitative prediction of abundance and distribution of tules.

Tech Memo #11; Critical Path for Flow Management During Initial Years[111]: Flow management descriptions for initial channel rewatering.

Tech Memo #13; Groundwater – Surface Water Interaction[112]: Interaction between surface and groundwater, related to the LORP.

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[107] Ecosystem Sciences, Tech Memo 1
[108] Ecosystem Sciences, Tech Memo 3
[109] Ecosystem Sciences, Tech Memo 7
[110] Ecosystem Sciences, Tech Memo 9, 1998
[111] Ecosystem Sciences, Tech Memo 11, 1999
[112] Ecosystem Sciences, Tech Memo 13, 1999

Tech Memo #14; Fisheries in the LORP-Existing and Future Conditions[113]*:* Qualitative analysis of fisheries and fish habitat.

Tech Memo #16; Revised Projections of Wildlife Habitat Units for the LORP Using HSI Models[114]*:* Quantitative analysis of Habitat Suitability Index (HSI) and habitat units (HU) for indicator species.

Tech Memo #20; Special Status Wildlife and Plants[115]*:* Qualitative analysis of habitat for special status species.

2.2.9.1 Tech Memo #1

Hydrologic Plan for Implementing Initial Maximum and Minimum River Flows[116]

This technical memorandum describes the manner in which minimum (base) flows and maximum (riparian) flows will be delivered to the Lower Owens River. It is important to note that the plan described here is only intended as the initial mechanism for delivering water to the river. The cornerstone of managing the Lower Owens River ecosystem is adaptive management, an approach that will allow us to improve upon stream flow inputs with knowledge gained from long-term monitoring. This initial hydrological plan is established on study case conditions of water losses, anticipated ecological corridors to link wetland and riverine habitats, and the results of mathematical simulations (modeling) of instream flows. Clearly the information base will change and improve with monitoring results; one must anticipate that the flow delivery system will be modified from time to time to improve the efficiency of delivering minimum and maximum flows and the conservation of water resources.

The controlled flow study performed in 1993[117] provided the basis for (1) establishing optimum flows for target fish species, (2) establishing optimum out-of-channel flows for riparian vegetation and instream habitat, and (3) determining the channel response to different flow levels. The controlled flow study was a mathematical simulation of both fish habitat and channel geomorphological and hydrological response, and, while models are by nature inexact because too few variables can be modeled, the results do establish reliable starting points for ecosystem management. The controlled flow study indicated that a base flow of 40 cfs (a year around minimum flow) will provide optimum habitat for target fish species and a freshet flow of up to 200 cfs will provide optimum water spreading to create and maintain riparian habitat. The controlled flow study also provided insight into water losses and gains in discrete river reaches from the intake to below Keeler Bridge.

River Flow Loss Analysis

River channels are not efficient conduits of water, nor can river channels create uniform flow conditions at all points along its course. Conditions favoring uniform flow in natural channels are rare compared with the well-controlled flow conditions in concrete canals or irrigation ditches. Flow in natural channels is typically varied, unsteady, turbulent, and subcritical[118]. In non-uniform or varied flow the water volume, depth and/or velocity change over distance[119]; examples are where the flow moves through a bedrock constriction or passes from a pool to a riffle.

Loss of water to groundwater aquifers and streambank storage represents the most significant influence on flow variation. Such is the case in the Lower Owens River where extreme variations in flow conditions (volume, depth, and velocity) were noted for different reaches during the controlled flow study. The most important influence on flow variation in

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[113] Ecosystem Sciences, Tech Memo 14, 2001

[114] Ecosystem Sciences, Tech Memo 16, 1998

[115] Ecosystem Sciences, Tech Memo 20, 1999

[116] Ecosystem Sciences, Tech Memo 1

[117] Hill,M., W.S. Platts, S. Jensen, and G. Ahlborn. 1994. Data base and modeling results for the lower Owens River Project: controlled flow study. LADWP, Bishop, CA.

[118] N. Gordon, T. McMahon, and B. Finlayson. 1993. Stream Hydrology. J. Wiley&Sons, NY.

[119] Brookes, A. 1994. River channel change. Pages 55-75 *In*, Calow, P. and Petts, G., eds., The Rivers Handbook, Vol.2. Blackwell Scientific Publ., Cambridge, MA.

the Lower Owens River is water loss from one reach to another.

REACH	REACH LENGTH (miles)	TOTAL LOSS (acre-ft)	LOSS DURATION (days)	LOSS RATE (cfs)	LOSS RATE (cfs/mile)
Intake to Blackrock	4.82	1300.66	37	17.72	3.68
Blackrock to Goose Lake	6.56	277.11	40	3.49	0.53
Goose Lake to Five Culverts	5.87	1210.52	36	16.95	2.89
Five Culverts to Mazourka	6.07	715.17	38	9.49	1.56
Mazourka to Manzanar Reward	8.80	402.61	38	5.34	0.61
Manzanar Reward to Reinhackle Spring	6.55	887.19	38	11.77	1.80
Reinhackle Spring to Lone Pine Road	10.94	664.47	41	8.17	0.75
Lone Pine Road to Keeler Bridge	6.05	72.47	41	0.89	0.15
TOTALS	55.66	5530.20		73.83	

TABLE 2.2. Water losses in the Lower Owens River as determined by integration of station hydrographs and subtraction of the downstream station total discharge from the upstream station total discharge (from Jackson 1994).

Reach Losses

Inyo County performed a detailed analysis of flow changes by reach in the Lower Owens using data collected during the controlled flow study in 1993.[120] Using discharge data from eight metered sections of the river and flows from various spill gates, Inyo County developed hydrographs, rating curves, wetting front velocities, and peak discharge wave velocities for each reach of the river. Discharge data was then used to estimate a water balance for the river during the 41-day controlled flow study. Results of Inyo County's water loss analysis are shown in Table 2.2.

Table 2.2 indicates that the principle losing reaches are from the Intake to Blackrock Ditch and from Goose Lake to Five Culverts; other reaches also lost a substantial amount of flow during the study. However, the water balance during the controlled flow study would indicate that all reaches of the Lower Owens River are losing reaches. In addition to water lost to the stream channel one must factor in water loss from evapotranspiration. A 1912 study of evapotranspiration loss from Charlie′s Butte to Mt. Whitney Bridge (about 53 miles) indicated a total loss of 10 cfs or 0.19 cfs/mile for this reach[121]. The Inyo County study factored in evapotranspiration losses for the river and spill gates using vegetation inventory data bases for the river and adjacent wetlands. Evapotranspiration combined with channel water losses for the river and spill gates amounts to 36,341 ac-ft/yr at a flow of 40 cfs.

It is important to understand that these losses are derived from the controlled flow study in which water balance or equilibrium was never reached. Although the data used by Inyo County is empirical it does not represent actual flow losses once a steady-state flow condition is achieved in the Lower Owens River.

Quoting from the Inyo County study[122]:

> *Factors limiting the accuracy of loss estimates include unsteady flow in the lower Owens River and the short duration of the established flow regime [controlled releases], as well as the frequency with which the discharge measurements were*

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[120] Jackson, R. 1994. Lower Owens River planning study: discharge data and preliminary estimates of losses for the lower Owens River. Inyo County Water Dept., Bishop, CA.

[121] Lee, C.H. 1912. An intensive study of the water resources of a part of the Owens Valley, California. USGS Water Supply Paper 294.

[122] Jackson, R. 1994. Lower Owens River planning study: discharge data and preliminary estimates of losses for the lower Owens River. Inyo County Water Dept., Bishop, CA.

> *taken and the level of their accuracy. On the rising limb of the river hydrograph, channel storage, high infiltration loss rates to the shallow aquifer, and bank storage effects probably continue to inflate the calculated loss in each reach over the actual loss rate that would be established once equilibrium is reached. Similarly, on the falling limb of the river hydrograph, channel storage and bank storage effects probably combine to reduce the actual loss rate in a reach by the contribution to flows in the river.*

Changes induced by pumping and annual hydrologic variation in shallow groundwater systems adjacent to the river will also affect streamflow. A 1996 review of shallow groundwater levels in the Lower Owens River valley[123] indicated positive net groundwater storage changes in the Blackrock, Independence and Lone Pine reaches of the valley, and a net negative change in the Manzanar and Union Wash portions of the valley. Surface flow in the Lower Owens River will probably improve the volume of stored groundwater adjacent to the river in the Manzanar and Union Wash areas; provided groundwater pumping does not outpace the rate of recharge. The actual water balance in the Lower Owens River will be known in time and will be a function of the filling of shallow aquifers and bank storage along the channel as well as the climax stage of riparian vegetation and aquatic macrophytes. While it is not possible to accurately predict how long it will take for the river flow to reach equilibrium or steady-state conditions, experience with similar conditions in the Owens River Gorge re-watering project indicate that the Lower Owens River might reach flow equilibrium in less than two years. In the meantime an approach is needed to ensure that minimum flows are maintained throughout the Lower Owens River.

Loss Assumptions for the Initial Plan

Given that the empirical data from the controlled flow study represents the high end, or worst-case conditions for flow losses, and the 1912 study on river evapotranspiration represents the low end, we can define a range of flow losses as 0.19 cfs/mile to 3.68 cfs/mile. Within this range (as shown in Table 2.2) there is great variability between reaches; the Lone Pine Road to Keeler Bridge may not even be a losing reach. Neither end of the range of flow loss is acceptable for planning the initial flow delivery system for the Lower Owens River Project.

Minimum Flow Delivery

The goal of providing year-around minimum (base) flow to the river is to achieve as close to 40 cfs as possible in all reaches of the river. The foregoing discussion makes it clear that it is impossible to achieve exactly 40 cfs at all points in the Lower Owens River. Nevertheless, it is possible to meet the minimum flow throughout the river with a reasonable amount of variability by augmenting flows from various spill gates from the intake to Alabama Gates. How the minimum flows are put into the river is the key issue.

Alternatives

There are numerous ways to deliver minimum flows to the Lower Owens River. All water input points are under direct hydrologic control by the LADWP aqueduct system so that specific volumes of water can be released at the intake and to a lesser degree at spill gates. The three basic methods for delivering minimum flows are: Alternative 1- releasing 40cfs at the intake only; Alternative 2- releasing enough flow at the intake to ensure 40cfs at the pumpback station; or Alternative 3- releasing the majority of flow at the intake and augmenting flow losses downstream through spill gates.

Each alternative is based upon an average flow loss of 1cfs/mile. The first alternative is clearly unworkable because 40 cfs could not be maintained in any reach and water losses along the channel would result in net flow deficits in the lower reaches of the river. Alternative 2 is equally unworkable because only the lower two reaches of the river would meet the minimum instream flow goal of optimizing

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[123] Jackson, R. 1996. Shallow groundwater levels in the Owens Valley: 1995 update. Inyo County Water Dept., Bishop, CA.

target fish species habitat; flows at 95 to 56 cfs would reduce the amount of habitat for many target species. Obviously, the only workable minimum delivery technique is Alternative 3. As shown in Table 2, maintaining as close to 40 cfs as possible in all reaches of the river is essentially a balancing effort. The majority of the minimum flow is released at the intake and flow losses within reaches are augmented with release from spill gates along the river.

Maximum Flow Delivery

The maximum flows to be delivered to the Lower Owens River are out-of-channel flows associated with freshet periods (rapid snow melt in the spring). Out-of-channel flows (termed riparian flows) are essential to the life of rivers because they create a disturbance regime that results in instream habitat diversity and the creation and maintenance of riparian habitat[124].

The controlled flow study concluded that riparian flows should emulate the natural hydrology to the degree possible (up to a maximum discharge of 200cfs) so that the lower river experiences the same wet year-dry year cycles as the upper river (above the intake). The variability of the natural hydrologic cycle in the river below the intake will be achieved with an analog model that proportionally mimics freshet conditions in the river above the intake.

Analog Model

Decisions on the annual riparian flow discharge to the Lower Owens River can be made from a series of deductive equations prior to each year's flow event. The basis for decision making will be the USGS stream gage located above Tinemaha Reservoir, and the period of record that defines average annual discharge (Q_A) as well as the 1 in 2-year and 1 in 10-year flood events (Q_2 and Q_{10}, respectively).

The analog equations are defined with the following terms:

Q_A = Average annual flow in the Owens River above the intake
Q_N = Natural flow (current year) in the Owens River above the intake
Q_B = Bankfull flow (the 1 in 2-year event) in the Owens River above the intake
Q_R = Riparian flow in the Owens River below the intake
Q_M = Minimum flow in the Owens River below the intake
Q_2 = 1 in 2-year flood event in the Owens River above the intake
Q_{10} = 1 in 10-year flood event in the Owens River above the intake

The decision on annual maximum flow releases is made as follows:

Dry Water Year Condition: If $Q_N \leq Q_A$ Then $Q_R = Q_M$
Normal Water Year Condition: If $Q_N > Q_A < Q_B$ Then $Q_R = (Q_B - Q_N)$/ratio of Q_B to Q_N (Note: the ratio of bankfull to natural flows is yet to be determined)
Wet Water Year Condition: If $Q_N > Q_B$ Then $Q_R = QN - (Q_{10} - Q_2)/5.64$ up to 200cfs [125]

These equations will require further careful review to be certain they meet the decision-making requirements for determining maximum flows each year.

Duration, Timing, and Point of Delivery

It is anticipated that riparian flows will be delivered as intake releases only. In their analysis of wave velocity during the controlled flow study Inyo County determined that the peak flow (155cfs) travel time was about 17 ft/min and required 12 days to reach Keeler Bridge from the intake. Wetting front velocities in the dry channel were roughly half of the velocity of the peak discharge in a wetted channel. Consequently, it can be expected that in time, Q_R will require something less than 12 days to travel from the intake to the pumpback station. The duration of

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[124] see Hill, M., and W. Platts. 1995. Lower Owens River Watershed Ecosystem Management Plan: Action Plan and Concept Document. LADWP, Bishop, CA., for a detailed discussion of the role of multiple flow regimes and riparian habitat in the functioning of riverine-riparian ecosystems.

[125] Note: 5.64 is the ratio of frequency of occurrence between Q_{10} and Q_2 flood events typical of snowmelt streams determined by Remy, M. 1994. *In*, Calow, P. and Petts, G., eds., The Rivers Handbook, Vol.2. Blackwell Scientific Publ., Cambridge, MA

riparian flows should be 10 to 14 days (based on experience from the Owens River Gorge) from the rise to the fall of the hydrograph. This flow duration appears to be adequate to irrigate riparian/wetland areas, promote germination, and recharge near-stream groundwater systems; however, flows must be timed to occur with the onset of willow and cottonwood seeding.

Timing riparian flows to enhance willow/cottonwood seed dispersal provides some selective advantage over salt cedar and optimizes the seeding and germination of native riparian plant species. Annual seed development will vary from the upper reaches of the Lower Owens River to the most downstream reaches. Consequently, riparian flow timing should be based on the reach of river where seed development is latest.

2.2.9.2 Tech Memo #1 Addendum Memo to MOU Parties

Riparian Flows in the Lower Owens River[126]

The Sierra Club has suggested that the method described in the first tech memo for picking riparian flows be improved upon by focusing on proportional flow reductions from 200 cfs in high water years to that needed in low water years.[127] The MOU states, "In years when runoff is forecasted to be less than average, the habitat [riparian] flows will be reduced from 200 cfs to as low as 40 cfs in general proportion to the forecasted runoff in the watershed". This is certainly a clear definition of how to determine riparian flows each year and only requires a proportional calculation method. However, the LADWP argues that there is a reality check in any proportional analysis and riparian flow determinations must account for real time water year conditions. The two approaches center on setting the lower limit of riparian flows in extreme dry years.

The straight-forward approach suggested by the Sierra Club recognizes the lower limit of riparian flows as 20% of normal runoff. This concept is based on the equation:

$$Q_R = QA \times 200/398516$$

Where: Q_R = Riparian Flow (cfs)
Q_A = Annual Runoff (ac-ft)
Q_R = 200cfs when QA = 398,516 ac-ft or 100% of normal runoff

Applying this equation to annual runoff results in Figure 2.12 where it can be seen that riparian flows are given in all water years except in years when runoff is < 20% of normal at which point 40 cfs is the minimum riparian flow. Thus the annual riparian flow level can be determined directly from the nomograph (Figure 2.12) or as a categorical flow for given water year.

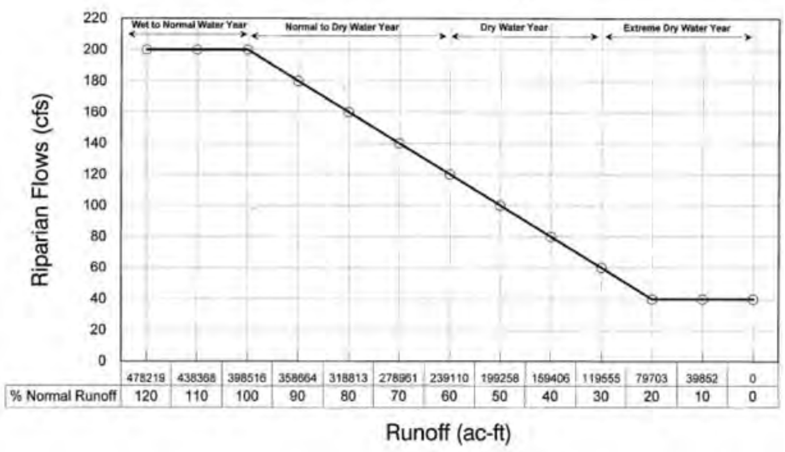

Figure 2.12. LORP Riverine-Riparian Flows

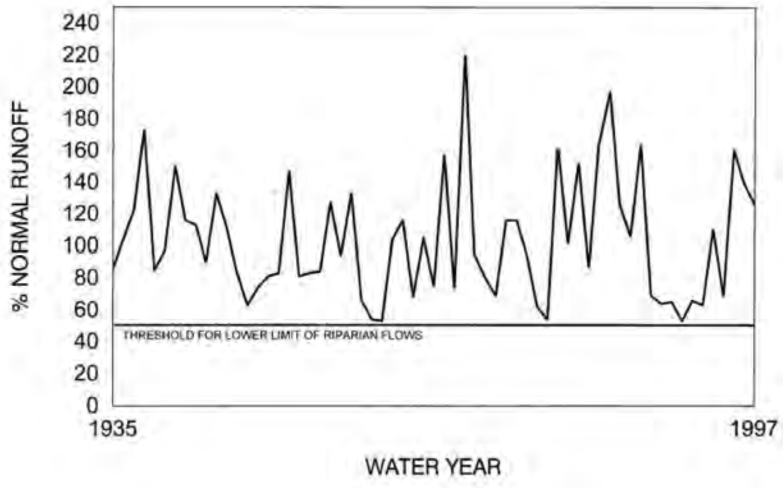

Figure 2.13. Period of Record

Runoff in Lower Owens River Watershed, 1935-1997.

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[126] Tech Memo 1 Addendum Letter from ES to MOU Parties. November 5, 1997

[127] M. Bagley letter of 10/15/97

Runoff Year Class	% of Normal Runoff	Riparian Flow (cfs)
Extreme Water Year	> 100%	200
Wet to Normal Water Year	-> 100%	200
Normal Water Year	100%	200
Normal to Dry Water Year	100% to 68%	125-200
Dry Water Year	67% to 20%	40- 120
Extreme Dry Water Year	< 20%	40

Table 2.3

Based upon historical runoff records, the LADWP suggests that a lower limit for riparian flows[128] be set at the lowest runoff on record.[129] From Figure 2.13 it can be seen that for the runoff period of record from 1935 through 1997 the lowest runoff years have never exceeded 53%. It is this limit that LADWP defines as the threshold for determining proportional riparian flow reductions because; (1) runoff has never and probably will never be as low as the 20% used in the Sierra Club calculation, and (2) in a dry water year represented by 53% of normal there will be water rationing in Los Angeles and in the Owens Valley, and all streams in the watershed will suffer extraordinary flow depletions.

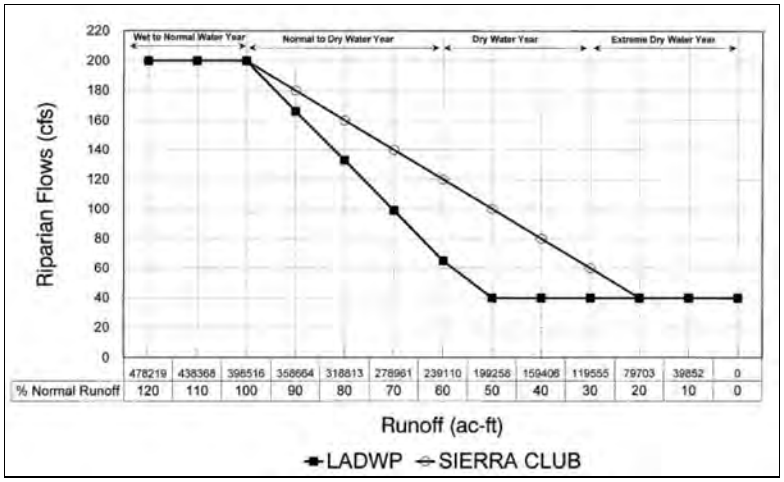

Figure 2.14. LORP Riverine-Riparian Flows

LADWP and Sierra Club comparison

The equation that defines LADWP's argument (for 3985 16 > QA > 210397) is:

$$Q_R = 200 - \frac{(398516 - Q_A) \times (200 - 40)}{(398516-210397)}$$

Where: Q_R = Riparian Flow (cfs)
Q_A = Annual Runoff (ac-ft)
Q_R = 200cfs when QA = 398,516 ac-ft or 100% of normal runoff and 210397 = 53% of normal runoff (ac-ft)

Comparison of the LADWP approach to the Sierra Club approach by runoff results in Figure 2.14. The LADWP approach results in a steeper sloped curve that provides no riparian flows in a 50% of normal water year.

Both approaches are mathematically correct. The fundamental difference is in selection of the lower limit of proportional riparian flow reduction. So the question is which lower limit is the most appropriate? Perhaps the best way to illustrate the effects of both methods on riparian flows is to compare what riparian flows would have been through time, i.e., 1935 through 1997.

Figures 2.14, 2.15 and 2.16 show theoretical riparian flows for each runoff year for both the LADWP and Sierra Club approaches.

Of the two approaches shown in Figures 2.14, 2.15 and 2.16, the LADWP approach would have more closely simulated natural freshet conditions over time. The Sierra Club approach, in the last 63 years, would never have had a riparian flow lower than 106 cfs and is certainly less robust in simulating normal-to-dry and dry water runoff year conditions. Thus the lower limit of riparian flow reduction imposed by the LADWP approach is more appropriate in terms of emulating nature. Nevertheless, the next question to address is which of the two approaches is biologically correct?

Even though riparian flows in dry years (< 68% of normal runoff) will not reach "out of channel" stages, some recharge of bank storage will occur with flows above the base of 40 cfs which argues in favor of the Sierra Club approach. Generally in Western states, flows that promote and support riparian vegetation

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[128] Annual predictions of runoff (in acre-feet) are made by the LADWP forecasting model using snow pack data as of April 1 of each water year. The model is quite accurate (+ 5%) and has been proven reliable over the years.

[129] LADWP: G. Singley letter of 10/27/97

occur at 1.5 year intervals.[130] However, dry and extreme dry water years in the Owens Valley are rare events (see Figure 2.13). Dry year runoff occurs on a return interval of 5.7 years while flows 100% of normal (wet to normal water years) occur every 2.1 years, thus in a dry year, as well as extreme dry year, flows occur at such low frequencies that establishing a threshold for the lower limit of riparian flows (as suggested by LADWP) would not adversely affect riparian vegetation or associated water tables.

In low runoff years all streams in the watershed will experience reduced freshet flows as well as reduced base flows. However, even without a freshet flow, the Lower Owens River would be better off than any other stream during dry and extreme dry conditions in the watershed because it would continue to receive a guaranteed base flow. In any case, it is a given that in extreme dry water years (< 20% of normal) the 40 cfs base flow will not be violated.

The decision on dry to normal and dry water year riparian flows in relation to the wording of the MOU rests with the MOU Signatory Group.

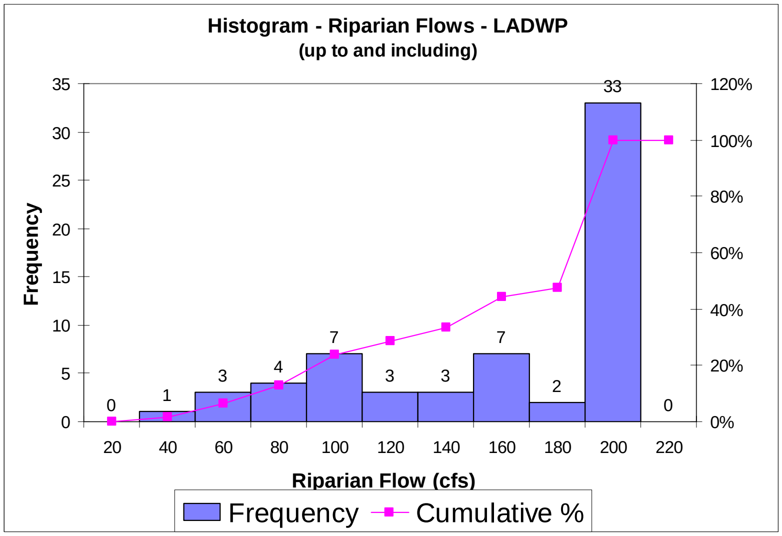

Figure 2.15. Histogram Riverine-Riparian Flows
LADWP

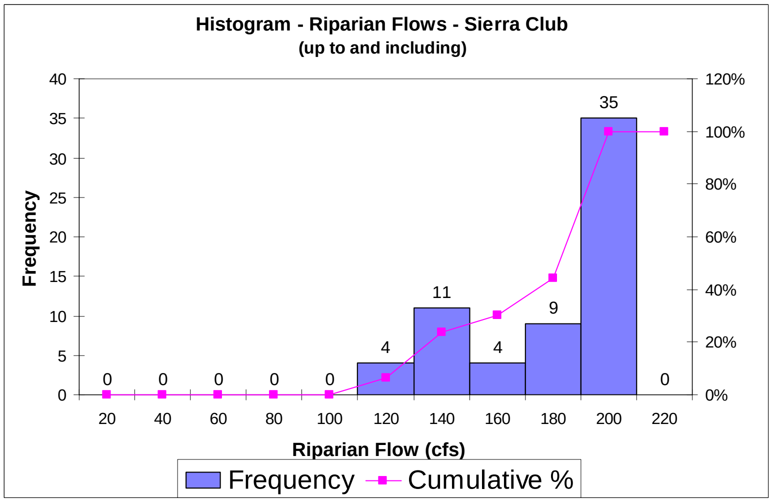

Figure 2.16. Histogram Riverine-Riparian Flows
Sierra Club

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[130] Hill, M.T., W.S. Platts, and R.L. Beschta. Ecological and geomorphological concepts for instream and out-of-channel flow requirements. Rivers 2(3): 198-2 10

2.2.9.3 Tech Memo #11 Critical Path for Flow Management During Initial Years[131]

The purpose of this tech memo is to recommend how flows should be managed, ramped and manipulated to meet both LORP goals and prevent adverse impacts on key environmental conditions during the first two or three years of flow reintroduction. This tech memo also recommends water spreading and flows in the island reach of the Lower Owens River.

Definition of Initial Years

The first two to three years of the LORP are defined as the ‘initial years’. The goal is not the release of riparian flows that promote seeding of riparian plants, but simply to reach base flow equilibrium as early as possible. Flows will be initiated in spring during the first frost-free period. This will avoid problems associated with frozen streambanks or icing in the channel that would prevent filling of bank storage aquifers. Initial flows will be allowed to fill shallow, near-channel aquifers, wetlands and bank storage areas over two to three years.

An out-of-channel riparian flow of 200 cfs will not be released in the initial years unless flow equilibrium is reached in the channel, fish remain healthy, unstressed and in good condition, and water quality has reached acceptable sustainable levels. Technical memorandum #1 (Hydrologic Plan for Implementing Initial Maximum and Minimum Flows) left the impression that riparian flows will be initiated during the first year; however, large freshet flows too early in the rewatering program could exacerbate poor water quality conditions by mobilizing organic material from adjacent lands and organic sediments from the river bed.

Flow Management in Initial Years

There are a number of resource issues associated with rewatering the Lower Owens River other than simply refilling dry aquifers and bank storage areas. An element of risk is associated with introducing flows too rapidly in the early years, thus careful ramping of flows, based on information and data from intensive monitoring of initial flows, is needed in order to minimize risk and to protect critical natural resources.

Water Quantity Issues

The goal of providing a year-around base flow to the river is to achieve as close to 40 cfs as possible in all reaches of the river. Tech memo #1 describes losing reaches and gaining reaches, and makes it clear that it is impossible to achieve exactly 40 cfs at all points in the lower Owens River. Nevertheless, it is possible to meet base flow goals throughout the river, with a reasonable amount of variability, once bank storage and groundwater aquifers are filled. The goal of water delivery in the initial years is to fill aquifers in losing reaches and adjust discharge as necessary once a predictable base flow condition is attained.

Second year flow releases of 40 to 50 cfs will allow a closer evaluation of gaining and losing reaches and will provide better projections of the time required to fill aquifers. Like the first year, second year releases will further fill aquifers and enhance stream bank stabilization. There will undoubtedly be a vegetation response to these flow releases, but this is not the primary purpose of initial water releases.

Third year flow releases will focus on attaining approximately 40 cfs flow throughout the river by adjusting the delivery system as needed. This may entail manipulating discharge from selected spill gates to augment flows in different river reaches.

Water Quality Issues

We anticipate two principle water quality problems associated with the rewatering of the river during the initial years. First is the potential for fish kills when water is reintroduced into the river. Second is the short-term influence on water quality conditions. It is possible, however, that correct ramping of flows will avert fish kills and that short term water quality will not become a problem. The approach to handling water quality problems, however, will be to anticipate adverse conditions and to adjust the system as needed.

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[131] Ecosystem Sciences, Tech Memo 11, 1999

During 1993 controlled flow studies the sudden release of large volumes of water caused a fish kill. The fish killed included game fish (largemouth and smallmouth bass, bluegill, and catfish) and non-game fish (carp, suckers, etc.). As flow was increased during the study, ammonia and hydrogen sulfide gases along with larger quantities of muck and cattle waste from floodplains were mobilized. These organically rich materials caused dissolved oxygen to drop rapidly and fish experienced both low dissolved oxygen, toxic gases, and high flows simultaneously. To reach the desired river flow levels necessary for the controlled flow study, water was released from several spillgates. Water in the spillgate channels was high in dissolved oxygen and exhibited low velocities; with increasing water levels the sills between spill channels and the river were inundated. Fish escaped the river's low dissolved oxygen by moving quickly to the spill channels for refuge. Unfortunately this movement of fish went undetected, and spill gates were closed without first ramping down the flows. As a consequence, fish were killed by stranding in the spill channels. Other fish mortalities occurred in the river as a consequence of low dissolved oxygen and possible ammonia toxicity that occurred when bottom water from beaver ponds was moved downstream.

The second area of concern is with short term water quality conditions. During the initial years it is possible that dissolved oxygen, ammonia, hydrogen sulfide, pH, temperature, and turbidity may not meet the objectives of the Water Quality Control Plan for the Lahontan Region. In time, however, as the channel is cleared, riparian vegetation increases, stream flows reach equilibrium, beaver ponds no longer affect flows, cattle wastes in the channel and on floodplains diminish, and muck deposits are buffered or assimilated, water quality objectives should be met.

<u>Management Options</u>

Initial flows were planned to be released into the Lower Owens River in the spring of 2003. To prevent fish kills and minimize stress on existing fish populations from rapidly deteriorating water quality conditions, initial flow introduction should be gradual and carefully monitored. During the period when channels, aquifers and bank storage systems are being re-filled, stream water quality and fish populations will be closely monitored. If water quality conditions should begin to deteriorate to toxic levels, action plans for emergency recovery of fish (catch and transportation to nearby lakes and ponds) may be implemented. Details of emergency fish recovery and protection plans will be provided in the technical memorandum on fisheries and riverine-riparian habitat. However, recommendations for how initial flows should be introduced and management options to respond to adverse conditions are described here.

The 1993 rapid flow releases indicated that a 30 cfs flow was a water quality threshold. At 30 cfs velocities increased in most river reaches to $\geq$ 1fps. At this velocity HEC-2 modeling showed that incipient bottom scour begins and surficial, unconsolidated muck deposits are mobilized. Water quality testing indicated that hydrogen sulfide, ammonia, and BOD increased dramatically at this point. While the data collected during 1993 could be indicative of water quality conditions during rapid flow reintroduction, it may not be representative or conclusive for deliberate, incremental rewatering that allows for river assimilation and equilibration. Nevertheless, it should be recognized that a risk may exist for aquatic life at flows approaching 30 cfs in the existing wetted reaches (from Mazourka Canyon Road downstream).

A two phased flow management approach is recommended during the initial year. The first phase is direct flow releases from the intake that continue until steady-state conditions (in terms of water quality and quantity) are attained at 20 cfs. The second phase minimizes the risk to a part of the wetted reach by augmenting flows from Alabama Gates.

The key to exercising flow management is continuous water quality monitoring during the early months of initial years. The approximate flow travel time from the intake to Keeler Bridge is 12 days. In that period of time deteriorating water quality in the wetted reach could go undetected without an extensive monitoring program. Monitoring will be performed daily from initiation through October and bi-monthly during winter months. Principal water quality constituents that will be monitored include conductivity, dissolved oxygen, pH, turbidity, temperature, ammonia, and hydrogen sulfide. Fish condition will also be monitored to determine if fish are stressed. Stress behavior includes jumping to escape poor conditions, remaining motionless near the surface, rapid gill movement, and body condition. Monitoring will be performed at the intake, below Goose Lake, at five culverts, Mazourka Canyon Road, Manzanar Reward Road, below Georges spillgate, at Reinhackle Springs, Lone Pine Ponds, Lone Pine Road, and Keeler Bridge. Monitoring data will be reviewed at 5 cfs intervals and will provide an early warning of water quality conditions and trends and fish health in all reaches of the river. Flow management under the two phases is described below.

Phase I

At start-up of flow reintroduction all discharge will be from the intake until the entire river length reaches about a 20 cfs steady state condition. The flow release on day 1 will be 1 cfs, or as close to that as control structures will allow. The flow will be increased by 1 cfs every 24 hours in 5 cfs intervals. At each 5 cfs incremental flow level (about every 5th day) monitoring data will be evaluated to determine flow effects on fish and water quality. Once it is determined that there are no adverse effects, or the effects are tolerable, the 1 cfs flow increase each 24 hours will continue. There could be a delay in this regime to allow for equilibration if fish life and water quality are not being adequately protected.

There are several management actions that can be taken depending upon the water quality and fisheries situation. If monitoring indicates a downward trend in water quality, flows can be (1) reduced until water quality conditions improve or (2) held steady until equilibrium is attained and water quality begins to improve. If flow augmentation and steady state flow conditions provide insufficient relief, the fisheries recovery program can be implemented to capture and remove fish to off-channel ponds and lakes. As water quality improves, transplanted fish can recolonize into the river channel.

Phase II

When a steady-state flow of about 20 cfs has been achieved in the river the primary point of discharge will switch from the intake to Alabama Gates. Discharge from the intake will be held steady and flows in the wetted reach will be managed from Alabama Gates. The Alabama spillgate is the last point at which flows can be augmented, thus the aquatic life currently in the wetted reach from Billy Lake return to just below Reinhackle Springs is not placed at risk. Using the Alabama spillgate to bring flows up to and past the 30 cfs threshold only places that reach of the river downstream to the lake at risk. It is also prudent to initiate Phase II at 20 cfs rather than 30 cfs to minimize risk even further.

The flow release from Alabama Gates will be 1 cfs, or as close to that as the control structure will allow. The flow will be increased by 1 cfs every 24 hours in 5 cfs intervals. At each 5 cfs incremental flow level (about every 5th day) monitoring data will be evaluated to determine flow effects on fish and water quality. Once it is determined that there are no adverse effects, or the effects are tolerable, the 1 cfs flow increase each 24 hours will continue.

Monitoring will take place at several locations below Alabama Gates to the Delta for the same water quality constituents described above. In the event of deteriorating water quality conditions the same actions described in Phase I will be implemented.

Once the flow from Alabama Gates to the pumpback station has reached steady-state conditions (in terms of water quality and quantity) at 40 cfs, flow from the spillgate will be reduced at the rate of 1cfs/day and intake flows will be increased at the rate of 1 cfs/day in 5 cfs increments accompanied by monitoring until the reach from the intake to Alabama Gates also reaches approximately 40 cfs.

Responses to changing situations will continue and flows will increase as water quality improves following each event. Until flows are initiated into the river we cannot predict how frequently actions must be taken to adjust for water quality and fisheries conditions. However, we anticipate that intensive monitoring and flow adjustments will only be needed in the first season of rewatering. Water quality and fisheries conditions should improve rapidly after the first season. The focus for the second initial year will be on flows needed to fill aquifers and to establish steady state flow conditions.

Island Reach

The island reach is in the Lower Owens River below Reinhackle Springs in the Alabama Hills area. The river channel aggrades in this reach creating a broad flat area. The channel is essentially undefined and water braids throughout the broad flat, resulting in isolated land areas surrounded by shallow water. Irrigation return flows and spring flows have created a substantial wetlands extending west to east from Highway 395 to the opposite side of the river channel. During the 1993 controlled flow study when flows were released from Alabama Gates water spread and ponding increased dramatically to nearly top Highway 395 immediately south of the Alabama Hills spillgate.

Flooding the highway obviously poses a risk to human safety as well as potential damage to the road bed. HEC-2 modeling during the controlled flow study showed that even at a base flow of 40 cfs substantial flooding could occur in this reach. However, CalTrans was consulted on this issue and they are comfortable that flooding associated with 200 cfs will not threaten the highway. Nevertheless, long term flooding in this reach will create particular management problems for mosquito control and cattle grazing.

Management Recommendation

Channels in the island area are remnants and portions of oxbows located mostly on the east side of the river. The riparian flows of up to 200 cfs will eventually reconnect with one or more of these historic channels to carry most of the 40 cfs base flow. The LORP will create literally thousands of acres of wetland and marsh habitat. We expect that a valuable willow-cottonwood riparian forest (rather than additional marsh land) can develop in the island reach in time and with proper land management. We recommend allowing the river to define the channels through the island area relying upon adaptive management to respond to grazing, mosquito, or flooding problems that may arise in the course of time.

2.2.9.4 Tech Memo #9 Management of Tules and Organic Sediments[132]

This technical memorandum describes alternative methods to manage tules and organic sediments (commonly called ‘muck’) in the Lower Owens River Project area. Existing and projected future conditions of tules and organic sediments are discussed, as well as a review of ecological values that are provided by tules in the riverine-riparian environment. Options to prepare the channel for initial flows are discussed and evaluated, and a management approach is recommended.

Background

The Lower Owens River supports a high biomass of rushes (*Scirpus acutus*) and cattails (*Typha* sp.) collectively known as tules. Tules completely dominate wetted reaches of the channel from just above Mazourka Canyon Road to the Delta. Rush and cattail dominance will continue in certain reaches, and perhaps increase, with future stream flows of 40 cfs base flow and up to 200 cfs annual riparian flow. Tules have both a positive and negative effect on water quality. Prolific tule growth and consequential die-off could have an ongoing and deleterious effect on dissolved oxygen, BOD and sediment transport and deposition. Channel dominance by tules, as well as the influence of beaver dams and other hydrologic controls, influences stream flow and creates backwater effects.

Excessive tule biomass can be a disadvantage in the development of a flowing and functioning river, but tules can also provide

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[132] Ecosystem Sciences, Tech Memo 9, 1998

many ecological benefits. Tule growth in the Lower Owens River provides bank and channel stability, reduces erosion and adds shade and nutrients. High density tule stands are essential habitat for many bird and animal species and provide winter habitat for waterfowl and shorebirds. Dense vegetation stands also provide valuable refuge and early rearing habitat for both native and introduced fish species. Stands of emergent vegetation also filter sediments from stream flow, which improves water quality; tules remove nutrients, organics and suspended solids, and modify low winter and high summer temperatures.

The issue, therefore, is not the <u>elimination</u> of tules but the <u>control</u> and management of excessive growth and its influence on river flow and function. We must acknowledge that tule encroachment into the channel will occur in the future no matter what method is used to prepare the channel, but will be influenced by the magnitude and interaction of depth, velocity and shading, as well as competition with other vegetation types.

Deposits of sand, silt and organic sediments (muck) are confined to the wetted reach of the Lower Owens River. Low volume and low velocity flows over the years have encouraged the accumulation of organic sediment and sand throughout the lower channel; deposits are several feet thick in some places, while in other areas less accumulation has occurred. Organic sediments can be a source of organic loading if high flows cause scour and mobilize bottom materials. On the other hand, organic sediments that are not mobilized can contribute to anaerobic streambed conditions.

Tules and Sediments as Ecosystem Building Blocks

Organic sediments can have a deleterious influence on water quality in the short term, but in the long term organic sediments that have been mobilized by stream flow are an important component of the riparian and streambank building process. Riparian flows build and irrigate landforms, redistribute sediments, scour pools and undercut banks. Landforms like streambanks, floodplains, terraces and channels in the lower Owens are platforms upon which riparian vegetation (primarily willow and cottonwood) grow. Riparian flows will vortice sediments onto landforms, which not only builds and maintains the landform, but sets the stage for seeding and germination of riparian plants. Organic sediments that are mobilized and deposited on landforms also contribute nutrients by functioning as fertilizer. This vorticing of organic sediments is particularly important in the Lower Owens River. Successful establishment of cottonwoods and willows commonly occurs first on point bars created by newly deposited material within the 2- to 10-year floodplain.[133] High flows are necessary to create the energy to mobilize organic sediments and allow lateral deposition.

Saturated, finely textured soils, often associated with low-gradient riparian zones, can cause anaerobic conditions. Such sites can be unsuitable for the establishment of cottonwoods and willows.[134] When these hydrologic and geomorphic conditions exist, natural plant communities can be dominated by tules and hydrophytic grasses. However, tules growing on slightly submerged landforms initially slow riparian flows and cause significant deposition of sediments. As landforms are built-up by tule-induced surface deposition, surface elevations exceed that of adjacent water surface elevations. Willows and cottonwoods can then establish and out-compete tules over time as these vegetated landforms develop. It is recognized that certain non-native, invasion plant species, such as salt cedar (tamarisk) and Russian olive, are present in substantial numbers along some reaches of the river. These species will continue to be present when flows are introduced and may increase in some areas of the river as a result of seed distribution with stream flows.

Tules and Fisheries Values

Many studies have shown the importance of aquatic vegetation in providing food and refuge for the juveniles of a number of fish species.[135] Human activities that reduce or eliminate aquatic vegetation such as dredging,

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[133] McBride and Strahan 1984; Bradley and Smith 1986

[134] Kauffman et al. 1997

[135] e.g., Savino and Stein 1982; Keast 1984; Rozas and Odum 1988; Schramm and Jirka 1989

herbicide application, or mechanical removal, could have severe impacts on the survival of juvenile fishes and thus on their recruitment to adult populations.[136] Laboratory studies have demonstrated that juvenile bluegills *(Lepomis macrochirus)* are highly vulnerable to predation by largemouth bass *(Micropterus salmoides)* when the stand density of vegetation falls below certain levels.[137] These studies also indicate that juvenile bass species discriminate among densities of vegetation and select vegetation densities that are high enough to reduce predation risk.[138]

In addition to reducing predation risk, increases in vegetation density can also decrease the rate at which juvenile bass catch invertebrate prey.[139] Thus, the selection among densities of vegetation by juvenile bass could depend upon a number of factors, especially the availability of invertebrate prey and the risk of predation in each of the vegetation densities available. Because other studies have suggested that predation risk and food availability may affect the density of artificial vegetation selected by juvenile fish, Hayse and Wissing (1996) conducted experiments to measure how growth rates of age-0 bluegills and predation by largemouth bass were affected by stem density. They found predation rates were significantly lower in medium and high stem densities than in low and zero densities; high-density vegetation offered significantly greater protection than medium density vegetation stands.[140]

Our snorkeling surveys in the Lower Owens River, and other streams in the watershed, substantiate both laboratory and field experiments in that small fish select for dense tule stands for both protection and a food source. In the event that a predator (typically largemouth bass) invades their territory, Owens tui chub quickly move deeper into the tule stand where larger fish cannot follow. We have observed similar behavior for juvenile largemouth bass in beaver ponds throughout the Lower Owens River.

Tules and Wildlife Values

Lower Owens River emergent wetlands provide valuable resources for a variety of resident and migrant wildlife. Aerial photo interpretation of riverine/riparian vegetation types mapped 442 acres of existing emergent vegetation[141]; most of this vegetation type is situated in a relatively narrow band from 2 to 3 m wide along riverbanks.[142] Emergent vegetation is also concentrated in other shallow water areas, especially in beaver ponds and other impoundments.

According to the California Department of Fish and Game's California Wildlife Habitat Relationships Program (CWHR), the number of wildlife species that are associated with aquatic emergent vegetation is 140 species with a preferred relationship[143], 75 with a secondarily essential relationship, and 34 with an essential relationship.[144]

Typical dominant plant species in the Lower Owens River are cattail and bulrush. These perennial species are ubiquitous in the Owens Valley and most temperate wetlands. Both cattail and bulrush provide food values for waterbirds, although they are far less productive and of much lesser importance than seeds, leaves and stems of many other plants.[145] Decomposing vegetation indirectly provides material (dead stems and leaves) that feed detrital-based food webs, including invertebrates that are necessary to waterbirds[146] and many species of herpetofauna, terrestrial

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[136] Hayse and Wissing 1996
[137] Savino and Stein 1982; Gotceitas and Colgan 1987
[138] Gotceitas and Colgan 1987
[139] Savino et al. 1992
[140] Hayse and Wissing 1996
[141] Ecosystem Sciences and White Horse Associates 1997
[142] Ecosystem Sciences 1994
[143] California Department of Fish and Game Wildlife Habitat Relationships habitat element definitions:
Preferred: the element is used by the species to a greater degree than what would be expected from its abundance, the element enhances the value of the habitat, but is not essential for the species presence;
Secondarily essential: Can element must be present within the home range of the species for the species to be present unless it is compensated by the presence of another secondarily essential element that serves the same function to the species;
Essential: the element must be present within the home range of a species for the species to be present.

[144] CDFG 1997
[145] Kadlec and Smith 1989
[146] Drobney 1980; Drobny and Fredrickson 1985; Heitmeyer 1988

avifauna and mammals (including many species of bats). Herbivores like mule deer and beaver consume the rhizomes, stems and leaves of young cattail and bulrush.[147]

One of the greatest values provided by cattail and bulrush is the tall robust structure that is important horizontal and vertical cover, structural habitat diversity, and micro-sites for other smaller emergent and aquatic plant species. Structure provides cover for nesting, protection from predators, habitat for broods, and attachment of nests, and protection from inclement weather.[148]

Wintering dabblers feed on residual grain in flooded grain fields or on aquatic vegetation in seasonal marshes. Winter resting cover for mallards (*Anas platyrhynchos*) consists of permanent marshes that contain at least 5-15% persistent emergent or woody vegetation.[149] Wintering Canada geese (*Branta canadensis*) feed on residual grain, grasses, and forbs in non-flooded grain fields and grasslands and roost during the day and night on islands or shorelines that are barren of trees or other tall vegetation.[150]

Mallard broods use wetlands that have sparse to dense emergent vegetation; wetlands devoid of either emergent vegetation or open water are usually avoided.[151] According to the U.S. Fish and Wildlife Service (1986b) habitat value is highest when a minimum of 25% of the wetland has emergent vegetation present (including along the shoreline). Canada geese nest in a variety of sites that include dense marshes, islands, cliffs, elevated platforms in marshes, tundra, mats of bulrush, tops of muskrat houses, tops of haystacks and abandoned heron and osprey nests in trees.[152]

Many species of amphibians, reptiles, mammals and birds directly and indirectly benefit from cattails, bulrush and other emergent vegetation.[153] The value of emergent vegetation is related to a complex of factors that include: the plant species composition and species richness; stem density or cover; size and configuration of the vegetation type; vegetation height; relative amount of open water; and surrounding vegetation types. To most species of wildlife the value of cattail and other emergent vegetation decreases in extensive and dense monotypic stands; waterbird and other wildlife species richness and abundance may decrease in these decadent conditions.[154]

Future Tule Conditions

Future riparian vegetation types along eight ecologically different reaches in the Lower Owens River, were predicted for a streamflow scenario consisting of 40 cfs base flow and up to 200 cfs annual riparian flow. Predicted future emergent vegetation (tules) was based on: (1) results of HEC-2 hydrologic analysis performed during the 1993 controlled flow study; (2) existing landforms and vegetation types mapped from aerial photos; (3) soil types; and (4) existing vegetation and landform attributes measured along cross-channel transects.[155] Figure 1 shows the planning area and the eight reaches of the Lower Owens River. The following 13 maps illustrate the predicted tule stands in each of the eight reaches.

Concentrations of tules shown in these maps are based upon limited modeling and very conservative analysis. Thus these maps represent a worst case condition. Other environmental conditions critical to limiting tule growth were not incorporated into the vegetation prediction model. The most important environmental influence on tules (after depth and velocity) is light. Predictions do not take into account the effects of shading at intermediate and climax seral stages of willows and cottonwoods nor were we able to incorporate limits on tule growth imposed by low water transparency that is and will be

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[147] Fredrickson and Laubhan 1994; Jenkins and Busher 1979; Hall 1981

[148] Fredrickson and Laubhan 1994

[149] U.S. Fish and Wildlife Service 1986a

[150] Springer and Lowe *in press*

[151] Berg 1956; Godin and Joyner 1981; Talent et al. 1982; Rumble and Flake 1983

[152] Bellrose 1978; pers. obs

[153] Zeiner et al. 1988; Zeiner et al. 1990a; Zeiner et al. 1990b

[154] Weller and Spatcher 1965; Weller and Fredrickson 1973

[155] Ecosystem Sciences 1997

typical of the Lower Owens (due to high primary productivity and total suspended solid load). Nevertheless, the maps indicate that tules, under a worst case scenario, will be confined to the stream margins, oxbows, and side channels.

Tules in the Lower Owens River grow on four principle landforms: the river channel; levees or streambanks; adjacent floodplains; and oxbows (old channel cuttoffs). Vegetation modeling predicts a total of about 350 acres of tules, excluding the Delta. Table 2.4 shows predictions for tule distribution by landform and river reach resulting from a 40 cfs base flow with periodic riparian flows of up to 200cfs.

Table 2.4 shows that the highest density of tules predicted occur in Reach 4 the island reach where, the channel is undefined and a broad wetland has formed. In general modeling allocates 55% of tules on channel landforms, 26% on levees (streambanks), 6% on floodplains, and 13% on oxbow landforms.

It must be emphasized that the model predictions for tule density and distribution is a rough approximation which does not account for the effect of shading from both riparian overstory and poor water clarity, thus model results must be taken as the worst case conditions.

Channel Preparation

Four channel preparation methods are considered:

(1) natural processes that rely on stream flow processes to create depths, velocities and shading that limit tules

(2) fire treatment to burn off existing tule and cattail stands in portions of the channel

(3) mechanical removal of obstructions and dredging to remove organic sediments deposits and deepen channel reaches

(4) treatment with herbicides or other chemicals to reduce the initial stands of tules and cattails

These four alternatives could be used in various combinations as well.

REACH	TOTAL TULES (acres)	CHANNEL (acres)	LEVEE (acres)	FLOOD-PLAIN (acres)	OXBOW (acres)
1	6.7	3.5	1.7	0.4	0.9
2	47.0	25.8	12.2	2.8	6.1
3	75.8	41.7	19.7	4.5	9.9
4	103.9	57.0	27.0	6.2	13.5
5	37.9	20.8	9.9	2.3	4.9
6	47.4	26.1	12.3	2.8	6.2
7	30.2	16.6	7.9	1.8	3.9
TOTAL	**348.9**	**191.5**	**90.7**	**20.8**	**45.4**

TABLE 2.4. Predicted distribution of tules in the lower Owens River by reach and landform.

Natural Competition and Succession

The natural approach is to simply let nature take her course. After base and riparian flows are initiated, no active intervention is taken to prepare the channel, and tules and beaver dams are left in place. However, manmade flow obstructions, such as remnant dams and unused irrigation diversions, will be removed. This approach will require time to show tangible results, perhaps three to five years. Relying upon natural forces of stream flows to limit tules by flooding, scouring and the redistribution of sediments and organic sediments in order to establish and grow woody riparian vegetation (willow, cottonwood, etc.) will require patience. In the short term the river could experience poor water quality from decomposing vegetation and suspended solids, some adverse affects on the health and size of fish populations, localized but non-destructive flooding, localized bank erosion in existing, unvegetated dry reaches, and slow development of open-water areas. The natural approach to tule control is based upon the proposition that humans cannot physically construct a river and do a better job than nature. Given adequate time, the river will build a better ecosystem without human intervention, which almost always entails significant and often irretrievable environmental impacts.

Fire Treatment

Fire intervention could temporarily open the channel by burning off the exposed stems and leaves of tules and cattails. This is an initial and one time only treatment to jump start the recovery process. The idea behind fire treatment is that natural forces of flowing water will have a more open channel to shape and form without the interference of dense vegetation, thus erosive powers within stream flows will be more efficiently utilized to limit future tule encroachment, redistribute sediments and organic sediments, scour substrate, build stream banks and create fish habitat. On the other hand, by preparing the channel by burning emergent vegetation we will cause a severe negative impact on wildlife. Birds and mammals will not have sufficient time to adjust to the sudden change in habitat, or even to escape the initial fire destruction. Risk associated with fire containment is also high. Fire will also destroy surrounding established riparian vegetation, killing existing willows and cottonwoods that are the seed source for riparian vegetation development, and fire may also give salt cedar a competitive edge over willows. Fire treatment will remove vegetative biomass that, under the natural alternative, would decrease dissolved oxygen. However, fire treatment will release nutrients that are bound in plant tissue. An adverse affect on air quality during burning would also be experienced. Costs associated with fire treatment include personnel time to set and manage fires, obtain necessary permits, and fire fighting and safety equipment. However, the single most important deleterious environmental impact from burning tules would be the irretrievable loss of seed sources critical for re-establishing riparian vegetation.

Based on recent experience, fire management may not be an effective tool. Photo number two shows the effects of a wildfire in the Lone Pine Pond area in 1996. While this fire did remove the standing crop of tules from the channel and surrounding landforms, it appears that the fire actually stimulated the regrowth of tules by burning off decadent vegetation that had occupied growing space. New tule rhizomes were quickly cloned to fill the vacant space. This wildfire also burned most of the adjacent mature cottonwood and willow trees.

Mechanical Treatment

(See also Section 2.2.9.5 for a discussion of recent in-channel mechanical treatment of tules in the LORP in selected locations.)

Mechanical and dredging alternatives focus upon heavy equipment to remove significant tule stands from channel reaches, as well as deepening the channel at selected locations to limit future tule encroachment. This alternative is not intended to build fish habitat (i.e., pools) and is a costly alternative that would require substantial manpower and equipment. While vegetation biomass would be removed from the system, activity associated with dredging would increase the amount of material carried in suspension by stream flows. Most importantly, extensive in-channel work could cause fish kills larger than the one in 1993. In the historically watered reaches of the lower Owens River organic sediments would be dredged; this material, along with the vegetation, must be hauled out of the watershed to a safe containment area.

It is our opinion that the deleterious effects of organic sediments have been over emphasized. Instead of removing organic sediments, the preferred objective should be to hold and incorporate organic sediments into the river system. It is true that organic sediment deposits are a source of growth media for tules, and mobilized organic sediments can deplete dissolved oxygen and release ammonia and hydrogen sulfide. However, it is also true that valuable nutrients and soil particles are bound in organic sediment deposits. Our suggestion is to allow stream flows, particularly high, and out-of-channel flows, to scour, suspend and redistribute organic sediments over a period of time. Energy associated with high stream flows creates a vorticing effect that lifts sediments and other organic particles up and onto the floodplain where it is deposited. Organic sediments are essential ingredients in stream bank building and riparian habitat development. Redistribution and deposition of organic sediments will take time, however, the benefits to the riverine ecosystem outweigh the disadvantages of the time required to redistribute the material.

Chemical Treatment

Tules can initially be controlled with an herbicide, or some other chemical approach, in a one time application intended to jump start recovery of the river. The drawbacks to this alternative are numerous, but the most important considerations are toxicity effects in both the acute and chronic time frames on wildlife and other organisms. Herbicides would also have residual effects. Decaying vegetation would cause severe oxygen depletion at the start up of instream flows and BOD loading could last for several years.

Management

Tules

Cattails are generally restricted to relatively calm water and bulrushes commonly grow in channel locations where water velocity is relatively fast. Rhizomes are the overwintering organ which perpetuates the clone each growing season; the survival and vigor of rhizomes will determine the survival of the clone. Cattail leaves and bulrush stems provide photosynthate and a free path for diffusion of oxygen to the rhizomes that remain buried in anoxic sediments; maintenance of emergent organs are necessary to maintain the rhizome.

Maintaining sufficient current velocity and depth is a potential natural strategy to control emergent plants in the Lower Owens River. Studies performed in 1993[156] showed that depth and velocity control tules by: (1) prevention of encroachment of tules into existing channels; and (2) removal of tule clones once they have become established in the channel; for both bulrushes and cattails a process of stem lodging may accomplish the former, and erosion of rhizomes from the substrate may serve the latter.

Stem lodging is the breaking of stems due to drag from current that deprives the rhizome of support from the stem (i.e., oxygen supply and photosynthate) and thus limits clonal expansion and rhizome vigor. The depth/velocity relation between lodged and unlodged stems is:

$$\frac{U \times D}{d} = 12.8$$

Where:
U is velocity measured in m/s (measurements in calm, clear water suggest that tule growth is limited by depths >2m)
D is depth in m
d = stem diameter in m = 0.025

The above equation establishes a mathematical envelope that describes lodging in tule stems. Where current or depth exceed this relationship, tule stems will lodge; clone expansion can be prevented if current velocities are greater than this limit. Results of measurements along tule trimlines during a peak flow event show that the current velocity necessary to move bed material may also eventually remove rhizomes.

Tules are ultimately controlled by the interaction of light, depth, velocity, as well as competition. Maximum depth limiting tule growth is a function of light penetration that permits photosynthesis by inundated portions of tule stems. By reducing photon flux, partial or complete shading of tules may greatly reduce the maximum depth where emergent plants can grow. As will be seen in the following analysis, light penetration (shading) of the Lower Owens River is a critical component for tule control in stream reaches where depth and velocity are inadequate.

We applied the depth-velocity relationship to the various flow scenarios modeled in the Lower Owens River. Analysis indicates that tule trimlines are clustered below about 50 cm/s, and at high flows in most reaches of the river both depth and velocity must approach or exceed 200 cfs to control tules.

As overhead canopy expands to shade the river light penetration into the water column becomes a significant tule control mechanism. As the river recovers to a healthy, functioning

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[156] Groeneveld, D. P. 1994. Hydrodynamic control of emergent aquatic plants in the Owens River Valley, California. Report to Into County and LADWP, Bishop, CA.

riverine ecosystem, shading by willows, cottonwoods and other trees will increase over time. A dense canopy will develop over much of the river within the first decade; this will create a very significant shading effect. The four-way interaction of depth, velocity, light and competition limiting tule growth should result in a natural tule control mechanism at flows also compatible with fish and wildlife. Strong evidence of this interaction occurs in many reaches of the Lower Owens River below Keeler Bridge. A dense cottonwood/willow canopy causes limited tule growth even though the water is shallow and has very little velocity.

Based upon our research and experience in the Owens River Gorge, we anticipate that tules will occupy channel landforms when the following environmental conditions occur: (1) riparian overstory (particularly tree willows and cottonwoods) does not develop; (2) water depth is less than six feet; (3) light penetration is greater than three feet; (4) and stream velocities associated with high flows are too low to prevent rhizome cloning. All four environmental conditions must be present to encourage significant tule stand density. Consequently, the management method we recommend for tule control is the natural approach. In most reaches of the Lower Owens River under the stream flow management program of 40 cfs base flow and up to 200 cfs annual riparian flows, the four environmental conditions necessary for tule growth should not occur as the riverine-riparian system recovers.

Organic sediments

We also recommend that management of organic sediments be based upon the natural consequences of stream flow. Mechanical removal of organic sediment deposits represents additional environmental impact and degradation in the wetted reaches that could retard river recovery. Redistribution of bottom sediments, including organic sediments, onto landforms is an essential stream bank and riparian vegetation building and maintenance processes. In the short term organic sediments may exacerbate poor water quality conditions, but in the long run as the ecosystem moves from a dysfunctional to a functional state, water quality will approach stasis and sediment redox potential will change as anaerobic conditions decline. In short, leaving organic sediments in place poses less risk to ecosystem recovery than mechanical removal.

At the same time, we are concerned and cautious that a fish kill not be repeated in the river when flows are reintroduced. To prevent a fish kill and to minimize stress on existing fish populations from rapidly deteriorating water quality conditions, flow introduction must be gradual and carefully monitored.

Adaptive Management

At this stage of planning we have only imperfect models and professional judgment to rely upon. The ultimate determinate of tule stand density and organic sediment influences throughout the Lower Owens River is empirical measurement and observation. Our recommendation for initiating natural river recovery is not intended to be absolute. It may be necessary to intervene and mechanically remove some tule stands to create channels and prevent excessive backwater effects. Adaptive management provides us with the flexibility to respond to real time conditions and revise management methods to fit actual conditions. For example, monitoring of tule beds may indicate that flow would be enhanced in the short term by removing tules in a specific problem area to create an open channel.

However, the keys to successful tule and organic sediment management with stream flow are time and patience; it will take time for riparian vegetation to develop and patience to recognize that tules and organic sediments are critical and important components of the Lower Owens River ecosystem. Tules provide extremely valuable fish and wildlife habitat, add to the overall diversity and to the ultimate stability of the ecosystem.

2.2.9.5 Tech Memo #9[157] Management of Tules Addendum Letter from LADWP

LADWP Letter to CDFG and ES Describing Mechanical Removal of Aquatic Vegetation[158]

Pursuant to the Amendment to Streambed Alteration Agreement 7600-2004-0727-R6 (Amendment), the Los Angeles Department of Water and Power provided the following information as a status report on aquatic vegetation removal efforts in the LORP. [LADWP decided to pursue a mechanical means of tule removal from the river channel at selected location to test the efficacy of this method].

Cattail and tule removal work commenced on November 28, 2007 at the pumpback station, and crews worked upstream to the Keeler measuring station using the *Aquaplant Terminator* (Terminator) [the Terminator is a mechanical floating barge that mows aquatic vegetation from the channel]. Work in this reach was conducted sporadically through December 13, 2007 due to several mechanical problems and unanticipated obstructions in the channel. Crews cleared a 10 to 20 foot swath through the vegetation to facilitate flows but encountered large woody debris/downed logs that impeded passage in several locations. In some areas, LADWP was forced to use an excavator to retrieve logs from the channel to make it passable (this activity is covered under Streambed Alteration Agreement 7600-2006-0230-R6). LADWP construction crews removed approximately 40 cubic yards of floating debris (primarily tules) from the pumpback station. Prior to using the Terminator, LADWP Watershed Resources Staff estimated ocular cover at 90 percent in this reach; post management cover was approximately 50 percent.

Crews conducted cattail/tule cutting work near Mazourka Canyon Road from December 14-17, 2007, and mowed the aquatic vegetation approximately 1/4 mile upstream and downstream of the main roadway. LADWP Construction Crews removed approximately 30 cubic yards of floating debris (primarily cattails) from this reach. Prior to implementing this management practice, LADWP Watershed Resources Staff estimated ocular cover at 95 to 97 percent; post management cover was approximately 40 percent.

Crews conducted work near Lone Pine Narrow Gauge Road on December 19, 2007, and cut aquatic vegetation approximately 1/4 mile upstream and downstream of the road. This reach was not as heavily vegetated as other sections, but was dominated by cattails and had an estimated overall cover of 70 percent before using the Terminator. Following the use of the cattail cutter, this section was approximately 30 percent cover. LADWP Construction Crews removed approximately 30 cubic yards of floating debris from this reach.

Crews conducted work at Manzanar Reward Road from December 20-22, 2007, clearing a swath through cattails approximately 1/4 mile upstream and downstream of the road. This section was highly choked with cattails, with estimated ocular cover of 95 percent prior to using the Terminator. Post management cover was approximately 50 percent. Roughly 60 cubic yards of detached floating vegetation were retrieved from the channel in this reach.

Work in the Islands Area was scheduled to begin in January 2008 and will be completed prior to flushing flows [Initial Seasonal Habitat Flows in February, 2008].

The contractor, LADWP Independence Construction, and Watershed Resources staffs were on-site at the above locations to operate the machine and ensure that all regulatory requirements were followed. While the project is not yet complete, the Terminator has proven to be highly effective in managing the cattails and tules in the Lower Owens River on a short-term basis. However, the Terminator encountered numerous mechanical problems throughout the scope of the project thus far, mainly due to the extremely thick aquatic vegetation, unexpected woody obstructions, and a machine that was not properly serviced prior to starting the job. As a result, there was a

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[157] Ecosystem Sciences, Tech Memo 9, 1998

[158] LADWP Letter of January 4, 2008 to CDG and ES. Subject: Reporting for Amendment to Streambed Alteration Agreement 1600-2004-01 27-R6

lot of downtime due to mechanical failure of the Terminator, and the contractor replaced many blades, bolts, propellers, etc., that became compromised during operation. In addition, LADWP did not anticipate the need for the excavator in pulling out downed logs from the channel. This will likely not continue to be such a problem if used in these areas in the future, as the first pass should be the most difficult.

Immediate results indicate that the Terminator was effective in clearing a swath and facilitating flows to meet court-ordered requirements. In addition, there is the added benefit of increased velocities contributing to the improved ability to measure flows. Consequently, it may be useful to use the Terminator (or some specialized variation thereof) in future channel maintenance of the Lower Owens River. However, long-term effects and patterns of cattail/tule regrowth are unknown at this time, so it is impossible to recommend how the machine may (or may not) be used in future maintenance activities. The effectiveness of this equipment can be more accurately determined once the growing season commences and regrowth can be observed.

2.2.9.6 Tech Memo #13 Groundwater – Surface Water Interaction[159]

The purpose of this tech memo is to describe the interaction between surface and groundwater, and to relate this, to the degree possible, to the Lower Owens River during flow reintroduction. The possible effects of groundwater pumping on surface water flow are also examined in this tech memo.

Background

Inyo County performed a detailed analysis of flow changes by reach in the Lower Owens using data collected during the controlled flow study in 1993[160]. Using discharge data from eight metered sections of the river and flows from various spill gates, Inyo County developed hydrographs, rating curves, wetting front velocities, and peak discharge wave velocities for each reach of the river. Discharge data was then used to estimate a water balance for the river during the 41-day controlled flow study. Results of Inyo County's water loss analysis are shown in Table 2.2.

Table 2.2 indicates that the principle losing reaches are from the Intake to Blackrock Ditch and from Goose Lake to Five Culverts; other reaches also lost a substantial amount of flow during the study. However, the water balance during the controlled flow study would indicate that all reaches of the Lower Owens River are losing reaches.

It is important to understand that these losses are derived from the controlled flow study in which water balance or equilibrium was never reached. Although the data used by Inyo County is empirical it does not represent actual flow losses once a steady-state flow condition is achieved in the Lower Owens River. Quoting from the Inyo County study:

> *"Factors limiting the accuracy of loss estimates include unsteady flow in the lower Owens River and the short duration of the established flow regime [controlled releases], as well as the frequency with which the discharge measurements were taken and the level of their accuracy. On the rising limb of the river hydrograph, channel storage, high infiltration loss rates to the shallow aquifer, and bank storage effects probably continue to inflate the calculated loss in each reach over the actual loss rate that would be established once equilibrium is reached. Similarly, on the falling limb of the river hydrograph, channel storage and bank storage effects probably combine to reduce the actual loss rate in a reach by the contribution to flows in the river".*

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[159] Ecosystem Sciences, Tech Memo 13, 1999

[160] Jackson, R. 1994. Lower Owens River planning study: discharge data and preliminary estimates of losses for the lower Owens River. Inyo County Water Dept., Bishop, CA.

The degree to which water is lost from different channel reaches in the Lower Owens River could be an important consideration during the initial two to three years of rewatering. As described in previous technical memorandums, the initial years of flow introduction will focus on recharging groundwater systems and establishing flow equilibrium throughout the river. Consequently, an understanding of the interaction between surface water and groundwater is important. In the following discussion of surface-groundwater relationships we rely heavily upon work by Bouwer and Maddock (1997) and borrow liberally from their descriptions of channel types.

The Surface-Groundwater Continuum

Groundwater occurs as one continuum in strata of different hydraulic conductivity and is underlain by bedrock or other “impermeable” formations. Also, groundwater may become surface water in some reaches of a stream, and surface water may become groundwater in other reaches. In the desert regions of the Southwest, natural recharge of groundwater from the land above it is very small; that is, about 1% or 1 mm per year of precipitation (Bouwer 1989), and groundwater levels tend to be at considerable distance below streambeds.

The main source of groundwater and groundwater recharge in the Lower Owens River is seepage from losing streams (ephemeral, intermittent, or perennial) in the valley and from alluvial fans or other upper elevations in the Sierra Nevada and Inyo-White Mountains. The seepage from the alluvial fans is called mountain-front recharge, and it consists primarily of infiltration from mountain streams, rivulets; and other surface runoff on the fans themselves. Under these conditions, essentially all groundwater at one time was streamflow that seeped into the ground and then became “subflow” as it joined the aquifer in the upper alluvium of the streambed or floodplain. It finally became “true” groundwater as it moved deeper and away from the stream in response to natural groundwater movement and groundwater withdrawals; such as, pumping, evaporation, and uptake by phreatophytes or riparian vegetation. The Lower Owens River has been dewatered for nearly 50 years. Since groundwater pumping was initiated without describing background conditions or measuring the effect of pumping on river flow, we can only describe general hydrologic conditions as they <u>might</u> relate to the river. Monitoring in the early years of flow reintroduction will help fill the information gap for the Lower Owens River.

<u>Hydrologic Aspects</u>

What are some basic hydrologic principles that build a strong basis for integrated groundwater and surface water? Theis (1940) introduced the following fundamental groundwater principle: Under natural conditions... previous to the development of wells, aquifers are in a state of approximate dynamic equilibrium. Discharge from wells is thus a new discharge superimposed upon a previous stable system, and must be balanced by an increase in the recharge of the aquifer, or by a decrease in the old natural discharge (e.g., flowing springs), or by loss of storage in the aquifer, or by a combination of these. Thus, prior to development, a regional groundwater system exists in a state of approximate dynamic equilibrium, and a long-term balance between natural recharge and discharge processes maintains this equilibrium. Over the millennia, wet years – when recharge exceeds discharge – are balanced by dry years, when discharge exceeds recharge. Because recharge to and discharge from the system are in balance, there is no change in groundwater storage. In this scenario, if R is the average recharge and D is the average discharge, the equilibrium condition is written: $R = D$.

Recharge to a basin primarily occurs from underflow from other watersheds, losing streams, and mountain- front recharge. Discharge out of the basin occurs from underflow out to other watersheds, gaining streams, and evapotranspiration. Discharge from wells, Q, is a new process imposed on a previously balanced groundwater system, and is balanced by a decrease in storage per unit time, $\Delta S/\Delta t$, and/or some combination of an increase in recharge, $R + \Delta R$, and a decrease in natural discharge, $D - \Delta D$. This principle requires a new equilibrium condition:

$$(R+\Delta R)-(D-\Delta D)-Q=\Delta S/\Delta t \quad (2)$$

Because $R - D = 0$, Equation (2) can be expressed as:

$$\Delta R+\Delta D-Q=\Delta S/\Delta t \quad (3)$$

The term (ΔR + ΔD) is called capture and is the sum of pumping-induced increased recharge plus pumping-induced decreased natural discharge.[161] Equation (3) states that the rate of storage loss in a system equals the deficit between the discharge from wells and the capture. Capture comes from increased infiltration from losing streams, interception of water to gaining streams, reduction in flow rates in springs, and reduction of evapotranspiration.

Equation (3) provides two important pieces of information:

l. If there are no sources of capture, that is, $\Delta R + \Delta D = 0$, then all the water that the wells pump comes from storage loss, that is, $Q = \Delta S/\Delta t$.

2. If a safe yield is defined as no increased storage loss, that is, $\Delta S/\Delta t = 0$, then the wells must be restricted to pump what they can capture, that is, $Q = \Delta R + \Delta D$.

During the initial stages of pumping, most water is withdrawn from storage because the lateral expanse of the cone of depression is initially small and sources of capture are unlikely to be disturbed. However, as pumping continues and the cone of depression expands, the growing zone of influence is more likely to intercept other sources of water such as streams. Furthermore, long after pumping ceases, the cones of depression will continue to capture water as they refill. For an understanding of the surface-and groundwater interactions, one must therefore analyze stream and spring capture. This technical memorandum focuses on stream capture.

Stream Capture

If the source of capture is a stream, four basic situations can be distinguished[162]:

Case l. Figure 2.17

The stream is perennial and the channel and the streambed are "clean" (no deposits of fine or organic material on the wetted perimeter). The groundwater table is above the water surface of the stream so that groundwater moves into the stream and the stream is gaining. The (upper) aquifer is relatively uniform, unconfined, and underlain at some distance by an impermeable boundary like clay or rock, or very permeable boundary like gravel

Case II. Figure 2.18

Same as Case I, but the groundwater table is below the water surface in the stream, causing water to flow from the stream and into the aquifer (losing stream). Two situations are shown in Figure 2.18: a shallow water table with predominantly horizontal flow in the aquifer, and a deep water table with vertical flow dominating below the stream.

Case III. Figure 2.19

Same as Case II, but the stream wetted perimeter is covered with a blanket of fine sand, silt, or clay, and possibly organic deposits (i.e., biofilm, benthic layer) called a clogging layer that restricts and controls the seepage rate and causes the underlying material to be unsaturated. Seepage water then percolates down as unsaturated flow until it hits the capillary fringe above the groundwater table.

Case IV. Figure 2.20

Same as Case II or III, but the stream is intermittent or ephemeral. The water table may be some distance below the wetted zone.

Perennial Streams

For Case I, seepage into the stream can be calculated on the basis of one-dimensional flow if there is an impermeable layer that forms a lower boundary at, or not far below the bottom of the channel so that the whole system is shallow and the groundwater flow is predominantly horizontal.[163] If the impermeable boundary is deeper or the lower

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[161] Bredehoeft et al. 1982

[162] Bouwer 1978

[163] Bouwer 1978

boundary is very permeable, vertical flow components become significant and the seepage flow system must be analyzed for two-dimensional flow.[164]

For Case I, there is a direct hydraulic connection between the groundwater and the stream. Groundwater is tributary to the stream, and the rate of flow of groundwater into the stream is directly proportional to the slope of the water table as determined by the height Dw of the groundwater table above the water level in the stream at some distance from the stream. If Dw is reduced by pumping groundwater, the rate of seepage flow into the stream will decrease linearly with Dw. Because the groundwater is tributary to the stream, there will then be “one cup of water less in the stream for each cup of water taken out of the aquifer.” Thus, all groundwater extractions from an aquifer that is tributary to a stream captures waters that would have entered the stream. Accumulated streamflow then is reduced by the total amount of water withdrawn from the tributary aquifer. This capture is a reduction in discharge from the aquifer to the stream.

If the water table away from the stream is sufficiently high to be within reach of plant roots (e.g., deep rooted trees like salt cedar, willow, cottonwood, or other “phreatophytes”), considerable amounts of water (often 1.5 – 7.5 ft per year) are lost from the groundwater due to uptake by tree roots and subsequent transpiration from the leaves. When groundwater levels are lowered, this consumptive use or water “loss” decreases and may stop altogether when the water table drops below the depth reached by the root system and the trees begin to die.[165] Reduction in evapotranspiration is another form of capture.

If the duration and quantity of the groundwater withdrawals are large enough, water levels in the tributary aquifer will drop until eventually the water table will be at the same elevation as the water surface in the stream and the flow of groundwater into the stream will stop. At this point, the stream’s baseflow has become zero and the stream’s flow is sustained only by surface runoff and, possibly, baseflow from farther upstream.

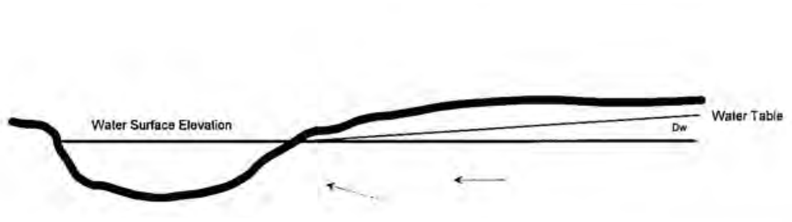
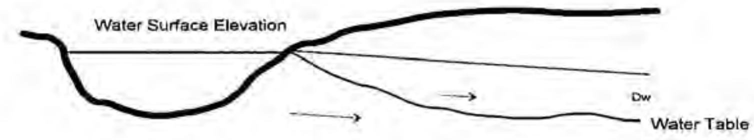
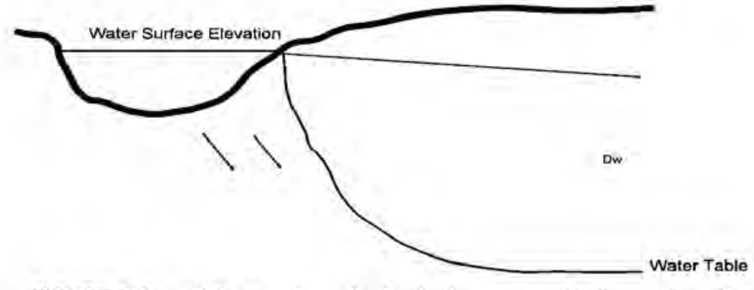


Figure 2.17. Case I

Aquifer with gaining stream. Dw = height of water table above WSE.





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[164] Bouwer 1969

[165] Bouwer 1975

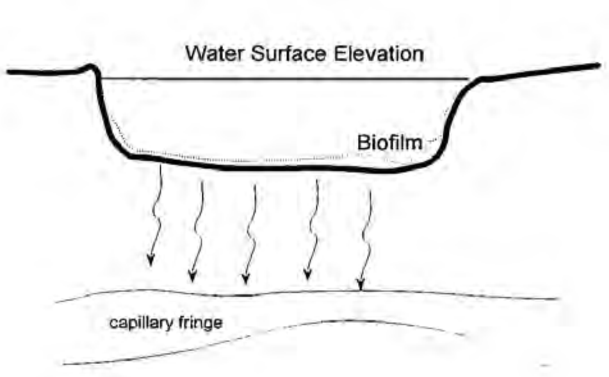

Figure 2.19. Case III

Unsaturated flow beneath a perennial stream.

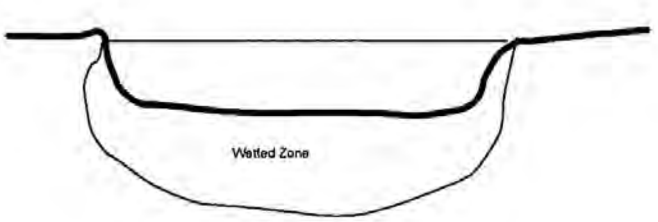

Figure 2.20. Case IV

Unsaturated infiltration flow beneath an ephemeral stream.

When groundwater pumping is continued, groundwater tables drop below the water surface in the stream, water seeps from the stream into the aquifer, and the stream becomes a losing stream with diminishing streamflows (Case II). Groundwater pumping then draws water directly out of the stream, in contrast with groundwater pumping in gaining stream situations (Case I) in which the pumping takes water out of the aquifer before it reaches the stream. For Case II, capture is in the form of increased recharge to the aquifer from the river. Hence, this capture is also called "induced" recharge. The term Dw now is the vertical distance between the groundwater table and the water surface of the stream.

If the water table in the losing stream situation is still relatively high and Dw is relatively small, the seepage losses from the stream will increase linearly with increasing Dw as caused by declining groundwater levels. However, as the water table continues to drop and Dw continues to increase, the seepage flow below the stream will become increasingly downward and more controlled by gravity rather than by the slope of the water table. Thus, if seepage losses from the stream are plotted against Dw, the curve will be near linear in the beginning (small Dw), but will then become curvilinear and asymptotically approach the maximum seepage value obtained when the groundwater is infinitely deep (Dw = ∞).

Figure 2.21 is obtained by extrapolation from curves developed by simulation models for deeper, irrigation-type channels.[166] The dimensionless term *I/K* expresses the seepage rate *I* per unit area of stream surface divided by the hydraulic conductivity *K* of the soil material. The term *I* can be visualized as the rate of fall of the water surface in the stream in a dammed section for which the inflow and outflow are both zero. The dimensionless-term Dw/W is the depth to groundwater divided by *W*, the width of the stream.

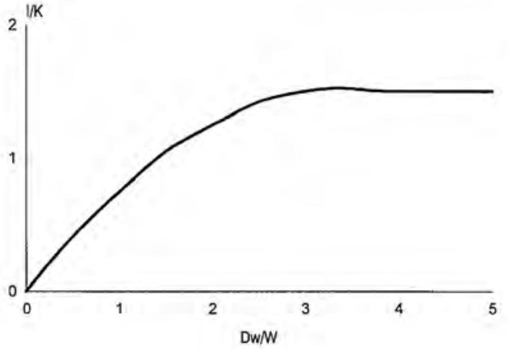

Figure 2.21.

The turnover from linear-like behavior to nonlinear behavior occurs when Dw is about one-and-a-half times the width of the stream.[167] If the value of Dw is greater than twice the stream width, the seepage begins to rapidly approach the maximum seepage for an

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[166] Bouwer 1969, 1975

[167] Bouwer 1969

infinitely deep water table.[168] Thus, if the water table is rather high and, at some distance away from the stream, less than *2W* below the water surface of the stream, lowering the water table by groundwater pumping will "pull" more water from the stream. However, if the water table at some distance is already more than 2W below the water level in the stream, further lowering of the groundwater table will not significantly increase the seepage, even when the groundwater table becomes "infinitely" deep. Thus, for a 10-ft wide stream, lowering the groundwater level by pumping will not increase seepage losses from the stream if the ground- water level was already deeper than 20 ft below the water surface of the stream. Conversely, reduction of groundwater pumping and rising groundwater levels will not increase streamflow as long as the groundwater level is more than 20 ft below the water level in the stream. For a 100-ft wide stream, these "critical" groundwater levels would be 200 ft below the water level in the stream.

Streams with Clogging Deposits

Cases I and II apply to clean streams (no clogging deposits of fine and/or organic materials with low hydraulic conductivity) like the dry reach of the Lower Owens River above Mazourka Canyon Road. These streams occur where flow velocities are rather high and sediment and organic growths cannot accumulate on the bottom. Also, erosion and sedimentation may constantly rework the bottom and continuous deposits of fines cannot develop. Such deposits, however, can form in slow flowing streams similar to the wetted reach of the Lower Owens from above Mazourka Canyon to the Delta. The clogging layer can have such a low hydraulic conductivity that it restricts seepage rates to values that are less than the saturated hydraulic conductivity of the underlying coarser materials (Case III). This causes the material below the clogging layer to become unsaturated and gravity flow to dominate. The underlying material then drains to a water content whereby the corresponding unsaturated hydraulic conductivity is numerically equal to the seepage rate. This seepage rate can be calculated by applying Darcy's equation to the flow through the saturated clogging layer, knowing the thickness and hydraulic conductivity of this layer.[169] Some clogging layers are too thin (clay films or biofilms) to measure their thickness *L* and hydraulic conductivity *K* individually. In those cases, the ratio of thickness to hydraulic conductivity or hydraulic impedance *(L/K)* is used. Sophocleous et al. (1995) rank streambed clogging as the top factor in determining seepage losses.

The downward flow in the unsaturated zone between the stream and the water table is controlled by gravity. Thus, the seepage rate is the same for a groundwater depth of 10 ft below the stream bottom with about 10 ft of unsaturated zone as for a groundwater depth of 100 ft below the stream with about 100 ft of unsaturated zone, or, for that matter, for an infinitely deep water table below an infinitely thick unsaturated zone. Groundwater depletion by pumping will then not significantly increase the seepage rate from the stream. To obtain unsaturated flow below the stream, the top of the capillary fringe above the water table must be below the stream bottom. The thickness of the capillary fringe may vary from 0.3 ft or less for coarse sandy and gravelly materials to about 1 ft for medium sands; 2 ft for silty or loamy sands; and 3 ft or more for loams and clays. Because most stream channels run in relatively coarse alluvium, it can be concluded that, for Case III, groundwater depletion by pumping of wells generally will not "pull" more water out of streams if the groundwater level is already deeper than about 3 ft below the stream bottom. However, the Lower Owens River channel is fine sediments rather than course alluvium, and the degree to which pumping pulls water out of the river is unknown.

For higher groundwater levels, Case III will become like Case I if the groundwater level is above the water level in the stream. The clogging layer can then restrict the rate of groundwater flow into the stream, but when the groundwater level drops, the rate of groundwater flow into the stream decreases linearly with Dw, until it becomes zero when

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[168] Bouwer 1988

[169] Bouwer 1982

Dw =0. Further water level declines will then cause seepage from the stream to the aquifer and the stream will become “losing.” Initially, this seepage will increase linearly with groundwater level drop until the top of the capillary fringe has dropped below the clogging layer on the stream bottom and an unsaturated zone is created between the stream bottom and the capillary fringe. At this point, which is often reached before the groundwater level has dropped to about 3 ft below the stream, seepage losses have reached maximum value and further lowering of groundwater levels will not increase seepage flows. Conversely, rising groundwater levels will not reduce seepage losses as long as the groundwater level is more than about 3 ft below the stream bottom.

Management

The reach of the Lower Owens River from just above Mazourka Canyon Road to the Delta can probably be described as a Case III stream with clogging deposits. This reach has been continuously wetted, and has substantial organic material and “muck” deposition and loses water to the aquifer. (The long term effect of riparian flows on these muck deposits is unpredictable since some areas may be scoured and some may not.) The river above this to the intake has been dewatered and lacks clogging deposits: thus, it is more likely a Case II stream since it appears that most reaches lose water to the aquifer. Nevertheless, it is not possible to describe all reaches of the Lower Owens under existing dry and partial wetted conditions. Only in time, when flow equilibrium has been established, will it be possible to accurately determine which reaches are Case I through IV.

Changes induced by pumping and annual hydrologic variation in shallow groundwater systems adjacent to the river might also affect streamflow. To what degree groundwater pumping affects surface flow remains to be seen. A 1996 review of shallow groundwater levels in the Lower Owens River Valley[170] indicated positive net groundwater storage changes in the Blackrock, Independence and Lone Pine reaches of the valley, and a net negative change in the Manzanar and Union Wash portions of the valley. Surface flow in the Lower Owens River will probably increase the volume of stored groundwater adjacent to the river in the Manzanar and Union Wash areas; providing groundwater pumping does not outpace the rate of recharge.

2.2.9.7 Tech Memo #14 Fisheries in the LORP-Existing and Future Conditions[171]

The purpose of this technical memorandum is to describe the existing fishery and habitat in the Lower Owens River and future conditions and habitat as a consequence of flow restoration to the channel and adjacent ponds, lakes, and wetlands. Management of the existing and future fishery and habitat is also described.

A goal of the Lower Owens River Project (LORP) is to, “Establish a healthy warm-water recreational fishery with habitat for native species”. The flows are intended to “enhance the recreational fishery” as well as to benefit biodiversity and T & E species. Habitat indicator species designated in the Memorandum of Understanding (MOU) for the LORP are:

- Largemouth bass (*Micropterus salmoides*)
- Smallmouth bass (*Micropterus dolomieui*)
- Bluegill (*Lepomis macrochirus*)
- Channel catfish (*Ictalurus punctatus*)
- Owens sucker (*Catostomus fumeiventris*)
- Owens pupfish (*Cyprinodon radiosus*)
- Owens tui chub (*Gila bicolor snyderi*)

It is expected that all of the above fish species' habitat will be enhanced quantitatively and qualitatively through developments and flows prescribed in the MOU.

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[170] Jackson, R. 1996. Shallow groundwater levels in the Owens Valley: 1995 update. Inyo County Water Dept., Bishop, CA.

[171] Ecosystem Sciences, Tech Memo 14, 2001

Existing Conditions

Historical records show that only four species of fish (Owens pupfish, Owens tui chub, Owens sucker, and Owens dace) were native to the Owens Valley at the time of white settlement in the Owens Valley.[172] During the 19th and 20th centuries, eleven species of fish were introduced into the Owens Valley; nine are game fish.

Exotic Fish

Introduction of exotics into the Owens Valley is well documented. The following exotic fish species are currently present in the LORP area with their dates of introduction:

- Largemouth Bass (1908)
- Smallmouth Bass (1874)
- Catfish (1875)
- Bluegill and sunfish (1930)
- Carp (1881)
- Brown Trout (1877-78)

Fish species introduced into the LORP area are briefly described below:

Brown trout
While not currently in the Lower Owens River, brown trout are an introduced species which have had an impact on native species in the past. Brown trout continue to impact natives in the Upper and Middle Owens.

Largemouth bass
In the Lower Owens River largemouth bass is doing well in channel habitats and off-channel lakes and ponds. Largemouth bass also inhabit ditches and canals and rely heavily on crayfish and other fish species (particularly juvenile fish and mosquito fish [*Gambusia* sp]) as a food source. Largemouth were first introduced into California in 1874[173] and they generally prefer the quiet slower water habitat of lakes, reservoirs, farm ponds and river backwaters. Because of their popularity as a game fish, largemouth can be found in nearly all parts of the world.

The lower half of the present Lower Owens River channel is watered from the Billy Lake return south to Owens Lake. The watered section has resident populations of primarily largemouth bass and bluegill, and other exotic species such as carp, catfish and the mosquito fish (*Gambusia affinis*). While snorkeling sections of the wetted reach of the river, largemouth bass were found in abundance and in good condition. Even with the limited flow that currently exists in the wetted reaches of the river largemouth are doing well and appear to find the tule-dominated, slow-moving water acceptable habitat. Existing beaver ponds, sloughs, off-channel lakes and ponds currently provide a small, but very popular sport fishery, particularly for the bass fishermen of the valley.

Smallmouth bass
Smallmouth bass are native to most of the Mississippi River system including the Great Lakes drainage. Their preferred habitat is generally clear lakes and rivers with cool summer temperatures in the range of 20-27 degrees Celsius. Smallmouth tend to stay in one place and wander less than largemouth, but both species have similar feeding habits that utilize crustaceans and fish. Smallmouth bass tend to be more restricted in their habitat requirements and exhibit growth that is less variable than largemouth. There are few smallmouth bass in the Lower Owens River below the intake. During snorkeling surveys very few individual smallmouth bass were observed. Current conditions in the Lower Owens favor largemouth bass, however smallmouth can and will utilize more of the river habitat when flows are reintroduced with the LORP.[174]

Bluegill
Bluegill are native to much of eastern and southern North America, mostly east of the Mississippi. Bluegill were introduced into California in 1908.[175] One of the most abundant fishes in California today, bluegill thrive in warm shallow lakes, ponds and sloughs; they can survive with limited oxygen and shallow water conditions. Bluegill are

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[172] Draft EIR 1990
[173] Moyle 1976a
[174] Refer to section 2.2.9.7 for a discussion on the suitability of the Lower Owens River for smallmouth bass.
[175] Moyle 1976a

opportunistic feeders, ingesting aquatic insects, snails and small fish. Bluegill are present and abundant in the Lower Owens River channel, beaver ponds, off-channel lakes and ponds, sloughs and marshes.

Channel catfish

Channel catfish were originally distributed throughout the Mississippi and Missouri river system and their range has greatly expanded due to introductions over the last 100 years. Channel catfish have become established in the Colorado River system and in most drainage systems in California. Channel catfish are adapted to living in river channels, but are also very successful in lake and pond habitats. Channel catfish are a very fast growing species of catfish that feed on crustaceans, aquatic insects and fish, and they require a secluded hole or recessed area for spawning and incubation.

Carp

Carp are common throughout the watered reaches of the Lower Owens river channel and beaver pond complexes. Carp are in poor condition currently; their poor condition is probably due to the cool water temperatures--they prefer warmer water temperatures than is typical of the Lower Owens.

Native Fish

The native fish of the Owens Valley are the Owens tui chub (*Gila bicolor snyderi*), Owens sucker (*Catostomus fumeiventris*), Owens pupfish (*Cyprinodon radiosus*) and Owens dace (*Rhinichthys osculus ssp*).[176] Historical records indicate that the decline of the native fish assemblage occurred during the period from 1930 to 1970.[177] The rapid decline of native fish species is attributed to introductions of exotic predatory fishes and loss of habitat. While pupfish are rare, they have been kept in a relatively stable condition in small refuge sites in the Owens Valley.

Extirpation of native species occurred before biological surveys of their populations were performed, thus quantitative descriptions of their historical natural distribution and abundance is not possible. It has been suggested that Owens dace would have historically been the dominant fish in the headwaters of the Owens system and the riffles of the lower sections.[178] Pupfish are thought to have originally inhabited springs and marsh areas, while suckers and tui chub dominated the slow-flowing lower sections of the river.

Owens pupfish and the Owens tui chub are both listed as T&E species by federal and state governments. Owens speckled dace is a California species of special concern and has been listed as a species of concern in the Federal Draft Species Recovery Plan for the Owens Basin; Owens sucker is a species of special concern with the State of California. A recovery plan for Owens pupfish was approved in 1984[179], and a draft recovery plan for Owens tui chub was prepared in the mid 1980's but never finalized.

Recent California Department of Fish and Game (CDFG) sampling in the LORP area for native fishes has shown that only pupfish are present and are found at only one location, Well 368 just below Mazourka Canyon road on the west side of the river.

Current status and brief descriptions of native indicator species of the LORP are described below:

Owens pupfish

Owens pupfish were listed as endangered by federal authorities on March 11, 1967 and by the State of California on June 27, 1971. Owens pupfish have a federal recovery priority of 3, which is the highest priority of the four native fish species. Owens pupfish were thought to be extinct in the mid-1940's, according to Miller and Pister (1971).

Early explorers[180] reported that pupfish were abundant throughout the Owens River but absent from tributary streams. Owens pupfish were present in the Owens River from Lone Pine in Inyo County to Fish Slough in Mono County.[181] During the early part of this century

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[176] Moyle 1976

[177] Sada 1989

[178] Moyle 1976a

[179] U.S. Fish and Wildlife Service 1984

[180] Davidson 1859

[181] Miller and Pister 1971

Owens pupfish were thought to have been abundant in springs, sloughs, swamps, irrigation ditches, and flooded pastureland along the Owens River.

Owens pupfish are opportunistic and omnivorous feeders; they typically consume invertebrates (midge larvae and mosquito larvae is preferred) and aquatic plants that are most abundant at any time. The maximum length of pupfish is approximately two and one half inches and the fish lives a maximum of 2-3 years. Studies reviewed by Miller and Pister (1971) show that pupfish are most abundant along the edges of marshes and sloughs along the Owens River. Male pupfish are territorial, defending areas of suitable spawning substrate from other males and other fish. Juvenile pupfish grow and mature rapidly and reach sexual maturity in 3 to 4 months; they are often able to spawn just after reaching maturity.

Populations of Owens pupfish currently exist in refuges at BLM Spring, Warm Springs, Mule springs, and Well 368 in the LORP. No pupfish or tui chub were observed in Fish Slough during visual surveys by the CDFG in 1997.

Owens tui chub

Owens tui chub historically lived in large numbers throughout the valley in river channels, springs and sloughs, irrigation and drainage ditches. By the time the species was described in 1973 tui chub had been eliminated from most of it natural habitat except for the Owens Gorge below Long Valley Dam and two springs at the Hot Creek Fish Hatchery.

Owens tui chub was listed by the State of California as endangered on January 10, 1974 and listed as endangered by the federal government on August 5, 1985. According to Miller (1973), introduction of exotic species and diversion and impoundment have been the factors negatively affecting the existence of Owens tui chub.

Jenkins (1990) reported that the best reproduction of chubs in the Owens River Gorge appears to be where trout density is lowest. Jenkins (1990) stated that tui chub reproduction appeared to be significant only in the first 2.8 miles below Long Valley Dam, in a weir pool and a disintegrating beaver pond. Jenkins (1990) found that the swift areas of riffle and run were devoid of tui chubs, but that the slower water areas were their preferred habitat.

The USFWS, in their draft recovery plan, has designated critical habitat for tui chub in two locations: an 8-mile stretch of the Owens River (including 50 feet on either side of the river) from Long Valley Dam south (approximately 39 hectares of area); and two springs at the Hot Creek Hatchery, which include 50 feet of the riparian vegetation on either side of the springs (approximately 2 hectares of area). Other locations where tui chub are present in the Owens Valley system can be seen in Table 2.5.

Owens speckled dace

Owens speckled dace (*Rhinichthys osculus ssp.*) is a species of concern (California Species of Special Concern) in the USFWS's draft species recovery plan. The draft recovery plan[182] states that populations of the dace appear to be stable at the present time, but there is a need for surveys to determine the current status more accurately.

According to Moyle (1976b) speckled dace largely inhabit cool, flowing, rocky-bottomed streams and rivers. Moyle also reports that dace are successful in a variety of other situations, including warm rivers (such as the Owens river), large lakes and the outflow of springs. Speckled dace are characterized as bottom-browsers of invertebrates; they are capable of spawning throughout the summer after their second year.

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[182] USFWS 1996

Location	Native Fish Species			
	Owens pupfish	**Owens tui chub**	**Owens speckled dace**	**Owens sucker**
Hot Creek Hatchery Springs		PRESENT (Target Species)		PRESENT (Target Species)
Whitmore Hot Springs			PRESENT (Target Species)	
Little Hot Creek Pond		PRESENT (Target Species)		
Bathtub Spring			NOT OBSERVED (Target Species)	
Upper Owens Gorge		NOT OBSERVED (Target Species)		PRESENT (Target Species)
Harris Ranch			(Target Species)	
Lower Owens Gorge		PRESENT (Target Species)		PRESENT (Target Species)
Rock Creek		PRESENT (Target Species)		PRESENT (Target Species)
Horton Creek			(Target Species)	
Wylie's Pond	PRESENT (Target Species)			
Mule Springs	PRESENT (Target Species)	PRESENT (Target Species)		
Owens Valley Native Fish Sanctuary	NOT OBSERVED (Target Species)	NOT OBSERVED (Target Species)		
BLM Spring	PRESENT (Target Species)			
Warm Springs	PRESENT (Target Species)			
Cabin Bar Ranch		(Target Species)		
Keeler Pond	Potential Site (Target Species)			
Well 368 and outfall	PRESENT (Target species)			

Table 2.5: Observations in spring monitoring report of T & Es in the Owens River System (CDFG 1997)

Existing information indicates that Owens speckled dace historically occupied spring and stream habitat in the Owens Valley, including the Owens River and Fish Slough.[183] Distributional studies conducted in the 1980s found that Owens speckled dace no longer occupy habitats in the Owens River, valley floor springs, or the historic habitat at Fish Slough.[184] According to CDFG's Natural Diversity Data Base[185] there are no sites currently containing Owens speckled dace in the LORP area. CDFG does consider the Owens speckled dace a special concern species.

USFWS' draft recovery plan recommends Owens speckled dace as one of the species to be included in the Blackrock Waterfowl Management Area.

According to Sada (1989) there are a few sites that provide potentially secure habitat for Owens speckled dace. Two of these sites (Big and Little Seeley springs, and Little Blackrock Spring) are potential sites for sanctuary development in the LORP. Springs may not necessarily be the best habitat for Owens speckled dace but springs do allow management techniques that exclude predators.

<u>Owens sucker</u>

Owens sucker is a State of California Species of Special Concern but it is thought to be doing well throughout most of its range.[186] According to Sigler (1987) the species needs protection from habitat degradation, exotic species predation, competition and disease.

Owens sucker are native to the Owens River and its tributaries, and they spawn from the end of May through early July within the river. According to Moyle[187], Owens sucker seem to thrive in the valley despite human perturbations. Owens suckers are present at the Hot Creek Hatchery springs, the upper Owens Gorge, the Lower Owens Gorge above Control Gorge Power Plant, and Rock Creek (see Table 2.5).

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[183] Sada 1989

[184] Sada 1989

[185] see Appendix I of Tech Memo 14

[186] CDFG 1997

[187] 1976b

Habitat

Fish habitat within the LORP area includes the river channel, beaver ponds, oxbows and side channels, off-channel lakes and ponds, spillgate ditches, and spring and artesian well ponds. The maps (Figures 2.22-2.26) illustrate the LORP area and delineate major features between the intake and the lake.

River

The Owens River channel is dry from the intake to just above the Billy Lake return channel. Flow releases from spillgates, spring and seep inflow, and irrigation return allows flows, generally, of 8 to 15 cfs between Billy Lake return above Mazourka Canyon Road to Owens Lake. Approximately one-half of the river channel in the Lower Owens River is wetted. The existing low-flow conditions provide limited fisheries habitat. Although many reaches of the wettted channel are choked with tules, these areas do support populations of exotic fish species (e.g., largemouth bass, carp, bluegill, catfish, and mosquito fish). Tules provide escapement and refuge for young-of-the-year fish, but adult-rearing space (open water) is limited in those reaches with a high biomass of tules. Low dissolved oxygen conditions in the summer also limit fish populations.

The only reach of the Lower Owens River that supports significant riparian habitat is from about Lone Pine pond to the lake. This reach also exhibits the most diversity of fish habitat.

Beaver Ponds

Beaver can have a dramatic effect on fisheries habitat; effects depend upon natural channel size, characteristics, and endemic fish species. In flatter-gradient streams like the Lower Owens River beaver-ponding covers streambed gravels, reduces habitat diversity, and inhibits or blocks fish migration, but beaver ponds also increase bass-spawning habitat. Beaver ponds also often provide critical rearing habitat in steep-gradient streams or in streams which cannot support much riparian habitat. Therefore, reductions in fish spawning success may be offset by increases in rearing space.

Depending upon site conditions, Lower Owens River beaver play both a positive and negative role in the ecosystem. Beaver activity occurs throughout the wetted portion of the river (from about Mazourka Canyon Road to the Delta) but is most pronounced in specific areas. The first major beaver dam downstream of Mazourka Canyon occurs at the Locust Spillgate, and several older and/or smaller dams occur upstream of Locust (at Billy Lake, for example), but these dams have less effect on the in-river ecosystem.

Locust Spillgate beaver dam creates a significant backwater effect that promotes substantial tule growth in the river bed. But this beaver dam also provides important rearing habitat for bass, bluegill, and other fish species. However, due to the high degree of deposition in the pond and backwater area, fish spawning habitat is very limited at the locust spillgate beaver dam.

Tree willows have grown around the pond margins of Locust Spillgate beaver dam, and mesic plant species dominate the understory. While a definitive survey of beaver numbers has not been performed throughout the river, the Locust Spillgate beaver dam seems to support five or six lodges.

The next large beaver dam downstream of Locust occurs just below Georges Spillgate. Like Locust, the Georges beaver dam creates a large tule bed upstream in backwater areas but provides substantial fish habitat. An estimated 7 or 8 lodges are associated with this large beaver dam, and several smaller dams also exist nearby and upstream.

The island reach, known as the Alabama Gates area, supports a substantial number of small beaver dams. Because of flow variation and shifting of stream discharge to different channels from time to time, large and old beaver dams have not been developed. Consequently, beaver ponds in this area provide little fish habitat, but they do contribute to the development of mesic meadows and elevated meadows. It is unknown how many beaver lodges occur in this area.

Another substantial beaver pond occurs upstream of the Lone Pine Pond area. This dam creates substantial deep water fish habitat and heavy riparian habitat upstream for nearly a mile. The Lone Pine Pond beaver dam also creates a large tule bed upstream stretching to the island reach. Another large beaver dam occurs downstream of the Lone Pine Pond and contributes to the formation of the backwater that makes up the Lone Pine Pond. Again, significant fish habitat is associated with beaver ponds and tule beds throughout this reach.

Off-River Lakes Ponds Ditches

One goal of the LORP is to maintain or establish the off-river water bodies to sustain diverse habitat for fisheries, waterfowl, shorebirds and other animals. Diverse natural habitats will be created or maintained consistent with the needs of the "habitat indicator species," as specified in the MOU. The major off channel lakes with standing water within the LORP area are Twin Lakes, Goose Lake, Coyote Lake and Billy Lake. Other significant lake beds are Long Lake, Hidden Lake and Duck Lake, or the Tulare swamp area. Calvert slough is outside the LORP area but is mentioned in the MOU for wetland enhancement. Diaz Lake south of Lone Pine is also isolated from the river and has more value as waterfowl and wetland habitat than for fisheries.

The future Blackrock Waterfowl Habitat Area will support a perennial water area of 116 acres that includes some of the off-river lakes and ponds. The Blackrock Area will consist of three cells, Drew Slough, Waggoner and Winerton areas, which will be alternately flooded and desiccated to control tule growth and encourage waterfowl and shorebird habitat. Therefore, the Blackrock wetlands, while large, may not be suitable for fish. Other existing ponds or lakes are the Thibaut pond areas that include the Tulare swamp; these areas are remote from the river and lack direct connections.

A network of canals and ditches was created in the late 1800s to move water for irrigation, livestock, drainage and other purposes. Many have been taken out of service and some still remain for moving water. Although there are numerous ditches scattered over the project area the major ditches/canals for water conveyance are the Blackrock Ditch, Independence Ditch, Stevens Ditch, Locust Ditch, McIver Ditch and Georges Ditch.

The off-channel lakes, ponds and ditches are in many cases connected to the main channel of the Owens River.

Springs & Seeps

Significant springs such as Big and Little Seeley, Reinhackle and Little Blackrock could provide suitable habitat and sanctuaries for native fishes because movement of fish into the springs can be controlled. Two artesian wells also have small areas of habitat with potential as native species sanctuaries. Well 368 (an existing pupfish sanctuary) and the Mazourka Canyon Road artesian are two wells that have could be used as controlled sanctuaries in order to increase populations of native fishes. Below Tinemaha Dam where five channels connect with the Owens River a major seep area occurs, and each of the five channels has a weir control structure that would allow water control for habitat regeneration and exclusion of predators.

Management

Recreation

Current management for recreation has largely been through the maintenance of flows for the off-channel lakes and ponds such as Billy Lake, Twin Lakes and Goose Lake; flows have been maintained for bass and bluegill habitat primarily. As a result, recreational fishing has become quite popular, particularly for largemouth bass. The lower sections of the Owens River below Billy Lake are watered by return flows from irrigation and ditch flows from the aqueduct. Beaver dams along the wetted reach have created ponded bass habitat areas that are popular recreational fishing sites in the LORP area. Where the Lower Owens River crosses the road at Mazourka Canyon and Manzanar Reward roads, heavy angler-use bass fishing pools have developed.

T & E Species
Several fish sanctuaries have been established throughout the Owens River Valley for threatened and endangered species (T & E species). The only special management area or sanctuary in the LORP is for pupfish, at Well 368. The last quantitative assessment of Well 368 was performed by the CDFG[188] and found 10 juvenile pupfish and one adult female in the spring outflow above the fence enclosing the ponds, and 5 juvenile or young-of-the-year and 6 adult females in the secondary channel. In another pond approximately 100 dead pupfish were observed.[189] Observations by LADWP staff in May 1998 found the pond sanctuaries were dry and the channel above them also showed no evidence of pupfish. However, the spring outflow in May, 1998 had shifted to the northern channel primarily. When the northern channel was assessed for pupfish, it was found to contain an estimated 4,000 to 5,000 pupfish in the channel and terminus pools downslope of the spring. Clearly, pupfish thrive in linear habitat better than in pool habitat, and a natural event at Well 368 has resulted in the dramatic expansion of the pupfish population in the LORP area.

In the past, native fish species management programs have had limited success. One example is the Owens Valley Native Fish Sanctuary where attempts have been made to isolate the native species through the creation of barriers. This attempt at isolation has largely failed due to repeated intentional and accidental introductions of exotic fish species; isolated sanctuaries such as this also encourage genetic introgression and reduced viability for native fish species. Simply isolating T&E species is not enough. Fish sanctuaries should be strategically placed so that once the native species populations have become established and stable, they can then access the greater riparian ecosystem and naturally recolonize by slowly filling niches that afford them protection and rearing habitat.

Future Conditions

Instream Flow
The controlled flow study performed in 1993[190] provided the basis for (1) establishing optimum channel flows for target fish species, (2) establishing optimum out-of-channel flows for riparian vegetation and instream habitat, and (3) determining the channel response to different flow levels. The controlled flow study was a mathematical simulation of both fish habitat and channel geomorphological and hydrological response, and, while models are by nature inexact because too few variables can be modeled, the results do establish reliable starting points for ecosystem management. The controlled flow study in 1993 indicated that a base flow of 40 cfs (a year-round minimum flow) will provide optimum habitat for target fish species. A freshet flow of up to 200 cfs will provide optimum water spreading for the regeneration and maintenance of riparian habitat.[191]

Connectivity and Corridors
In addition to instream channel flows, flows will be used to connect off-channel fish habitats with the river channel. These connections will serve as corridors for fish migration, spawning and nursery areas, and rearing areas; corridors also provide pathways for fish movement and create riparian habitat for a variety of birds, mammals, reptiles and amphibians.

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[188] Cunningham 1992
[189] Cunningham 1992

[190] Hill,M., W.S. Platts, S. Jensen, and G. Ahlborn. 1994. Data base and modeling results for the lower Owens River Project: controlled flow study. LADWP, Bishop, CA.

[191] See Technical Memorandum #1 for a detailed description of instream flow management

HABITAT	Large-mouth Bass	Small-mouth Bass	Bluegill	Catfish	Brown Trout	Carp	Sucker	Dace	Pupfish	Tui Chub	Gambusia
Above Intake	X	X	X	X	X	X	X	X	X	X	X
Upper Twin Lakes	H	L	H	M	N	H	N	N	N	N	M
Lower Twin Lake	H	L	H	M	N	H	N	N	N	N	M
Blackrock Wetland	X	X	X	X	X	X	X	X	X	X	X
Blackrock Ditch	H	H	H	M	L	H	N	N	N	N	M
Coyote-Grass Lake	H	N	L	L	N	H	N	N	N	N	M
Goose Lake	H	N	H	M	N	H	N	N	N	N	M
Long Pond	M	N	M	L	N	H	N	N	N	N	M
Independence Ditch	X	X	X	X	X	X	X	X	X	X	X
Billy Lake	H	N	H	M	N	H	N	N	N	N	M
Billy Lake Return to Owens River	X	X	X	X	X	X	X	X	X	X	X
Owens River: Billy Lake to Locust Ditch	H	N	H	M	N	H	N	N	N	N	H
Locust Ditch	M	H	H	L	L	H	N	N	N	N	H
Owens River: Locust Ditch to Manzanar-Reward	M	L	M	M	N	H	N	N	N	N	H
Owens River: Manzanar-Reward to Georges Creek Return	M	N	M	M	N	H	N	N	N	N	H
Owens River: Georges Creek Return to Reinhackle Springs	X	X	X	X	X	X	X	X	X	X	X
Reinhackle Springs	X	X	X	X	X	X	X	X	X	X	X
Owens River: Reinhackel Springs to the Island (Alabama Hills)	U	U	U	U	U	U	U	U	U	U	U
Owens River: the Island area	U	U	U	U	U	U	U	U	U	U	U
Owens River: Island to Lone Pine Station Road	L	N	L	L	N	L	N	N	N	N	M
Owens River: Lone Pine Station Road to Keeler Bridge	L	N	L	L	N	L	N	N	N	N	M
Owens River: Keeler Bridge to the Delta	H	N	H	U	N	H	N	N	N	N	M

N=not present; U=presence/absence unknown; L=low abundance; M=moderate abundance; H=high abundance; X=no angling

Table 2.6. Distributions of fish species by river reach in the Lower Owens River (source is angler surveys).

Connectivity is a measure of how well a corridor is spatially contiguous, and which may be simply quantified by the number of breaks per unit length of corridor.[192] Since the presence or absence of breaks in a corridor is considered the most important factor in determining the effectiveness of both the conduit and barrier functions, connectivity is the primary measure of corridor structure.[193]

Corridors originate by the same processes as patches (landscape disturbance). A key characteristic of corridors, as seen from the air, is connectivity, or the presence of breaks. Nodes in the breaks contain interior species that are commonly found in corridors, and, when seen from the air, nodes form a "string-of-lights" structure. Corridors usually have sharp contrasts in microclimatic and soil gradients from one side to the other, and their centers usually form a typically unique habitat that has been partly determined by the

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[192] Forman and Godron 1986

[193] Merriam 1984; Baudry 1984; Forman and Godron 1984

transportation or movement taking place along the corridor.[194]

A stream corridor is a band of vegetation and waters that houses and moves biotic and abiotic elements. This type of stream corridor may cover the edges of the channel, the floodplain, the banks above the floodplain, and part of the upland above the banks. Stream corridors and their associated riparian vegetation have an important role in controlling water and mineral nutrient flows.[195] Stream corridors also act as routes for the movement of fish, terrestrial plants and animals across the landscape[196]; various butterflies, birds, and other animal and plant species commonly depend upon this open strip within the stream corridor.

Stream corridors to be developed in the Lower Owens River with the LORP will capitalize on existing connections (see maps - Figures 2.22-2.26). The corridor from Blackrock Ditch to Upper and Lower Twin Lakes through Waggoner wetlands and the Coyote/Grass Lake complex to Upper and Lower Goose Lake will be extended to connect with the river channel[197]. This will be accomplished by directing approximately 5 cfs of flow through the existing channel that currently runs south from Goose Lake and nearly parallel with the river to a confluence just above Five Culverts. Flow in the Blackrock Ditch will be extended to the river so that a continuous corridor from the Lower Owens River through the Blackrock wetlands, through the Twin Lakes complex, through Goose Lake, and back to the river channel, will be created. This corridor will allow the free movement of fish between the off-channel lakes and ponds to the river, thus providing substantially more habitat that offers greater diversity.

A second corridor originating from Independence Spillgate through Long Pond to Billy Lake and the river channel will be enhanced and maintained (see Figures 2.22-2.26).

Habitat Diversity and Utilization

River Channel

The principle habitat feature of the Lower Owens River will be riparian vegetation. The type of riparian vegetation that develops in each river reach will have a strong influence on the fish species present and their relative abundance. It is anticipated that the Lower Owens River will consist primarily of open and closed vegetation canopy reaches. Those river reaches where tree willow is the dominant overstory, or canopy vegetation, will have extensive shading, bank cover, and open-water habitat that will be very different from river reaches that lack a vegetation canopy and where tules are common.

Many studies have shown the importance of aquatic vegetation to provide food and refuge for the juveniles of a number of fish species.[198] Human activities such as dredging, herbicide application, or mechanical removal that reduce or eliminate aquatic vegetation, could have severe impacts on the survival of juvenile fishes and therefore also on fish recruitment to adult populations.[199] Laboratory studies have demonstrated that juvenile bluegills (Lepomis macrochirus) are highly vulnerable to predation by largemouth bass (Micropterus salmoides) when the stand density of vegetation falls below certain levels.[200] These studies also indicate that juvenile bass species discriminate among densities of vegetation and select vegetation densities that are high enough to reduce predation risk.[201]

Just as smallmouth bass currently do above the intake, populations of smallmouth will probably expand into the restored riverine habitat. It is anticipated that their populations will increase over time; however, it is expected that largemouth bass will remain the dominant bass species despite greater numbers of smallmouth.

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[194] Forman and Godron 1986
[195] Schlosser and Karr 1981
[196] Forman and Godron 1986
[197] An optional corridor may be established linking Lower Twin Lake directly with the Coyote/Grass lake complex as shown in the river map.
[198] e.g., Savino and Stein 1982; Keast 1984; Rozas and Odum 1988; Schramm and Jirka 1989
[199] Hayse and Wissing 1996
[200] Savino and Stein 1982; Gotceitas and Colgan 1987
[201] Gotceitas and Colgan 1987

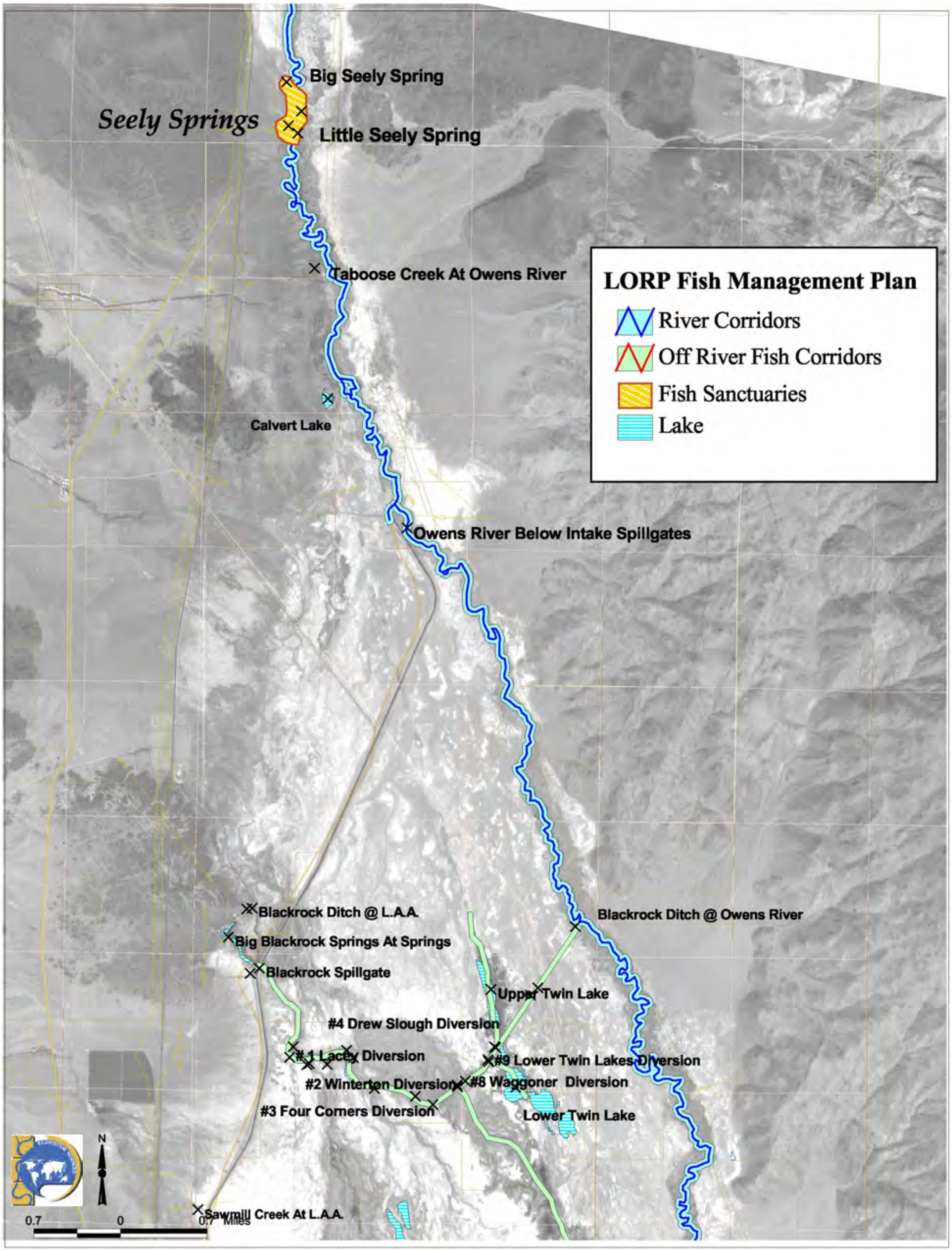

Figure 2.22. LORP Fish Management Plan Corridors

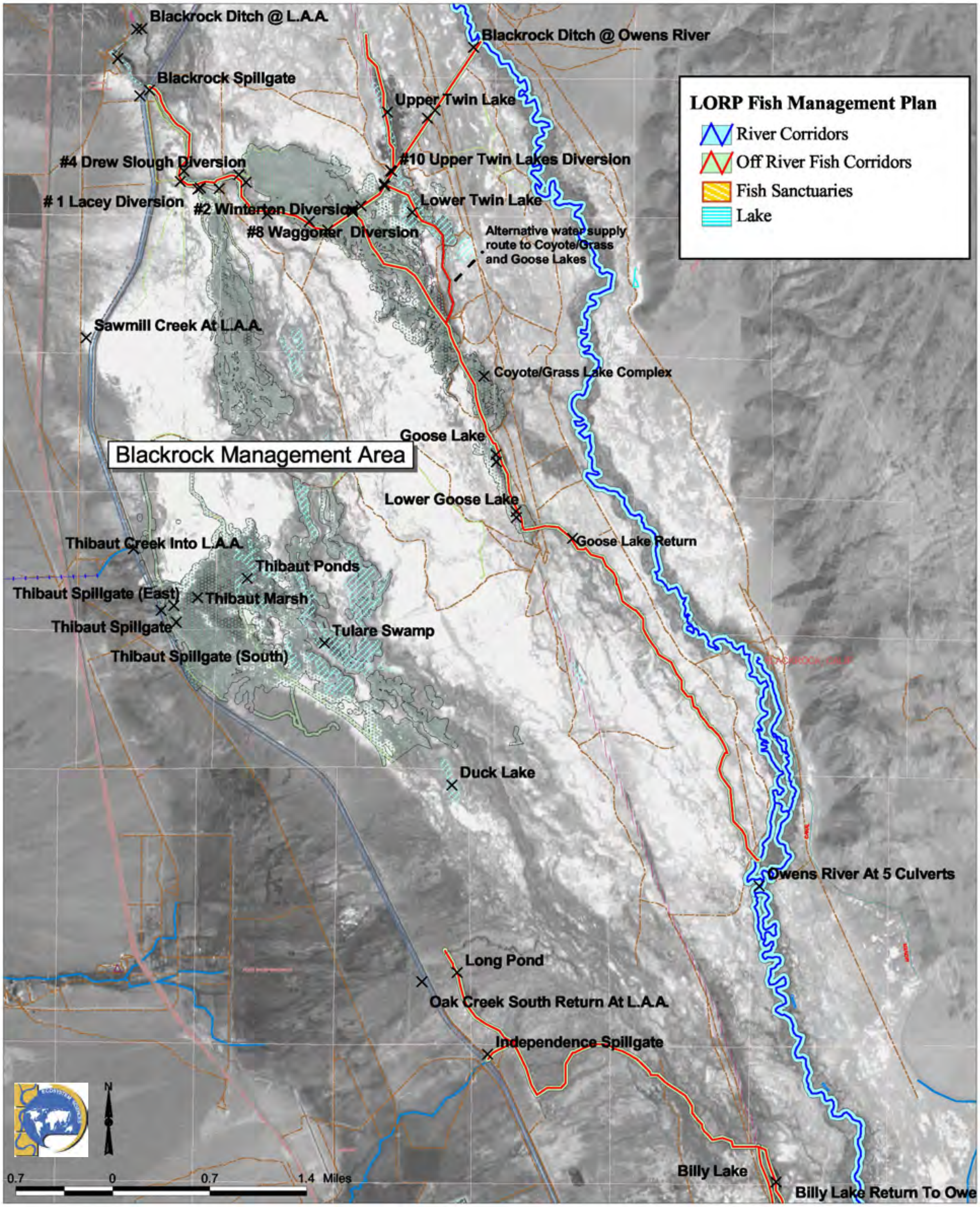

Figure 2.23. LORP Fish Management Plan Corridors

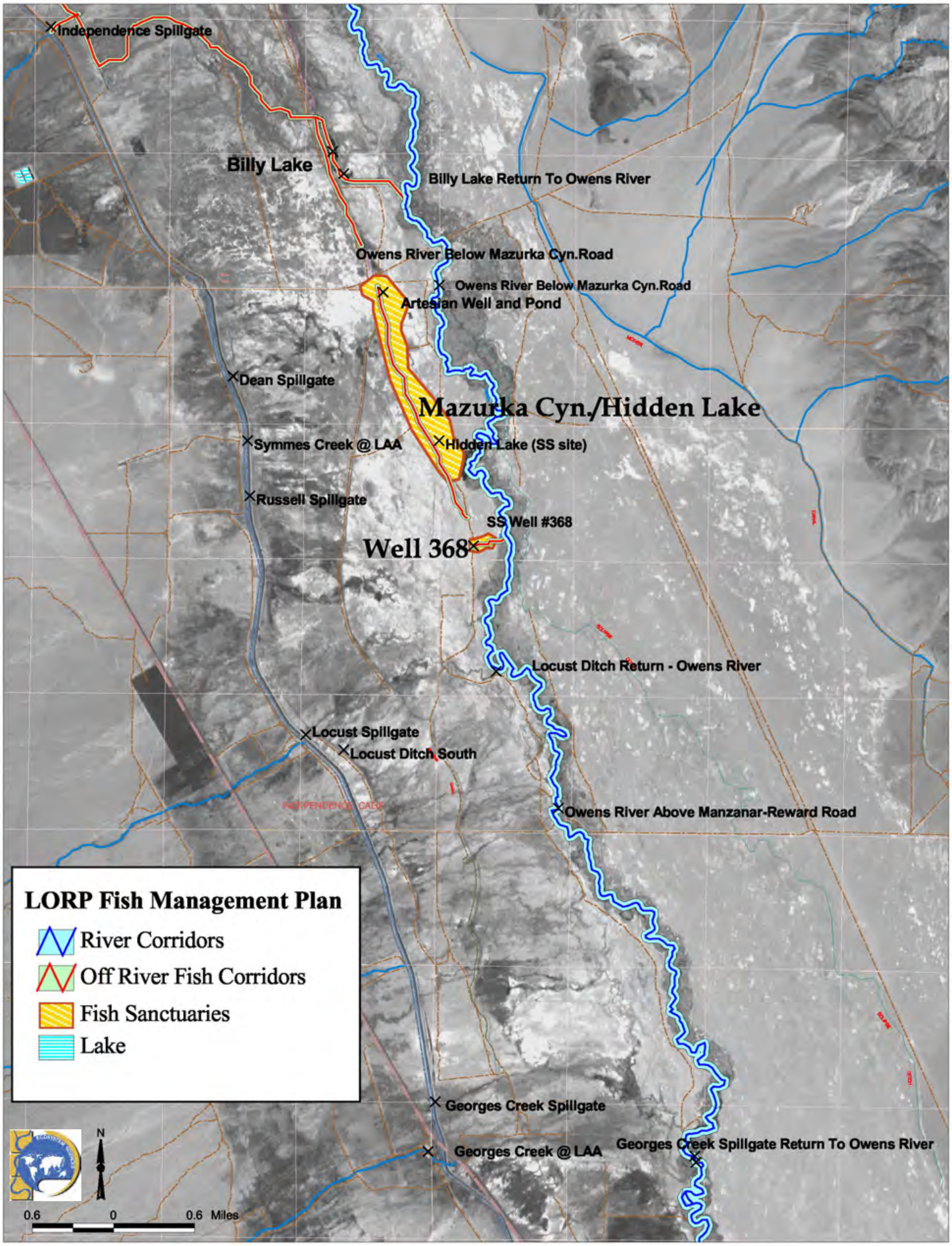

Figure 2.24. LORP Fish Management Plan Corridors

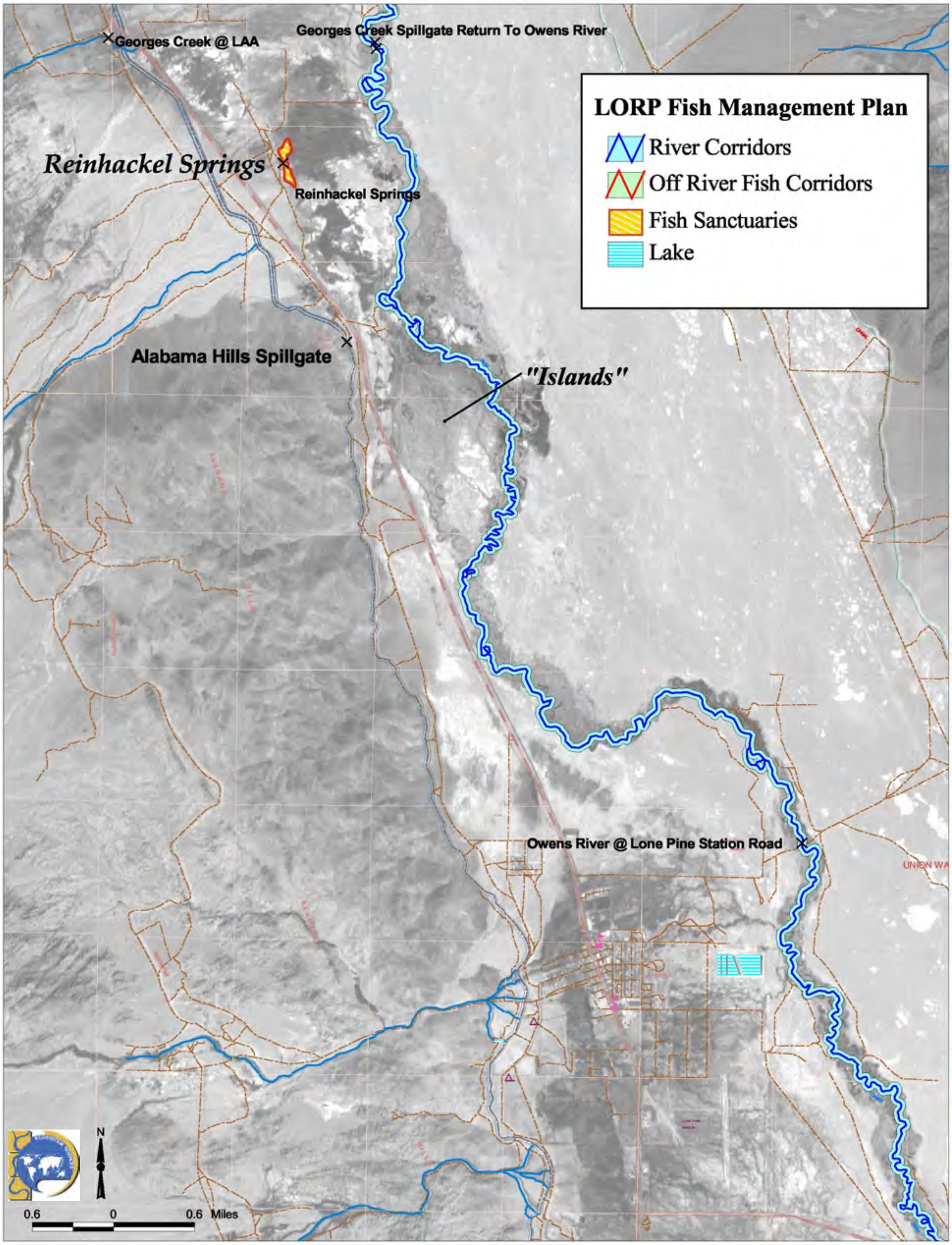

Figure 2.25. LORP Fish Management Plan Corridors

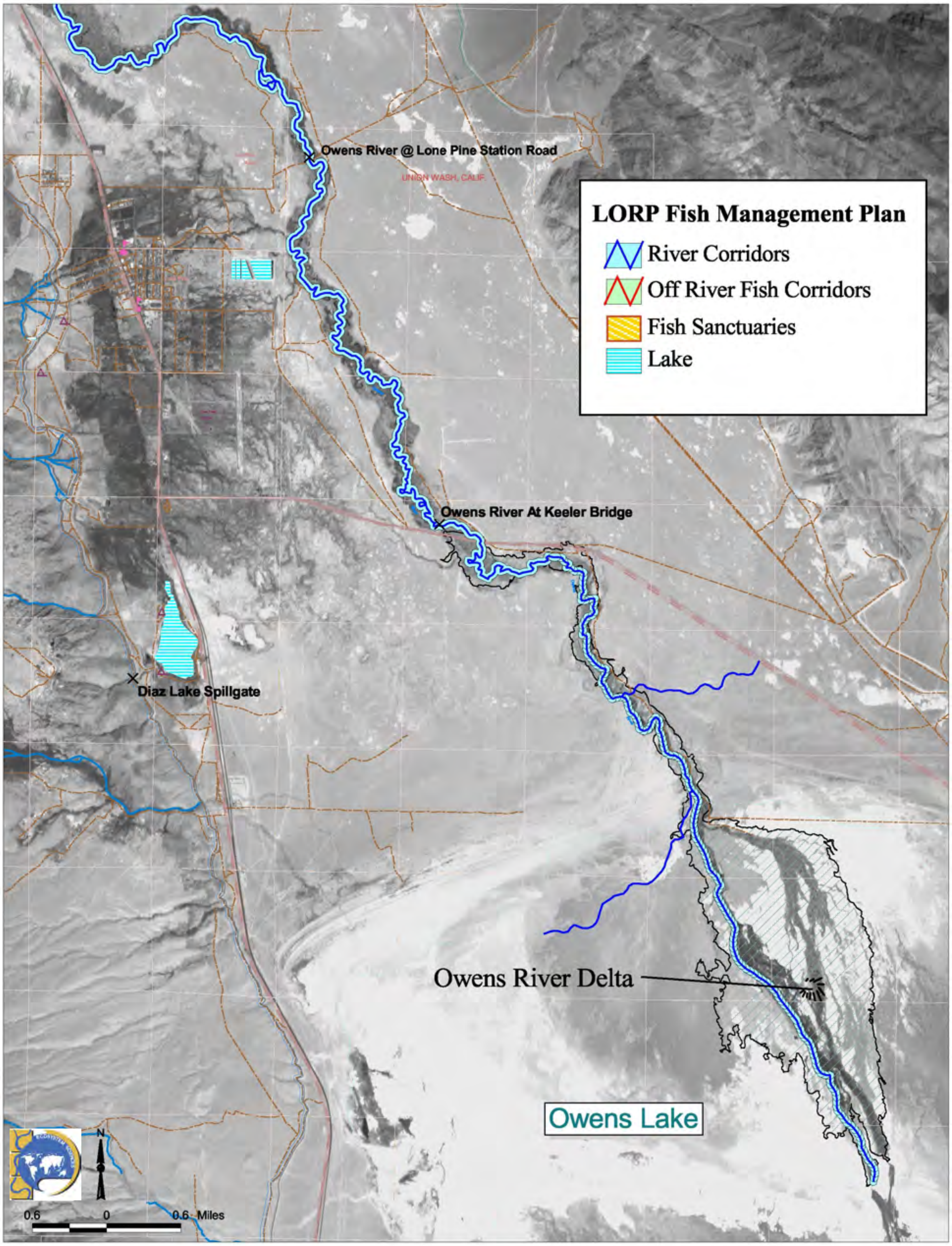

Figure 2.26. LORP Fish Management Plan Corridors

In addition to reducing predation risk, increases in vegetation density can also decrease the rate at which juvenile bass catch invertebrate prey.[202] Thus, the selection among densities of vegetation by juvenile bass could depend upon a number of factors, especially the availability of invertebrate prey and the risk of predation in each of the vegetation densities available. Because other studies have suggested that predation risk and food availability may affect the density of artificial vegetation that is selected by juvenile fish, Hayse and Wissing (1996) conducted experiments to measure how growth rates of age-0 bluegills and predation by largemouth bass were affected by stem density. They found predation rates were significantly lower in medium and high stem densities compared to low and zero stem densities; high-density vegetation offered significantly greater protection than medium density vegetation stands.[203]

The Owens River reach from the intake to Five Culverts will represent the area of greatest habitat diversity in the LORP area. In this reach warmwater fish species will have access to numerous off-channel lakes and ponds and will capitalize on the corridors between water bodies. Water quality modeling indicates that this reach will exhibit lower temperatures and higher dissolved oxygen.

The island reach will be a transition-type habitat, and the river in this reach will spread and flow through numerous channels where emergent wetland-type vegetation and tules will dominate. The island reach will provide substantial nursery and early rearing habitat for warmwater fishes. Below the island reach to the Delta, riparian vegetation currently includes tree willow canopy and complex in-channel habitat. It is anticipated that side channels and oxbows in this reach will create warmwater fish habitat as diverse as the upper-most river reach.

Beaver Ponds

Although beaver activity has removed much of the willow and other shrub and woody vegetation, beaver dams also create favorable tule conditions, provide important fish rearing habitat and mesic meadows, and promote the growth of other riparian species. The physical removal of beaver dams will undoubtedly result in more adverse environmental impacts than environmental benefits.

In the short-term beaver ponds will continue to provide the dominant fish habitat type in the river reach below Mazourka Canyon Road to the Delta. In the long-term beaver ponds will be slowly washed away and incorporated into the river system, but will leave behind deep pools and open water surrounded by riparian vegetation.

It is our conclusion that beaver dams should be left as they are and allow the natural forces associated with future out-of-channel and base flows to remove or incorporate them into the riverine ecosystem. Instead the LORP uses a management strategy that will focus upon controlling the number of beaver by river reach through trapping. Fish will continue to concentrate in beaver ponds in the river reach below Mazourka Canyon Road in the short term, however, as instream and riparian flows begin to alter river channel habitat and beaver ponds, game fish will quickly expand into the increasing river habitat as pond habitat declines.

Off Channel Lakes and Ponds

Off-channel lakes and ponds currently provide high quality warmwater fish habitat for largemouth bass and bluegill, in particular. Habitat quality will probably increase as more water flows through Twin and Goose Lake complexes to meet corridor flow requirements; the flow will increase the turnover time in the lakes and slightly raise water surface elevations. Warmwater fish species will have access between the river and lakes, but due to high water temperatures and low dissolved oxygen concentrations in the migration corridors throughout the day, fish will probably exhibit the greatest migration activity at dusk and early evening.

Migration Corridors

The shallow water habitat, biomass of vegetation, high water temperatures, low dissolved oxygen and low flow velocities that

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[202] Savino et al. 1992
[203] Hayse and Wissing 1996

will characterize LORP migration corridors will be preferred habitat for non-game fish species like mosquito fish, carp and suckers. In time, as native fish populations recover and recolonize the LORP area, pupfish will be commonly found in the corridors connecting lakes, ponds, wetlands and the river.

The conditions that will make the corridors unappealing to warmwater game fish are the preferred conditions for pupfish. Pupfish and other native fishes will find good spawning and rearing habitat, and escapement and cover from predators that is associated with dense vegetation. High temperatures and low oxygen conditions will limit bass utilization of the corridors for most life cycle requirements except migration.

T& E Habitat

Native fish habitat will be enhanced through re-watering efforts planned for the Lower Owens River Project to restore river habitat in the channel, floodplains and shallow flooded areas through the entire river. Predation by, and competition with exotic fish species will be the principle drawback to species recovery. The predation threat will be ameliorated with fish sanctuaries that will allow the recovery of viable reproducing populations of native species within and outside of the project area. When native fish populations reach levels of recovery that allow for their delisting as T&E species they will be released from the sanctuaries via the corridors to the river and off-channel habitat. In time, it is anticipated that T&E fish species will recolonize suitable habitat throughout the Lower Owens River ecosystem.

Once T&E species have been reintroduced to the greater ecosystem, competition and predation will be minimized through habitat complexity and diversity. The continued survival of native fishes will depend upon total aquatic habitat diversity of the LORP area. Habitat diversity and complexity will be a natural consequence of increasing riparian vegetation growth and maturation and access to off-channel lakes and ponds--corridors in particular. Pupfish especially will select shallow water corridor habitat with high water temperatures, low dissolved oxygen and dense aquatic plant biomass. While Owens pupfish will also thrive in such habitats, corridors will be less desirable to largemouth bass, bluegill, and other predators. Thus, native fish will find refuge, spawning, nursery and rearing habitat in corridors that are relatively predator-free and competition-free.

While the native species will be able to immigrate from sanctuaries to the larger river and off-river systems, the native species sanctuaries should remain intact at least until it is seen that habitat in the river and off-channel areas can sustain viable reproducing populations of native species.

Sanctuaries

The known populations of Owens tui chub and pupfish are far too fragile and too few in numbers to successfully reintroduce them to the LORP area at the present time. Sanctuaries are necessary to produce adequate numbers (critical mass) of threatened and endangered fish species for recovery into habitat that has been regenerated by re-watering the Lower Owens River.

The criteria for the selection of sanctuaries includes: (1) the quality of the habitat to serve as a sanctuary; (2) the manageability of the water body, including the water supply and discharge elements; and (3) whether the sanctuary is or can be connected to the greater Lower Owens ecosystem.

In general, each of the sanctuaries will need to remain predator-free and will require a limited amount of construction to ensure that they remain so. Each sanctuary will also require a small dam with a spillway to prevent exotic fish from migrating into the sanctuary, yet allow, in some cases, movement of the native species out of the sanctuary and into habitat below. Since T&E species will be in sanctuaries with existing control structures, or in places where control structures are not needed, fish screens will not be required.

Future Management

Fish habitat management, which will include land use and flow management, will be performed as part of the overall LORP management by the LADWP. Fisheries management per se (i.e., stocking and regulations) is the responsibility of the CDFG. Both agencies must collaborate to pool and analyze data during the monitoring years to implement adaptive management strategies.

A fundamental concept in watershed management is adaptive management--"learn as you go and make changes as needed." Successful implementation of adaptive management requires management to take risk-prone actions while providing institutional patience and stability. The experimental nature of adaptive management requires that managers and politicians redefine success so that learning from error becomes an acceptable part of the learning process. In addition, information must be collected and analyzed over time frames that often exceed the typical tenure of political decision-makers. Adaptive management also needs to be predicated upon clearly established goals and decision criteria that will allow for accountability and evaluation of how well goals are being met. Furthermore, the goals must be compatible with natural processes, existing or achievable technology, and social norms. One of the fundamental obstacles in the way of effective implementation of adaptive management is an agreed-upon definition of the term, how, and if adaptive management changes should be implemented. The application of adaptive management decisions and actions would show greater success in resolving natural resource management conflicts if it were universally defined as a link of scientific knowledge and methodology with management, and an implementation of management as a problem-solving process requiring flexibility and change when problems demand workable solutions.

In the case of fisheries in the Lower Owens River, adaptive management will be the critical tool to reach the desired goal of a healthy warmwater fishery. Monitoring of fish habitat as the ecosystem restoration processes continue, will provide the essential feed-back from which decisions on game fish and T&E species management can be made. Management decisions over time will undoubtedly include refinement of connectivity and corridors that link habitats, recovery rate and level for reintroducing native fish species; stocking, harvest, access, regulation of angling, and altering actions in relation to land and water uses and events. It will also become apparent in time how species interact spatially and temporally and how fisheries management should proceed when the ecosystem reaches a dynamic equilibrium.

Location of Sanctuaries	**Native Fish Species**			
	Owens pupfish	**Owens tui chub**	**Owens speckled dace**	**Owens sucker**
Little Blackrock Springs	X	X	X	
Big Seeley Springs	X	X		
Little Seeley Springs	X	X	X	
Artesian Well 368	X			
Hidden Lake Corridor	X		X	X
Reinhackle Spring	X	X	X	X

Table 2.7 Primary sanctuary sites for T&E fish species in relation to the LORP.

LORP Technical Document: Alternative Goose Lake Fish Corridor; Route Development, Field Assessment, and Description[204]

The Ecosystem Management Plan[205] describes a fish corridor connecting the off-river lakes and ponds (via Goose Lake), the Blackrock Management Area, and the Lower Owens River. The plan was developed over a number of years and encompasses a broad range of projects. During the LORP implementation phase the viability and usefulness of the water connecting route laid out in the Ecosystem Management Plan came into doubt. To determine if alternate routes were feasible, and potentially superior, an investigation into the merits of the possible fish passage routes was undertaken in early 2006. Ecosystem Sciences

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[204] Ecosystem Sciences, 2006
[205] Ecosystem Sciences 2002

and LADWP personnel (survey department) performed separate field investigations of the original route described in the Ecosystems Management Plan, and an alternate, shorter route. The conclusions of the field investigations were presented in a technical report; *LORP Technical Document, Goose Lake Fish Corridor Project Development, Field Assessment, and Route Selection Recommendation*.[206] The results of these investigations led to the cooperative decision by both LADWP and Inyo County Water Department (ICWD) to develop the alternative fish corridor route with some minor modifications (Figures 2.27 and 2.28).

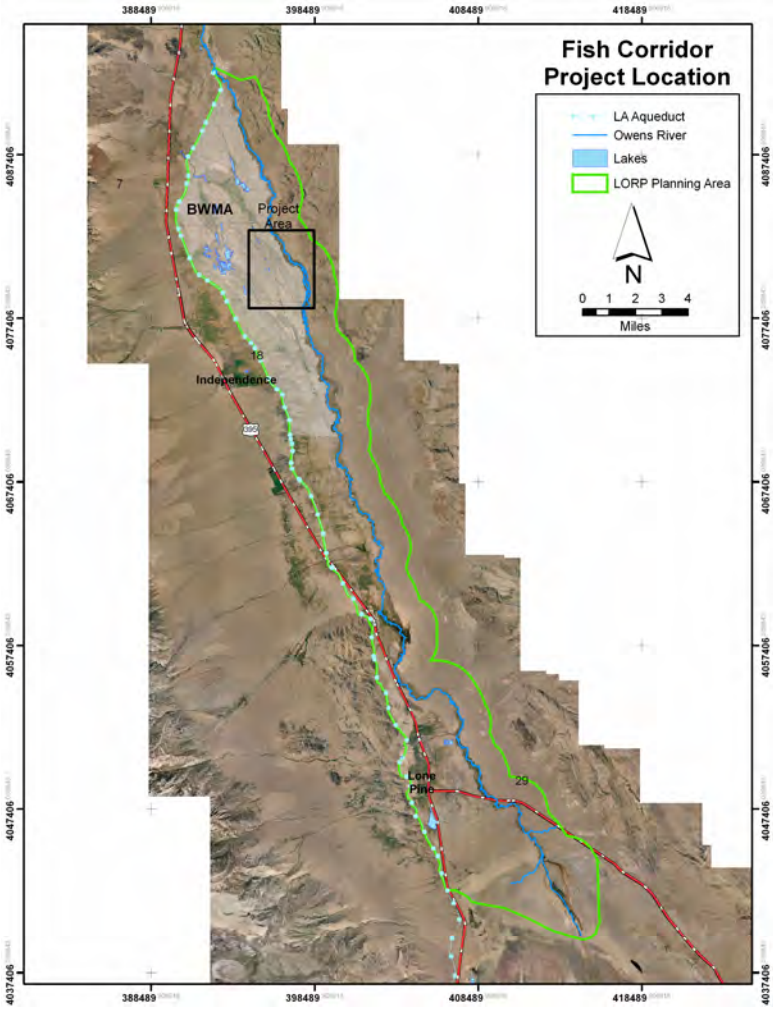

Figure 2.27. Alternative Fish Corridor Route Location in LORP

This document describes the agreed upon alternative fish corridor route.

The background section below is excerpted from the Ecosystem Management Plan and is included to provide a framework from which to view the development of the fish corridor.

Background[207]

In addition to instream river channel flows, flows will also be managed to connect off-channel fish habitats with the river channel. These connections will serve as corridors for fish migration, spawning and rearing areas; corridors will provide pathways for fish movement and create riparian habitat for a variety of birds, mammals, reptiles and amphibians.

Stream corridors to be developed in the Lower Owens River area will capitalize on existing connections. Flow in the Blackrock Ditch will be extended to the river so that a continuous corridor from the Lower Owens River through the Blackrock wetlands, through the Twin Lakes complex, through Goose Lake and back to the Owens River will be created. This corridor will allow the movement of fish between the off-channel lakes and ponds to the river, thus providing substantially more habitat with greater diversity. Largemouth bass and bluegill are already present in these lakes and ponds and the corridor will give these game species access to and egress from the river. A connection will be established from Blackrock Ditch to Upper and Lower Twin Lakes through Waggoner wetlands, and from Coyote/Grass Lake complex to Upper and Lower Goose Lakes forming a corridor that will be extended to connect with the river channel. The connections will be accomplished by directing approximately 5 cfs of flow through the corridor to the Owens River. An old, undefined runoff channel currently runs south from Goose Lake and nearly parallel with the river to a confluence just above Five Culverts (now Two Culverts, after recent modifications).

Shallow water habitat, aquatic vegetation, high and low water temperatures, low dissolved

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[206] Ecosystem Sciences, August 2006

[207] LORP Ecosystem Management Plan (Ecosystem Sciences, 2002) and LORP EIR (LADWP, 2004)

oxygen, and low flow velocities are expected to characterize corridors, and will most likely be preferred habitat for non-game fish species like mosquito fish, carp and suckers. In time, as native fish populations recover and are allowed to recolonize aquatic habitats, pupfish might also be found in the corridors connecting lakes, ponds, wetlands and the river.

The primary management objective for off-channel lakes connectivity is to sustain a warmwater recreational fishery in good condition. The first action is to provide a water connection from Lower Twin Lake to the Coyote/Grass Lake Complex, through Goose Lake, and then to the river. Approximately 5 cfs will be maintained between Goose Lake and the Owens River to allow unimpeded passage for fish between the lakes and river.

The second action is to maintain Upper Twin and Goose Lakes at a staff gage reading of 1.5 to 3 feet to ensure that water levels are high enough for Goose Lake to spill and, thus, create corridor connectivity with the river.

Field Assessment Methods

LADWP survey crews conducted a detailed topographic survey of the route. The survey information was entered into AutoCAD and ArcView GIS programs. Ecosystem Sciences personnel walked the route in the field. The route starts at the basin edge below Goose

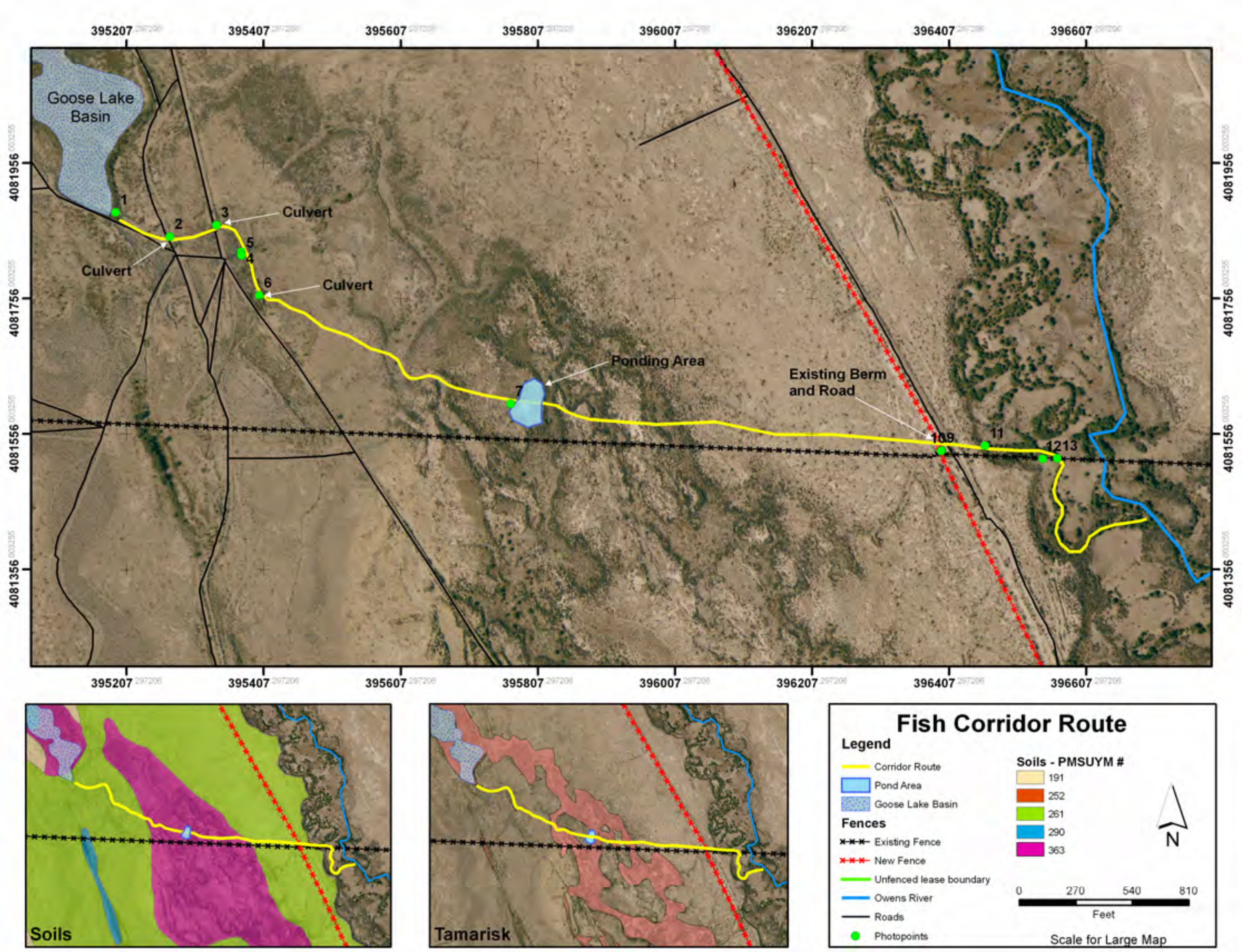

Figure 2.28. Goose Lake to River Channel Alternative Fish Corridor Route

Lake and continues down the route to the confluence with the Lower Owens River (Figure 2.28). The field investigation of the route includes a general description of the route conditions, the topography and existing vegetation, channel definition (if there was a channel present) and photo points of site features along the length of the route. Any existing water control structures were photographed and described. GIS points of each existing water control structure were taken and are shown on the route map along with the corresponding LADWP water structure number. Soil conditions are overlaid from existing GIS soil shapefiles of the LORP area, as are vegetation conditions.

Description

The fish corridor route originates below the Goose Lake basin (Figures 2.27). In order to provide connected fish passage the Goose Lake basin will be permanently flooded rather than have a ditch through lower Goose. The existing flow control structure will be rebuilt to allow a 5cfs outflow and create backwater. This will result in a new, 14-acre pond. This route is a combination of old, undefined runoff channels and uneven terrace terrain. The route generally runs east-south-east from Goose Lake to the river.

Final Route

This fish corridor route has been agreed to by both LADWP and ICWD. This new, alternative route takes a more direct heading to the river. The shorter route will achieve the same fish corridor goals, but with fewer impacts to the landscape, less maintenance required, and much less cost of construction than that of the original route described in the LORP EIR.

The main reasons for developing this alternative route are:

1. Alternative route meets the goals of the Ecosystem Management Plan and the FEIR for fish corridors.
2. The length and maintenance of the alternative corridor route, such that it provides conditions for healthy fish habitat and passage, will be easier to achieve than a long route to the river.
3. Maintaining necessary water flow conditions along the length of this corridor will be much easier to achieve.
4. The shorter, alternative route will minimize construction impacts on the landscape. Because the route is shorter, heavy equipment excavation and removal of vegetation over the 0.71 miles will have much less impact than development of the longer route to the river (over 5 miles in length).
5. The short route will minimize disturbance and spreading of salt cedar. The alternative route crosses only one spreading basin that contains salt cedar. The potential for construction activities to disturb and spread tamarisk along the length of the route is high, but much less of a concern then the long route. Also, costs for the removal and treatment of tamarisk will be significantly lower for the short route versus the long route.
6. The alternative route will be much less expensive to construct and to maintain over time than the longer route.
7. The alternative route will have very little effect on future water spreading needs within the existing spreading basins. The alternative will not breach the existing water spreading basins to the south.

In conclusion, this alternative route, the shorter and more direct route to the river, will be developed as the fish corridor linking Goose Lake to the river channel. Using this route minimizes probable impacts to existing resources resulting from construction and maintenance, while the primary goal of fish egress between the lake, wetlands and river are met. Also, this route will result in the creation and maintenance of more then 14 acres of ponded, open-water habitat.

2.2.9.8 Tech Memo #14 Addendum[208]

Suitability of Smallmouth Bass as a Target Species for the LORP

The question has been raised whether smallmouth bass is a suitable target species toward which to direct decisions on streamflow requirements to restore the fish and wildlife of the Lower Owens River. The concern centers on spawning habitat or, rather, the lack of it in the river. The Lower Owens River is a sandbed stream with very little gravel. It is doubtful that streamflows will downcut the bed to some underlying strata of material larger then the silt-sand-pebble material currently dominating the substrate. More likely, streamflows will mimic historic lateral movement of the channel resulting in continued colluvial input of sand and pebble-sized material. While some gravel-sized material does occur in the streambed, it is rare and unlikely to increase appreciably unless tributaries make significant contributions. However, it can be expected that velocity patterns will redistribute large-sized material (existing gravel and pebble) throughout the stream. This is particularly likely in the tail-outs of pools.

Given the existing and potential size of bed material, it has been suggested that smallmouth bass spawning will be limited which will have a depressing effect on annual recruitment and ultimately, the current crop of smallmouth bass that can occur in the Lower Owens River over time. This concern originates from the assumption that smallmouth bass require gravel-sized bed material for successful spawning. We used the smallmouth bass suitability curves developed by the USFWS[209] in our PHABSIM modeling, as required by the CDFG. In the documentation for these curves, Edwards et al. (1983) state "...the species requires a clean stone, rock, or gravel substrate for spawning."[210] This is a misrepresentation by Edwards et al. We reviewed the original source material for the statement by Edwards et al., and found that Robbins and MacCrimmon (1974) were not that emphatic but stressed that smallmouth bass can and do use everything from silt to bedrock-sized material, but prefer gravel-sized material for spawning.

The suitability graph Edwards et al. presented for smallmouth bass substrate is shown in Figure 2.29.[211] Clearly this figure indicates that more smallmouth bass are associated with gravel substrate[212]. However, this figure also shows that, while gravel substrate is preferred, smallmouth bass will also utilize silt/sand, pebble, and even bedrock-sized substrate. The conclusion here is that smallmouth bass will spawn in various sized substrate; the species prefers gravel, but in the absence of the preferred habitat other, smaller sized material will be utilized.

A note of caution was presented in the suitability curve documentation by Edwards et al. (1983):

> *"Smallmouth bass may be present even if the HSI [habitat suitability index] determined by one of the above models is zero. On the other hand, habitat with a high HSI may contain few fish. The HSI determined by use of these models will not necessarily represent the population of smallmouth bass in the study area. This is because the standing crop does not totally depend on the ability of the habitat to meet all life requirements of the species. If the model is a good representation of smallmouth bass riverine or lacustrine habitat, the HSI should be positively correlated with long term average population levels in areas where smallmouth bass population levels are due primarily to habitat related factors. However, this relationship has not been tested. The proper interpretation of the HSI is one of comparison. If two habitats have different HSI's, the one with the higher HSI should have the potential to support more smallmouth bass than the one with the lower*

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[208] Ecosystem Sciences, Tech Memo 14. Appendix II.
[209] Edwards et al. 1983
[210] Robbins and MacCrimmon 1974
[211] Suitability indexes are calculated from histograms such as this using a running-mean or curve smoothing technique.
[212] Edwards et al. (1983) note that the data used in the suitability curves probably reflect a very high preference for instream cover objects, rather than an actual substrate preference.

> *HSI, given that the model assumptions have not been violated.*
>
> *The sample data sets are not actual field measurements, but represent combinations of variable values that could occur in a riverine or lacustrine habitat. The HSI's calculated from the data rank the sites in the order that we believe represents the carrying capacity in habitats with the listed characteristics. The relationship of the model-generated index to measurable indices of carrying capacity, such as production or standing crop, is unknown. The model must be viewed as conceptual. Any attempt to use the model, or the model components, as predictive tools should be preceded by the evaluation of the model with actual field measurements to better define which, if any, model variables are important habitat descriptors in the proposed area of model application."*

We reviewed the scientific literature on this topic and found that smallmouth bass spawn on substrates of silt, clay, shells, and detritus[213] although most nesting usually occurs on sand, gravel, or rubble.[214] While the Lower Owens River does not contain much gravel-sized material, the IFIM field work showed that substrate at 20 of the sample sites consists of sand, 3 sites have a silt-sand substrate, and 3 sites have a mud-detritus substrate. Since smallmouth bass will certainly spawn in a sand substrate as noted above, there is ample evidence to indicate that smallmouth bass will have suitable, but not ideal, spawning habitat. Successful smallmouth bass spawning is not simply a function of substrate type but is also dependent upon the interaction with depth and velocity of streamflow.

Coble (1975) stated that smallmouth bass spawning nests were located away from strong current or wave action. Smallmouth bass spawning is commonly associated with lentic systems (lakes, ponds) or lotic systems (streams) of minimal water current.[215] Most spawning occurs in relatively shallow, stable littoral areas in water depths of 2 m or less.[216] Depth of smallmouth bass nests has been reported as 0.3 to 2 m[217], although Mraz (1964) reported smallmouth bass nesting at a depth of 6.1 m, also, Trautman (1981) reported a maximum spawning depth of 6.7 m in very clear waters.

Nests may be constructed within four feet of each other although usually they are farther apart.[218] Doan (1940) found densities of one nest per 20 to 75 square yards, and Surber (1943), Cleary (1956), and Brown (1960) reported 5 to 414 nests per mile of rivers and streams. Even though some streams lacked ideal spawning habitat or large quantities of it, these investigators did not indicate smallmouth bass were spawning limited. Standing crops of smallmouth bass below a stream's carrying capacity may not necessarily reflect lack of spawning habitat[219] because bass need relatively small amounts of spawning habitat to fill the available rearing habitat.[220] In general, stream smallmouth bass annually produce sufficient recruits to maintain bass fisheries of high quality.[221] Heavy exploitation, however, in combination with floods, predation and inadequate food reduces fishing quality, increases total annual mortality, decreases the biomass of larger bass, and diminishes the effectiveness of bass as predators.[222]

In terms of substrate influence on habitat utilization, Todd and Rabeni (1989) found that boulders were the most preferred substrate, but were never used in proportion to its availability. Smallmouth bass use intermediate depths the most and show no daily or seasonal changes in depth preferences and prefer velocities less than 0.2 m/s at all times of day and in all seasons.[223] Given the low gradient of the Lower Owens River, HEC-2 modeling predicts very low velocities (> 0.2 m/s)

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[213] Lydell 1906; Rawson 1938; Bennett and Childers 1957; Turner and MacCrimmon 1970

[214] Reighard 1905; Hubbs and Bailey 1938; Latta 1963; Mraz 1974; Coble 1975; Miller 1975

[215] Scott and Crossman 1973; Probst et al. 1984

[216] Bennett 1976

[217] Beeman 1924; Stone et al. 1954; Watson 1955; Cleary 1956; Bennett and Childers 1957; Scott and Crossman 1973; Coble 1975

[218] Marz 1964, Pflieger 1966

[219] Fajen 1975

[220] Sanderson 1958; Fajen 1974; Funk 1975

[221] Fajen 1975

[222] Fajen 1975

[223] Todd and Rabeni 1989

throughout most of the channel at low flows. In addition to spawning habitat, substrate, cover, and velocity, smallmouth bass productivity is dependent upon a variable diet.

From the time they begin to feed, the diet of smallmouth bass changes from small to large food items as the fish grows. The time that changes occur depend on size of bass, size of prey, and kind of prey available.[224] If zooplankton is present, young bass begin feeding on such plankters as Copepods and Cladocera; then insects become progressively more important in the diet, and finally fish and crayfish.[225] Insects (immature midges and mayflies) may enter the diet when bass are < 3 inches long[226], and may remain the staple of the diet throughout the first summer.[227] On the other hand, fish may become an important part of the diet when bass are as small as 3 inches[228]; or bass may not start eating fish until they reach 6 inches.[229] When zooplankton is scarce, as in streams, small insects make up a large part of the diet from the beginning.[230] Older bass feed mainly on fish and crayfish.[231] Members of the minnow family are the most important prey item.[232]

It is our conclusion that smallmouth bass will spawn in the Lower Owens River and there will be subsequent recruitment into the standing crop of adults. We cannot predict how large the standing crop will be nor can we predict if spawning will be limited in the sense that standing crop will not reach the river's carrying capacity in the absence of a spawning limitation. We do know that smallmouth bass, in the absence of preferred gravel-sized substrate, will spawn on the sand-pebble sized streambed material in the Lower Owens River and that depths and velocities will be adequate for nest construction and incubation. It is only through monitoring that we will know what survival rates are from egg to fry and fry to adult and whether smallmouth bass are indeed spawning limited. Providing stream flows are allowed that create habitat for prey species (suckers and dace primarily), it is unlikely that smallmouth bass will be food limited. Current experience also testifies to the conclusion that a smallmouth bass fishery will develop in the Lower Owens River because smallmouth bass are present in the Lower Owens above the intake - a reach with similar gradient, substrate, and geomorphology as below the intake.

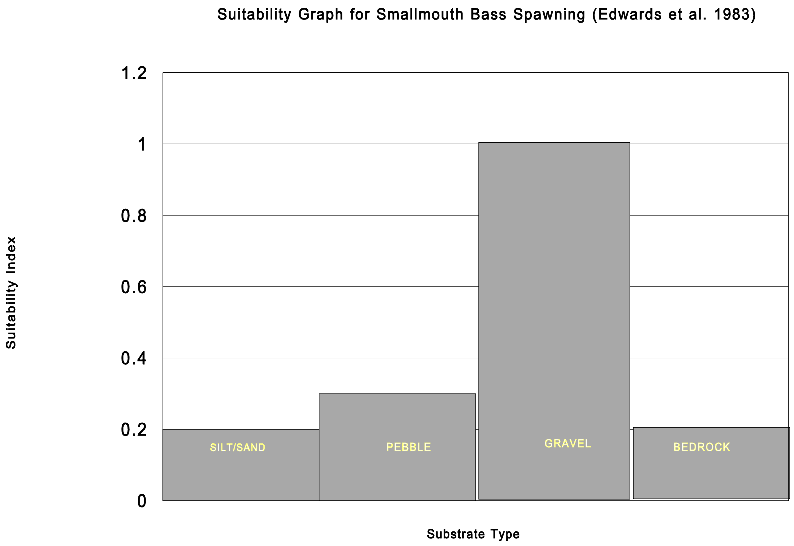

Figure 2.29 Suitability Graph for Smallmouth Bass Spawning.

It must be understood that the Lower Owens River of the future will not resemble the Owens River of today or yesterday. The hydrologic history of the Lower Owens River can be seen in the average annual hydrographs prior to the construction of the aqueduct, and upstream reservoirs and diversions. Historically the Lower Owens River was subject to multiple, extreme run-off events, often exceeding 1600 cfs (perhaps as high as 2000 cfs). In some years such run-off events occurred more than once in January and several times throughout the winter and spring. Late summer flows in some years were less than 2 to 3 cfs and some reaches were dry. In some years both extreme flow events occurred;

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[224] Coble 1975
[225] Wickliff 1920; Tester 1932; Doan 1940
[226] Wickliff 1920; Tester 1932; Webster 1954; Pflieger 1966
[227] Surber 1941; Webster 1954; Paragamian 1973
[228] Wickliff 1920; Pflieger 1966
[229] Tester 1932, Lachner 1950, Webster 1954
[230] Surber 1941; Lachner 1950; Pflieger 1966; Paragamian 1973
[231] Adams and Hankinson 1928; Tester 1932; Doan 1940; Tate 1949; Watt 1959; Reynolds 1965; Keating 1970; Probst et al. 1984
[232] Wickliff 1920; Tate 1949; Reynolds 1965

multiple extreme run-off events followed by extreme summer low flow conditions. Thus, it can be concluded that prior to impoundments and diversions in the valley, the Owens River was very unstable.

We anticipate that the growth of riparian habitat under a stable, managed flow regime will result in substantial shading with a positive effect on water temperatures, enhance the input of woody debris, which is critical smallmouth bass habitat[233], improve and maintain good water clarity, enhance stream sinuosity and habitat diversity, while providing allochthanous inputs (leaf litter and insects) that will provide the basic food base for young-of-the-year bass and adult forage fish.

Past introductions of exotic species like carp, catfish, crappie, bluegill, bass and trout into the Lower Owens River may not provide the best ecological balance in the river. The ecological conditions that will develop in the re-watered river can certainly be compatible with indigenous species or even the recolonization of listed endangered or threatened species such as the tui chub and Owens pupfish. Selecting exotics like smallmouth bass, bluegill, and brown trout for the target species needs to be done with the complete consideration of native fish needs. While smallmouth bass will "fit" into the Lower Owens River it has not evolved in such a system and, thus, its ecological fitness is not entirely patterned for Owens River conditions.

Because largemouth bass are evolutionarily more aligned with lake-type habitats[234] than smallmouth bass, they represent a species that may have an even harder time adapting to a river environment (particularly the future condition of the Lower Owens River) and will do best in reaches that contain beaver ponds. Largemouth bass seem to prefer a mud-detritus or vegetation substrate for spawning[235], but, as noted previously, IFIM transects showed that such substrate conditions only occur at three sample sites in the Lower Owens River. While it is unlikely that smallmouth bass will be spawning limited, the same cannot be said for largemouth bass.

We suggest that the best mix of target species include the indigenous and threatened and endangered pupfish, Owens sucker, Owens tui chub, and speckled dace. These species evolved in the Owens River and are the obvious, prime candidates for reestablishing the aquatic ecosystem. These four native species evolved in the Lower Owens River and, because of their high reproductive potential and ability to survive very harsh conditions, were able to maintain populations despite the historical harsh flow regime of the river. Ecologically, the most appropriate approach would be to establish flows that optimize native plus exotic fish habitat. Exotic species like smallmouth bass would depend upon the availability of a niche (in this case the bass would be the top predator) and the ability of the exotic species to utilize that niche under the flow conditions that are also compatible with native species. Such an approach would establish a recreational fishery by allowing a game fish population to attain whatever standing crop it could within the flow conditions equally suitable for native fishes.

We recognize that the primary objective for the Lower Owens River is the development of a recreational fishery, but a close, secondary objective should be to protect and maintain the native fishery. Therefore, the flow regime must (1) create a stable habitat avoiding extreme flood flows and extreme low flows, (2) encourage the growth and development of riparian vegetation like cottonwood and willow to provide the requisite woody debris, shading, water quality conditions, and habitat diversity essential to smallmouth bass rearing, and (3) provide adequate habitat for native fishes that

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[233] The importance of woody debris for smallmouth bass cover cannot be overstated. Virtually all investigations of smallmouth bass we reviewed cited woody debris as a critical habitat feature for resting, cover, forage, and even spawning. The absence of woody debris is correlated with reduced early rearing survival and lower overall population and biomass within a stream; the greater the volume of woody debris the greater the recruitment and standing crop of smallmouth bass.

[234] Webster 1954; Trautman 1957; Latta 1963; Cross 1967; Scott and Crossman 1973; Robbins and MacCrimmon 1974; Eddy and Underhill 1974; Miller 1975; Ramsey 1975; Fajen 1975

[235] Robbins and MacCrimmon 1974; Miller 1975; Coble 1975; Scott and Crossman 1973; Latta 1975; Eddy and Underhill 1974

may have more difficulty adapting to a completely stable environment. The native fishery will form not only the ecological cornerstone of the total fishery but the food base for the recreational fishery as well. How well we achieve this balance can only be determined through long-term monitoring of the fisheries, aquatic and terrestrial habitat.

2.2.9.9 Tech Memo #3 Distribution and Abundance of Beaver in the Lower Owens River [236]

This technical memorandum presents a plan for the distribution and abundance of beaver (*Castor canadensis*) in reaches of the Lower Owens River. Beaver are the river's keystone species in that their dam building and use of willows affect the riparian habitat and flow system more than any other wildlife species. How beavers influence flow and riparian habitat also influences how other species of fish and wildlife use the river. Beaver alteration of river flow and riparian habitat must be an important component of present riverine-riparian ecosystem management and future adaptive management decisions.

Beaver are the largest rodent in North America, weighing up to 75 pounds. Beaver are highly specialized obligate riparian/aquatic rodents found in ponds, lakes, rivers and streams. Beavers are generalized herbivores: they consume a wide variety of plants (aquatics, forbs, grasses shrubs, trees), and many parts of plants including, leaves, bark, twigs, rhizomes and flowers. Beavers eat a variety of foods they prefer, and are most dependent on woody riparian species such as aspen (*Populus tremuloides*), willow (*Salix spp.*), cottonwood (*Populus spp.*) and many other tree and shrub species. [237]

Beaver are native to some regions of California west of the Sierra Nevada, but are not native east of the Sierra crest. Beavers were introduced to many locations during the 1930's and 40's as part of the Federal Aid in Wildlife Restoration Project California. Beaver in the Owens Valley probably belong to the Idaho subspecies, *Castor canadensis taylori*, Davis.

Beaver provide a striking example of how animals influence ecosystem structure and dynamics in a hierarchical fashion. Initially beaver modify stream morphology and hydrology by cutting wood and building dams. These activities retain sediment and organic matter in the channel, create and maintain wetlands, modify nutrient cycling and decomposition dynamics, modify the structure and dynamics of the riparian zone, influence the character of water and materials transported downstream, and ultimately influence plant and animal community composition and diversity. [238]

Beaver can influence wildlife, water quantity, water quality, fish habitat and fish populations, esthetics, and recreational opportunities, and the relationship of cattle grazing to riparian and streambank condition. Beaver influences interact with other land use and resource management practices along the Lower Owens River. These interactions have had, and will continue to have a major role in the Lower Owens River ecosystem. Consequently, beaver abundance and their distribution throughout the Lower Owens River must be a key consideration with all ecosystem management plans.

Beaver Influence on Wildlife

Beaver ponds and associated flooding and high water tables create habitat diversity, edge effect, and vegetative changes that attract wildlife species that are not often found in non-beaver areas. Waterfowl, shorebirds, and songbirds that feed over open water are

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[236] Ecosystem Sciences, Tech Memo 3.

[237] See Jenkins, S.H. and P.E. Busher. 1979. *Castor canadensis.* Mammalian Species, 120-1-8[0] and Hall, E.R. 1981. The mammals of North America. John Wiley&Sons, New York.

[238] See Naiman, R.J., C.A. Johnston, and J.C. Kelley. 1988. Alteration of North American streams by beaver; the structure and dynamics of streams are changing as beaver recoloize their historic habitat. BioSci 38(11):753-762.

commonly attracted to flooded areas.[239] The higher water tables often create vegetative responses that provide cover, forage, or edge effects that are attractive to a variety of wildlife. In healthy riparian ecosystems, beaver ponds generally provide unique and valuable habitat for many species of wildlife. Increased structural complexity and high interspersion of unique plant communities and habitat features are important factors influencing wildlife species presence and abundance. High breeding bird density, bird species richness and diversity, and total breeding bird biomass are typically associated with beaver ponds. Perhaps the most noticeable wildlife are the large ungulates. Elk and deer are commonly associated with beaver influenced habitats in greater densities than areas without beaver.[240]

Beaver Influence on Water Quantity and Quality

The reduction of stream velocity as the Owens River runs through beaver ponds results in considerable amounts of sediments deposited in the ponds, depending upon the age and structure of the pond. Reductions in stream sediment of up to 90 percent have been documented.[241] Downstream resources or biological cycles that are adversely influenced by sediment often benefit from this reduction. On the other hand, sediment-dependent processes like bank building can be adversely affected by reduced sediment flow.

Beaver ponds in the Lower Owens River can also modify water temperatures. The ponding action tends to increase stream temperatures in the summer and reduce temperatures in the winter.[242] Fish populations existing in marginal water temperatures could be adversely affected. Beaver also have the potential to increase the level of pathogens downstream from their activities, resulting from beaver excrement. Beaver are one of many warm blooded mammals capable of transmitting the flagellated protozoan, *Giardia lamblia*. Unless the water is used in municipal supply systems, giardia transmission by beavers is generally of little concern.

The normal variability in seasonal stream flows is commonly reduced through the reservoir effect of bank storage adjacent to the pond. The amount of this storage capability is often quite low relative to the total amount of spring runoff flows; however, as this bank storage is released through the late summer, the additional amount of water may be important.

Beaver Influence on Fisheries

Beaver can have a dramatic effect on fisheries habitat, depending upon the natural channel size, characteristics, and endemic fish species. In flatter gradient streams like the Lower Owens, beaver ponding covers streambed gravels, reduces habitat diversity, inhibits or blocks fish migration, and reduces fish spawning habitat for trout, but increases it for bass.[243] On the other hand, beaver ponds often provide critical rearing habitat in steep gradient streams or in streams which cannot support much riparian habitat, so that reductions in spawning success may be offset by increases in rearing space.[244]

Beaver Influence on Range Management

Beaver have influenced the vegetative state of riparian and adjacent lands in the wetted reaches of the Lower Owens River by the construction of ponds and the cutting of deciduous overstory as food supplies. Vegetation adjacent to ponds is often composed of more mesic types than those

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[239] See Neff, J.D., 1957. Ecological effects of beaver habitat abandonment in the Colorado Rockies. J.Wildlife Manag. 21:80-89.

[240] See Munther, G.L. 1981. Beaver management in grazed riparian ecosystems. Proceedings of the wildlife-livestock relationships symposium. Univ. Idaho Forest, Wildlife and Range Exper. Sta. Pp.234-241.

[241] See Smith, B. 1980. Not all beaver are bad; or an ecosystem approach to stream habitat management. Proc. 15 Ann.Meet., Am. Fish. Soc., Bethsda, MD.

[242] See Reid, K.A. 1952. Effects of beaver on trout waters. Md. Cons 29:21-23.

[243] See Churchill, J.E. 1980. Beaver are killing our trout streams. Trout 21:4.

[244] See Gaqrd, R. 1961. Effects of beaver on trout in Sagehen Creek, California. J. Wildl. Manag. 25:221-242.

without ponds, due to the higher water tables and more moist soils associated with ponding. The backwater effect of beaver dams can also promote the growth of tules.

This beaver activity can influence the distribution of livestock and the response of vegetation to livestock use. Ponds can create partial or complete livestock barriers to individual plants adjacent to water. Some plant species, such as deciduous shrubs, are vulnerable to severe damage or elimination by overgrazing. In such cases, a plant species such as willow continues to exist in a plant community subject to heavy grazing because of beaver-created isolation from livestock caused by flooding. If beaver are removed from the stream and the ponds recede, these plants become more vulnerable once again and can rapidly be eliminated from the plant community.

Beaver in some areas of the Lower Owens River have created elevated meadows through the deposition of sediments over several generations of pond maintenance that perched the meadow higher than the geologic knick point elevation. Streambanks formed through old beaver activity are generally low in rock content and are sensitive to mechanical damage. Heavy grazing can result in streambank collapse, accelerated meandering, enlarged channels, and losses of stream dependent resources. As a consequence, the loss of beaver in these circumstances can lead to the lowering of water tables and can ultimately lead to the change from a mesic meadow type to a more xeric plant community, thus resulting in reduced forage production.[245] In contrast, the amount of forage flooded by beaver ponds is more than compensated for in many cases by the increased production of adjacent lands resulting from higher water tables.

Beaver Influence on Esthetics and Recreation

Water is often used to enhance the esthetic quality of a scenic area. The presence of small streams is often noticed only when a stream is in the foreground of a viewer; however, the larger expanse of water created by beaver ponds is noticeable from a greater distance, as is the vegetative diversity that is usually associated with the beaver pond. The variety that a beaver pond can create in an otherwise stream-oriented environment offers visual diversity.

The disproportionate numbers and diversity of wildlife associated with beaver ponds is attractive to recreationists, in part, because wildlife is typically more viewable in the semi-open setting. Beaver and sign of their activity is one of the more viewable forms of wildlife that can add measurably to a recreation experience. Beaver ponds create fishing opportunities because large open water bodies are easier to fish than adjacent stream reaches. This is particularly true in the Lower Owens River where the density of future riparian vegetation may limit fisherman access to some river reaches. Anglers with small children find that beaver ponds are relatively safer for youngsters than a flowing stream.

Beaver Status and Impacts in the Lower Owens

Present condition of the Lower Owens River ecosystem is, in part, a result of beaver impacts. Other interacting influences on environmental conditions include water management and land use practices, domestic livestock grazing and grazing other large ungulates. One of the primary conditions of concern on the Lower Owens River is the widespread paucity of woody riparian vegetation recruitment. Survival and persistence of the numerous sprouts produced each year by willow also appears very low. Furthermore, many of the established shrubs and trees are showing signs of stress and are dying. These conditions are particularly evident in the reaches from the Islands to the Delta.

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[245] See Munther *ibid*

Contrary to some popular beliefs, beaver are not necessarily prudent consumers. Beaver are known to cover exploit their food resources causing habitat degradation and starvation of the colony. While we understand that beaver are one of many influences of habitat conditions in the Lower Owens River ecosystem, we expect that given the relatively poor habitat conditions, beaver might suppress or inhibit the pace and magnitude of recovery. In a healthier state, the river system will be more resilient and beaver management will be carried out on a maintenance basis.

The Lower Owens River beaver play both a positive and negative role in the ecosystem depending upon site conditions. Beaver activity occurs throughout the wetted portion of the river (from about Mazourka Canyon Road to the Delta), but is most pronounced in specific areas. The first major beaver dam downstream of Mazourka Canyon occurs at the Locust Spillgate. There are several older or smaller dams upstream of Locust (at Billy Lake for example) but these dams have less effect on the in-river ecosystem.

The Locust dam creates a significant backwater effect, which promotes substantial tule growth in the river bed. The dam also provides important bass, bluegill, and other fish species rearing habitat. However, due to the high degree of deposition in the pond and backwater area, fish spawning habitat is very limited. Tree willows have grown around the pond margins as well as mesic plant species in the understory. While a definitive survey of beaver numbers has not been performed throughout the river, the Locust dam seems to support five or six lodges.

The next large beaver dam downstream of Locust occurs just below Georges Spillgate. Like Locust, the Georges beaver dam creates a large tule bed upstream in backwater areas but provides substantial fish habitat. An estimated 7 or 8 lodges are associated with this dam but several smaller dams occur upstream.

The Island reach (Alabama Gates area) supports a substantial number of small beaver dams. Because of flow variation and shifting of stream discharge to different channels from time to time, larger and old beaver dams have not been developed. Consequently, beaver ponds in this area provide little fish habitat but do contribute to the development of mesic meadows and elevated meadows. It is unknown how many beaver lodges occur in this area.

Another substantial beaver pond occurs upstream of the Lone Pine Pond area. This dam creates substantial fish habitat of deep water and heavy riparian habitat upstream for nearly a mile. The dam also creates a large tule bed upstream to the Island reach. Another large beaver dam occurs downstream of the Lone Pine Pond and contributes to the formation of the backwater that makes up the Lone Pine Pond. Again, significant fish habitat is associated with beaver ponds throughout this reach as well as tule beds.

Although beaver activity has resulted in the removal of much willow and other shrub and woody vegetation and the dams create favorable tule conditions and reduce fish spawning habitat, they also provide important fish rearing habitat, mesic meadows, and promote the growth of other riparian species. It is most likely that the physical removal of beaver dams will result in more adverse environmental impacts than environmental benefits.

It is our conclusion that beaver dams should be left as they are, allow the natural forces associated with future out-of-channel and base flows to remove or incorporate them into the riverine ecosystem, but focus on controlling the number of beaver by reach through trapping as the management strategy.

Beaver Management

The goal of beaver management in the Lower Owens River is to protect the development and sustainability of riparian vegetation particularly willow and other shrub species. Thus management must be a function of the allowable number of beavers per acre of willow by river reach and vegetative condition. Beaver numbers based on colonies/km does not relate directly to available willow habitat and assumes that the number of animals per colony does not vary greatly throughout an area. In general, the number of beaver in a colony remains relatively constant in small areas of river; however, the Lower Owens covers over 60 miles of river and past studies have shown than the number of animals per colony varies substantially over entire river lengths.[246] In time, with consistent flows, the riverine-riparian will become more homogenous with higher surface water elevation and discharge and some beaver may turn to bank dwelling rather than dam building.

Based on past experience in beaver control and riparian habitat development, we suggest an allowable density of 1 beaver/29 acres of available willow habitat during the early seral stages of willow development. A final allowable density of 1 beaver/8 acres of available willow habitat may be possible when willow habitat reaches good condition.

Table 2.8 shows the allowable abundance and distribution of beaver by river reach for each condition of willow development. Maintaining these densities of beaver by river reach and riparian condition will be achieved through trapping under the direction of the CDFG.

Beaver management is the responsibility of the California Department of Fish and Game. Monitoring of beaver activity and numbers will be an integral part of the longterm monitoring program and adaptive management. Numbers of beaver per river reach will be determined by fall cache counts as needed to guide adaptive management.

REACH	DESCRIPTION	LENGTH (miles)	RIPARIAN WIDTH (ft)	EXISTING BEAVER INFLUENCE	PREDICTED WILLOW HABITAT (acres)	ALLOWABLE NUMBER OF BEAVERS POOR WILLOW CONDITION (1 beaver per 29 acres of willow)	ALLOWABLE NUMBER OF BEAVERS GOOD WILLOW CONDITION (1 beaver per 8 acres of willow)
1	Intake to 1 mile above Blackrock Ditch	4	119	NONE	26.8	1	3
2	Above Blackrock Ditch to Five Culverts	14	65	NONE	88.4	3	11
3	Five Culverts to Alabama Spill Gates	18	153	HEAVY	161	6	20
4	Alabama Spill Gates to Below "Islands"	6	-	HEAVY	50.1	1	5
5	Below "Islands" to Lone Pine Ponds	10	163	MODERATE	41.3	1	5
6	Lone Pine Ponds to Keeler Road	4	107	HEAVY	4.7	0	0
7	Keeler Road to Delta	4	98	LIGHT	11.5	0	1
TOTAL		**60**			**383.8**	**12**	**45**

Table 2.8. Allowable Abundance and Distribution of Beaver by River Reach

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[246] See regression equations developed by Slough, B., and R. Sadleir. 1977. A land capability classification system for beaver. Can. J. Zool. 55:1324-1335, in which numerous stream reaches were used that exhibited high variability in beaver density/colony.

2.2.9.10 Tech Memo #8 Delta Habitat Area[247]

This technical memorandum describes the extent and condition of natural resources in the Owens River Delta Habitat Area. Existing and future resource values in the Delta are outlined, and future management of these resources is discussed. Management of Delta resources relies on river flows passing through the pumpback station. The timing magnitude and duration of Delta flows will insure that long term habitat diversity, condition, and extent are maintained and enhanced.

Background

The Owens River Delta Habitat Area is one of four physical features identified in the (LORP). The Owens River delta is a unique, rare and extremely valuable resource. Curry (1993) identified about 5,000 acres of shoreline wetlands associated with Owens Lake. More recently, Jones and Stokes (1998) delineated approximately 4,353 acres of wetlands[248] in the Owens Lakes Study Area.[249] Delta wetlands comprise about 25 percent or 1,113 acres of all the remaining wetlands adjacent to Owens Lake.

About 84 percent or 1,499 acres of the area mapped in the Delta (1,779 acres) are owned by the State of California and managed by the California State Lands Commission.

"Owens Lake wetlands and perennially flooded surface area of Owens Lake has been diminishing for several thousand years. Uplift processes in the Coso Range, combined with a post-glacial drying trend, eliminated overland outflow from the basin about 2000 years ago.[250] Wetlands have tended to become more isolated with Owens River water diversions and subsequent lakeshore retreat[251]".[252] In contrast to many of the Owens Lake wetlands, the Owens River Delta wetlands are not isolated islands on the expansive playa.[253] Delta wetlands are physically and functionally connected to the Lower Owens River.

The MOU specifies that the LORP will manage flows in the Owens River to provide minimum flows of about 40 cfs and riparian flows of about 200 cfs, depending on forecasted runoff.[254] The management goal of Owens River Habitat Area is to enhance and maintain existing habitat consisting of riparian areas and ponds suitable for shorebirds, waterfowl and other animals and to establish and maintain new habitat consisting of riparian areas and ponds suitable for shorebirds, waterfowl and other animals within the Owens River Delta Habitat Area. Diverse natural habitats will be created and maintained through flow and land management, to the extent feasible, consistent with the needs of the "habitat indicator species" for the Owens River Delta Habitat Area. These habitats will be as self-sustaining as possible. Water releases below the pumpback station will be an annual average of approximately 6 to 9 cfs.

Ecosystem Management

The Owens River Delta Habitat Area is an important component of a much larger program to restore and manage the Lower Owens Valley and adjoining watersheds on a sustainable basis. The fundamental approach is to apply ecosystem management concepts throughout the gathering, planning and implementation activities.[255] This approach requires adoption of a long-term and large-scale perspective. This frame of reference is appropriate for the Delta as well as the entire Lower Owen River Project. Management, monitoring and evaluation are all founded on the common goal of long-term ecosystem sustainability. Ecosystem management recognizes humans as part of ecosystems, and the pursuit of past, present, and future desires, needs and values have and will continue to influence ecosystems.

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[247] Ecosystem Sciences, Tech Memo 7, 1999.
[248] Jurisdictional Waters of the United States
[249] GBUAPCD 1998
[250] Smith and Street-Perrott 1983
[251] Lee 1915
[252] GBUAPCD 1998
[253] GBUAPCD 1998
[254] Ecosystem Sciences 1997, Predicted Future Vegetation Types. And, MOU, 1997.
[255] ESA 1997

Adaptive management provides an understanding and process for dealing with the inevitable uncertainty and "limits to knowledge" of ecosystems. Adaptive management concepts,[256] in concert with monitoring activities provide an approach conducive to successful resource management, informed decision making and the scientific process. Monitoring evaluates progress toward meeting management goals and objectives and determines maintenance needs. Monitoring is an important feedback mechanism that provides a basis for adaptive resource management. Taken in tandem, these factors can foster progress by increasing our understanding of the resources in a project area, and the available means to manage and restore them.

Temporal and Spatial Scales

Each management activity will stimulate an environmental response across several temporal and spatial scales. In turn, each environmental response has an inherently different lag time associated with it. For example, it is expected to take several years for the species composition and cover values of adjacent upland vegetation to respond to new water regimes. The greatest lag is expected at the initial flooding stage of the wet-cycle, although there will be some time lag associated with any change.

There will be even more of a lag in response time of wildlife to conversion of vegetation types, initial establishment of wetland management types, and redistribution of resources within and among the management area. The rate of a species response to changes will depend, in part, to their present distribution, their mobility, reproductive potential, and distribution of limiting or alternative resources.

Spatial scale is another very important management consideration. While vegetation responses will be site specific and restricted to the "footprint" of the management action, the wildlife response can be very widespread, depending in part on the home range and habitat requirements of each species, and the configuration and availability of resources within that range. Many of the wildlife species expected to gain the most from the proposed management changes, including many of the indicator species, are migratory and spend a considerable part of their life cycle outside of the Owens Valley and Inyo County, some many thousands of miles away in other biomes, and in other continents. It is necessary to keep in mind these "off-site" influences to properly interpret and understand changes in species abundance and composition observed in the Owens Valley.

Benefits

The benefits to wildlife and their habitats must be viewed from a landscape perspective and evaluated over a long time frame. Wildlife populations that will benefit from these actions are extremely diverse. The list of species that will benefit from the Delta Habitat Area and other LORP projects includes the obvious wetland obligate and facultative species such as those listed as wildlife indicator species. Numerous species of bats and insectivorous birds will also benefit significantly, albeit indirectly, from the Delta Habitat Area. In certain cases, specific species are selected as models for a particular community or function. Models are used as a means to simplify and attempt to observe, mimic and/or quantify change based on a range of actions or conditions.

There is need for a fundamental understanding that not all species can be present and abundant, at all locations, all of the time. To frame it another way, it's impossible to optimize conditions for all species, all of the time. While this notion seems ludicrous, many observers of wildlife have come to expect this condition, especially with regard to their "pet" resource. Local populations expand and contract, habitats evolve and vegetation patterns are dynamic. As conditions change there are always tradeoffs among the species that will exploit the resources and any particular point in time.

Cumulative Benefits

Management of the Delta will result in significant direct and indirect benefits to wildlife and their habitat in the Owens Valley. Benefits will be widespread and effect a very

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[256] Walters 1986, Holling 1984

large cross section of vertebrate and invertebrate species. Positive cumulative impacts are expected to accrue and build as various aspects of the LORP are implemented, mature and each of the discreet project components begin to interact and function together. Some of these project components include the Blackrock Waterfowl Habitat Area, the Riverine/Riparian Plan, the Fisheries Management Plan, the Owens River Delta Habitat Area, etc.

Methods

Physical, biological and land management data were integrated and used to develop the Owens River Delta Habitat Area Plan. Existing data sources were used for the majority of this report, although many reconnaissance level surveys of the delta were conducted to validate, confirm and better interpret data.

Wildlife Indicator Species

The MOU identifies a list of "habitat indicator species" that represent the range of habitat conditions that are desired to be achieved for each of the four areas discussed in the LORP. Within each of these areas, the management objective is to create and maintain through flow and land management, to the extent feasible, diverse natural habitats consistent with the needs of the "habitat indicator species." The MOU provides a list of wildlife indicator species that should be considered for management. The list includes several general species groups.

Special Status Plants and Wildlife

Many special status animals are known to occur or have potential to occur in the Owens River Delta Habitat Area. Many of these species potentially occur in or within the vicinity of the project area for a short period during migration. Others are residents of the Owens Valley and use the Delta for more extended periods. There are also several special status plants that potentially occur in the Owens River Delta Habitat Area. A list of special status species was developed from existing information.

Vegetation Type Mapping

Information on the location and extent of vegetation types was derived from two sources. The primary source of data was the 1993 mapping of the Lower Owens River corridor conducted as part of the initial LORP flow evaluation .[257] During this study the location and extent of existing vegetation types along the River was determined by a combination of photo interpretation of vegetation types and landforms, field data collection of landform/vegetation types associations, and HEC2 hydrologic analysis.[258] About 64 miles of river corridor was mapped from the intake down to and including the delta. River Reach #8 is about 6.5 miles in length and generally coincides with the Delta Habitat Area. Information from cross channel transects and HEC2 hydrologic analysis was critical for predicting vegetation type composition at various flows. In the delta, channel morphology and landform precluded use of these techniques.

The second source of vegetation data was the various mapping, characterization and monitoring and studies conducted as part of the Owens Valley PM10 Planning Area Demonstration of Attainment State Implementation Plan Draft EIR.[259]

Delta Water Budget and Flows

River flows are intercepted by the delta pumpback station and released to the delta as described in this document. Management of river flows from the pumback station to the delta is the most critical element of the resource management in the delta. The Bureau of Reclamation is assisting in the design the LORP pumpback station.[260] The draft conceptual design indicates that the station will be located within a mile upstream of the point where the river channel splits and the delta begins to broaden. Capacity of the pumpback system is 30 to 75 cfs. The diversion structure will have the capacity to pass riparian flows of 200 cfs and annual average flows of 6-9 cfs.

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[257] Ecosystem Sciences 1994. Study Plans and Controlled Flow Studies.

[258] White Horse Associates [WHA] in Ecosystem Sciences 1994 and Ecosystem Sciences 1997

[259] GBUAPCD 1997a, Jones and Stokes 1998

[260] USBOR 1997

Future Water Budget

The amount of surface water necessary to maintain and enhance the extent and quality of this habitat is estimated from existing information. Factors that were considered for this evaluation included evapotranspiration rates, estimated water use for proposed dust mitigation control measures[261], the relative composition of the existing vegetation types in the delta, the distribution of water, and the timing, magnitude and duration of flows. One of the most important sources was information developed as part of the Owens Valley PM10 Planning Area Demonstration of Attainment State Implementation Plan Draft EIR.[262] The Great Basin Unified Air Pollution Control District (GBUAPCD) information is recent, site specific and appears reasonable when contrasted to information developed elsewhere.

Water evaporation from free water sources such as open lakes, ponds and soils and evapotranspiration (ET) from different vegetation types are important considerations for determining management and enhancement for the Owens River Delta Habitat Area. Several sources of information were synthesized to estimate a water budget for the delta area wetlands. ET rates reported in the Green Book, various Great Basin Air Pollution Control District documents, and a report by Inyo County Water Department[263] were reviewed and considered for this management document.

Existing Conditions

Owens River Delta Value and Function

The Owens River delta is a unique, rare and extremely valuable resource. Jones and Stokes (1998) delineated approximately 4,353 acres of wetlands[264] in the Owens Lakes Study Area.[265] Delta wetlands comprise about 25 percent of this total area (1,113 acres). In contrast to many of the Owens Lake wetlands, the Owens River delta wetlands are not isolated islands on the expansive playa.[266] Delta wetlands are physically and functionally connected and to the Lower Owens River. The ecosystem value of the delta is multifaceted. Physically, the delta is composed of several diverse and contrasting vegetation types and landforms, each of which has their own high intrinsic values.

These individual habitat components are arranged in a relatively extensive contiguous block of wetlands. The delta connects the 70,000 acre Owens Lake with 70 miles of river in the LORP area. The delta functions as a conduit for water, nutrients and energy. It is the primary supply point to the Owens Lake.

The delta concentrates and provides many unique and limiting resources to an array of wildlife species that reside in, and migrate through, the Owens Valley. Wildlife species relationships with delta wetlands and adjacent open lake playa embrace broad continuum of associations. Some of these species use delta resources directly and on a regular basis. For example, red-shouldered hawks might regularly nest in delta riparian habitat and feed on a resident, obligate herbaceous wetland species such as, the Owens Valley vole. Other species simply exploit delta resources (products and services) in a rather indirect manner such as the dozen or so species of bats and insectivorous birds that rely on avian invertebrates that are produced in delta wetlands.

Delta riparian vegetation is used yearlong by tule elk for food and cover. Many different bird species use the delta for the unique multi-layered structure, diverse food supply and special habitat elements (e.g., snags, logs, cut-banks, etc.) that are characteristic of riparian areas. Some of these species include, warbling vireo (*Vireo gilvus*), yellow warbler (*Dendroica petechia*), common yellowthroat (*Geothlypis trichas*), yellow-breasted chat (*Icteria virens*), Vaux's swift, (*Chiaetura vauxi*), Nuttall's woodpecker (*Picoides nuttallii*), northern flicker (*Colaptes auratus*), summer tanager (*Piranga rubra*), blue grosbeak (*Guiraca caerulea*), song sparrow (*Melospiza melodia*), tree swallow (*Tachycineta bicolor*), black phoebe (*Sayornis

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[261] Shallow Flooding Control Areas and Managed Vegetation Control Areas

[262] GBUAPCD 1997a

[263] Stienwald 1998

[264] Jurisdictional Waters of the United States

[265] GBUAPCD 1998

[266] GBUAPCD 1998

nigricans) and blue-gray gnatcatcher (*Polioptila caerulea).*

The playa provides unique opportunities and resources to many species of resident and migratory shorebirds and waterfowl. An abundant invertebrate food supply, fresh water and wide open expanses interact to attract many different wildlife species. The playa in and adjacent to the delta is possibly more significant than other areas on Owens Lake, because of the reliable water supply and the interspersion with other wetland and riparian communities.

In terms of species richness and abundance, shorebirds and waterfowl directly and indirectly use delta resources like no other group. Some of the shorebirds that occur in and near the delta include, western snowy plover (*Charadrius alexandrinus nivosus*), American avocet (*Recurvirostra americana*), black-necked stilt (*Himantopus mexicanus*), spotted sandpiper (*Actitis macuharia*), semipalmated plover (*Charadrius semipahmatus*), black-bellied plover (*Pluvialis squatarola*), greater yellowlegs (*Tringa mehanoheuca*), lesser yellowlegs (*Tringa flavipes*), western sandpiper (*Cahidris mauri*), whimbrel (*Numenius phaeopus*), least sandpiper (*Calidris minutihla*), dunlin (*Calidris alpina*), marbled godwit (*Limosa fedoa*), killdeer (*Chiaradrius vociferus*), mountain plover (*Chiaradrius montanus*), willet (*Catoptrophiorus semipahmatus*) and long-billed curlew (*Numenius americanus*).

Waterfowl species that occur in the delta in a range of habitats from riparian forest, open water ponds, semi-marsh, and wet meadows include mallard (*Anas platyrhynchos*), northern pintail (*Anas acuta*), gadwall (*Anas strepera*), cinnamon teal (*Anas cyanoptera*), green-winged teal (*Anas crecca*), redheads (A*ythya americana*), northern shovelers (*Anas clypeata*), American wigeon (*Anas americana*), canvasback (*Aythya valisineria*), ruddy duck (*Oxyura jamaicensis*), Canada geese (*Branta canadensis*) and wood duck (*Aix sponsa*).

Some characteristic species of the transmontane alkali marsh include, American bittern (*Botaurus lentiginosus*), great blue heron (*Ardea herodias*), great egret (*Casmerodius albus*), black-crowned night-heron (*Nycticorax nycticorax*), Virginia rail (*Rallus limicola*), sora (*Porzana carolina*), Bewick’s wren (*Thryomanes bewickii*), marsh wren (*Cistothorus palustris*), red-winged blackbird (*Agelaius phoeniceus*), and yellow-headed blackbird (*Xanthiocephialus xanthiocephialus*).

Solitude, refuge and security are also very important qualities of the delta and Owens Lake playa. Many species especially those that congregate in large groups and/or nest and feed on land, require refuge areas. This attribute will continue to become more important as viable refuge areas naturally decline. There is no substitute for the Owens River delta in the Valley.

Wildlife Indicator Species

The MOU designates several individual species and species groups that will help guide wildlife resource management in the Owens River Delta Habitat Area. The list of wildlife indicator species for the Delta Habitat Area includes a broad cross section of species. The species in Table 1 [of Tech Memo 8, this table is not included with this document] represent species in the three general groups listed in the MOU (i.e., resident, migratory and wintering waterfowl and resident, migratory and wintering wading birds, and resident, migratory and wintering shorebirds). These species may occur in the Delta Habitat Area or adjacent areas that are strongly influenced by the delta, for example lake playa and shallow saline ponds (see above).

Special Status Plants and Wildlife

Wildlife

There are many special status animals that are known or expected to occur in the Owens River Delta Habitat Area. Several species of wildlife that are known to occur in the delta area are mentioned throughout the document.

Plants

Thirteen special status plants were identified that have a reasonable potential to occur in the Owens River Delta Habitat Area. This list of species was developed by reviewing existing literature and databases (Table 3 [of Tech Memo 8, this table is not included with this document]). We have not conducted any field surveys to locate suspected plant species, but ongoing work in the delta suggests none of these species actually occur in the Delta Habitat area.

GBUAPCD (1997) identified state or federally designated sensitive plant species that have the potential to occur within the Owens Lake study area. This list was developed by researching published literature and unpublished reports pertaining to area botany.[267] GBUAPCD botanical staff has conducted annual sensitive plant surveys in the Owens River Delta Habitat Area for the past four years, and have not located any of these potential species in the delta.[268]

Vegetation Types

During 1993, a total of 918 acres were mapped within the Owens River Delta Habitat Area.[269] About 440 acres or 48 % of this area is occupied by riparian and wetland vegetation types, and 478 acres or 57 % of the area was mapped as riverine (water) or non-vegetated (<10% cover) playa (Table 4, Figure 3 [of Tech Memo 8, this table is not included with this document]). The most dominant vegetation types are alkali meadow (51 %) and transmontane alkali marsh (29 %). The delta receives a relatively abundant and reliable source of surface and ground water. The extent and interspersion of vegetation types associated with the River Delta are unique to the Owens Lake Area. Modoc-Great Basin mixed riparian, riverine, alkali meadow, transmontane alkali marsh, alkali scrub meadow and desert sink shrub form a extensive block of vegetation in expanse of nearly barren playa. At least 99 species of plants were observed during a brief reconnaissance survey of the delta and riparian corridor to just above Keeler Bridge (Appendix A [of Tech Memo 8, this table is not included with this document]).

In addition to the areas mapped by Ecosystem Sciences (1994, 1997), Jones and Stokes Inc. and GBUAPCD (1997) identified and mapped about 673 acres of transmontane alkaline meadow adjacent to the 918 acres mapped by Ecosystems Sciences. Including this area the total amount of vegetation in the delta area is about 1,113 acres (Table 4 [of Tech Memo 8, this table is not included with this document]).

The 1996 wetland delineation for Owens Lake identified an additional 673 acres of transmontane alkaline meadow outside and adjacent to the Owens River Delta Habitat Area.[270]

Jones and Stokes and GBUAPCD (1997) described an alkali meadow complex or “transmontane alkaline meadow”. The alkaline meadow community has been separated for monitoring purposes into three distinct subcommunities: saturated, moist, and dry alkaline meadow (abbreviated as SAM, MAM, and DAM, respectively).

In the delta, this community has developed in response to a range of soil and water conditions as the river spreads out over the playa. Portions of this area that are semi-permanently flooded, includes vegetation dominated by bulrush and cattail with a thick under-story of saltgrass (*Distichlis spicata*). Several species of perennial grasses and low emergent species are also characteristic of this vegetation type.

On slightly higher terrain where seasonal flooding is less frequent and duration of flooding is usually shorter, the dominant over-story vegetation is saltgrass, with short emergent species and several annuals. Occasionally these lush stands of saltgrass are interspersed with shallow open water areas 10-15 cm in depth. On the margins of these mesic associations are drier transition areas that are usually dominated by sparse saltgrass. The Dry Alkaline Meadow (DAM) subtype, appears to represent a marginal or transitional wetland zone with very sparse vegetation cover and a somewhat ephemeral nature. The extent of alkali meadow (i.e., transmontane alkaline

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[267] Holland, 1986, Yoder and DeDecker 1989, LADWP 1990, Montgomery-Watson 1993, Bagley 1994, CDFG 1994 and Skinner and Pavlik 1994

[268] Scheidlinger pers. comm.1998

[269] Ecosystem Sciences 1994, 1997

[270] Jones and Stokes, Inc., and Great Basin Unified Air Pollution Control District 1996

meadow) is known to fluctuate from year to year in relation to seasonal and annual precipitation.[271] In the Owens Lake PM10 project area that includes the Delta, the amount of change observed between two years was more than 50 percent, or 800 acres.[272] The extent of these wetlands are considered to have measurable outside boundaries but these edges "are in no sense permanent".[273]

Alkali meadow is the most abundant community type occurring on about 899 acres or 81 percent of the vegetated land surface. Alkali meadow and alkali scrub meadow (9 acres) occurs in areas with shallow water tables in a range of moisture conditions from saturated soils to very dry marginal or transitional sites.[274] Saltgrass is the dominant plant species in this vegetation type. Vegetation cover in alkali meadow ranges from 100 percent that is characteristic of mesic sites, to sometimes broad transitional zones with cover well below 10 percent.[275]

Alkali playa covers about 619 acres or 35 % of the total 1779 acres in the delta area (see above). The playa generally supports very little vegetation. When soil and water conditions permit, saltgrass and several other invasive salt tolerant species encroach and colonize the playa. The transition area between bare playa and alkali meadow “may be interpreted as the furthest extent of currently available wetland water and leached wetland soils”.[276]

The floodplain in the upper extent of the Delta Habitat Area in somewhat confined. The riparian areas are very narrow with an intermittent and disconnected canopy. The under-story is mostly transmontane alkali marsh adjacent to riverine. Alkali meadow and alkali scrub meadow occurs in a slightly higher and more saline position in the flood plain. Throughout the Lower Owens Valley there is an abrupt moisture gradient and associated concentration of soluble minerals that usually results in a sharp demarcation between wetland and upland vegetation types.

The river channel splits in two, at the point where floodplain broadens to several miles forming the delta. The primary river channel is located along the west boundary of the delta. The river channel is straight and narrow. Low sand dunes several meters in height border the west side of the channel in the upper section but disappear about half the way down the length of the delta. Pockets of very dense stands of cattail and bulrush occur along the length of the rivers. Open water is not common, although there sections with pools and runs several hundred meters in length and 1 to 3 meters in depth.

The secondary channel departs the main stem at an acute angle and flows east-southeast. There is almost no riparian vegetation associated with this corridor. The channel continues for about 1 mile until it fragments into numerous shallow rivulets and swales that fan out across the playa.

Modoc-Great Basin mixed riparian and transmontane alkali marsh are closely associated and intermixed in diverse azonal patches along the main river channel (i.e., the west side of the delta). Riverine areas weave throughout this riparian-wetland complex. In the upper portion of the delta from about 0.5 miles above the channel split to about 1mile below the split, the riparian area widens and forms a very high quality multi-layered stand.

Delta Water Budget

Owens River Flows

Owens River flows at Keeler Bridge have been recorded since 1927. Flows at Keeler Bridge represent a combination of natural surface discharge and releases back into the Owens River as a result of various irrigation projects and when runoff exceeds the aqueduct capacity. Highest flows are usually during the period from February through April. Using data from all years, mean annual flow is 15,693 acre-feet (ac-ft), maximum annual flow of 249,914 ac-ft (1938), and minimum annual flow of 1,923 ac-ft (1931) LADWP 1997. Using data from all years except two

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[271] Schultz and Hatzell 1996
[272] GBUAPCD 1997
[273] Jones and Stokes 1998
[274] GBUAPCD 1997
[275] GBUAPCD 1997
[276] GBUAPCD 1997

exceptionally high years (1938 and 1969), mean annual flow is 9,259 acre-feet (ac-ft), maximum annual flow of 90,682 ac-ft (1983), minimum annual flow of 1,923 ac-ft (1931).[277]

Evapotranspiration

Water evaporation from free water sources such as riverine areas and evapotranspiration (ET) from soils and different vegetation types are important considerations for determining management and enhancement options for the Owens River Delta. The amount of water loss in the Delta is estimated from values provided in the Owens Valley PM10 Planning Area Demonstration of Attainment State Implementation Plan Draft Environmental Impact Report.[278] Generally, the water losses are lowest in the fall and winter and highest during the warm dry summer. Evaporation from bare playa with thick sand deposits e.g., the North Flood Irrigation Project (NFIP), adjacent to the Delta, is estimated to be 3.4 in/year. Clay/crust playa areas indicated rates of about 4.11 in/yr. Evaporation from open water (brine pool) is estimated at 0.088 in/day for the period of February through May and a rate of 0.107 in/day for the period June through January.[279]

Evapotranspiration from riparian and wetland vegetation in the Owens River Delta varies by vegetation type, species composition and percent cover. Estimated evapotranspiration rates for the mixture of vegetation types in the Owens River Delta range from between 2.5 to 5.0 ft/yr.[280] ET rates for very sparse alkali meadow range from between 0.7 to 1.3 ft/yr.[281] and for desert sink shrub vegetation rates range from between 1.0 to 1.6 ft/yr.[282]

Timing and Magnitude of Flows

Another important consideration for estimating the amount of water to maintain and enhance the delta ecosystem is the timing, duration of flooding, and distribution of flows to the delta. Owens River Riparian maintenance flows at about 200 cfs, will occur for about 14 days in late May to early June. The pumpback station will remove from 35 to 75 cfs leaving 165 to 125 cfs for the Delta maintenance flows. These flows are expected to provide a level of disturbance to that riparian and wetland communities that will benefit the quality of habitat and is vital to the long term health of the communities.

Groeneveld (1994) estimated a minimum irrigation requirement of 3.1 ft/yr. for maintaining established saltgrass meadows in the Owens Valley (35% living cover, 60% total cover). In irrigation trials GBUAPCD[283] found that the actual amount of water required to maintain meadows in short duration trials was “substantially below the minimum hypothesized for meeting meadow ET demand at Owens Lake”. However, it is important to note that the minimum amount of water to maintain saltgrass over several years is probably considerably different than the amount of water to maintain meadows in “healthy condition” on a long term basis.

An important aspect of minimizing water use while maintaining healthy saltgrass meadows may relate to timing of the first irrigation, as plants leave winter dormancy.[284] Jim Paulus (unpubl. data) suggested that saltgrass might be “adapted to take advantage of available water by adding most of most of their annual biomass incrementally during the months of April through June”.

GBUAPCD Experimental Dust Control

Experimental dust control sites on the Owens Lake playa provided some useful data on water use.

GBUAPCD Shallow Flooding: The goal of shallow flooding areas is to flood 75 % of the area in standing water or saturated soils between September 15 and June 15. Minimal water flows are required to maintain vegetation and enhance wildlife habitat values from June 15 and July 31. For the remainder of the year, between July 31 to September 15 flooding is not required. The estimated amount of water to control dust using shallow flooding is approximately 4 ac-ft/yr. of water per year per

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[277] LADWP 1997
[278] GBUAPCD 1997
[279] Blevens et al. 1976
[280] LADWP 1993, Lopes 1988
[281] Brad Schultz, Desert Research Institute reported in GBUAPCD 1997
[282] Duell 1990
[283] GBUAPCD 1996
[284] GBUAPCD 1996

acre of playa controlled.[285] The North Flood Irrigation Project (FIP) or “Area A” is approximately 1,210 acres and is located about 1 mile west of the lower Delta.

GBUAPCD Managed Vegetation: The goal of the Managed Vegetation Areas is to establish 50 % cover of alive and dead vegetation on 75 % of the designated control area.[286] Cover is measured using a point intercept method.[287] Initially 3.5 to 6 feet of water will be needed to leach the upper 2 feet of soil to reduce salinity to a level treated by saltgrass.[288] GBUAPCD data indicates that to maintain managed vegetation areas will require approximately two ac-ft/yr. of water per acre of controlled area or 2.5 ac-ft/yr. of water per irrigated acre.[289]

Tule Elk

Tule Elk (*Cervus elaphus nanodes*), formerly a State Endangered species, is a State Harvest Species and is not native to Owens Valley. Tule elk is one of six subspecies of elk in North America and is indigenous to California. In 1933 and 1934, 56 elk were introduced to the Owens Valley in the area around Aberdeen. Today there are six elk herds recognized in the Owens Valley with a total population of about 500 animals. The Owens Valley tule elk herd is very important to the continued recovery of this species.

Elk require available water, bushy vegetation cover with scattered openings and seclusion from human disturbance for calving. Calving occurs from April to July. Critical areas for tule elk include rutting areas, winter range, calving areas and migration routes. In 1991 the California Department of Fish and Game counted 341 elk during an aerial census of the valley. The recommended maximum herd size for the Owens Valley is 490 animals.[290]

Elk consume a wide variety of forbs, grasses, herbaceous, browse plants. They tend to be quite adaptable and opportunistic, utilizing succulent growth when available. Species such as willow and greasewood are consumed as long as green leaves are available. Other species such as winterfat, shadscale, allscale and big sagebrush provide important winter foods, are used at times other then their flowering period. Some species such as alkali sacaton and needle grass are used when they completely cure and are important foods during fall and early winter. Precipitation and snow depth influence the quality and quantity of available vegetation to tule elk and thus, influence the health of elk herds.

Herd composition, boundaries and overall size is somewhat fluid and variable according to season and local conditions.[291] Most of the tule elk that occur in the Blackrock lease are members of two different herds. The Independence herd is the primary herd in the northern portion of the lease and the Lone Pine Herd is the predominant herd in the south.

The Independence herd uses the grasslands, wet meadows and undulating saltbush terrain to the east of Fort Independence during the summer and the rut. The Owens River floodplain is also used during the rut. Some elk winter along the bajadas and foothills of the Inyo Mountains. Secluded areas in canyons of the Inyo Mountains and dense cover along the Owens River are used for calving.[292]

The Lone Pine elk herd occurs east of the Los Angeles Aqueduct from Manzanar-Reward Road in the north to the Bartlett on the west shore of Owens Lake. The herd uses the alluvial fans of the Inyo Mountains along the entire eastern portion of that range. The herd spends the summer and fall along the Owens River in willow patches in the "Island" area and in irrigated pastures northeast of the Island. In spring the herd congregates in the Owens River bottom. In summer, preferred forage species include willow, Bassia, Indian ricegrass, wire rush and some greasewood. In fall and winter elk consume more browse including four-wing saltbush and greasewood. The Lone Pine Herd depends more on riparian vegetation and irrigated pastures than annual forbs.[293] The "Islands" area is considered the

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[285] GBUAPCD 1997
[286] GBUAPCD 1997
[287] Scheidlinger 1997 Appendix E
[288] Ayers 1997
[289] GBUAPCD 1997
[290] BLM 1992
[291] McCullough 1969, Fowler 1985
[292] Racine et. al. 1988
[293] Racine et. al. 1988

most critical area for this herd. In 1997, the Lone Pine herd was estimated to include about 120 animals. Recommended herd size is at or below 60-80 individuals.[294]

Future Conditions

Management Goals

The management goal of the Owens River Delta Habitat Area is to "...enhance and maintain existing habitat consisting of riparian areas and ponds suitable for shorebirds, waterfowl and other animals and to establish and maintain new habitat consisting of riparian areas and ponds suitable for shorebirds, waterfowl and other animals within the Owens River Delta Habitat Area. Diverse natural habitats will be created and maintained through flow and land management, to the extent feasible, consistent with the needs of the "habitat indicator species" for the Owens River Delta Habitat Area. These habitats will be as self-sustaining as possible."[295]

Management Objectives

Management goals will be achieved by implementing a series of management objectives. The delta will be managed in concert with other aspects of the LORP using ecosystem management concepts and guided by adaptive management principals. Implementation of management objectives will result in specific long-term ecological benefits to the Delta Habitat Area and positive cumulative benefits to the Lower Owens Valley ecosystem.

Objectives

Implement flows to enhance and maintain existing habitat and if possible, establish and maintain new habitat. Estimated water use to maintain and enhance delta habitat is about 5,205 ac-ft/yr.

Implement 3 to 4 periodic habitat maintenance flows to the delta that will increase the distribution and availability of water and nutrients at key times throughout the year and cause minor disturbance to habitat.

On a contingency basis, implement beaver control measures and selective use of prescribed burning.

Implement an evaluation and monitoring program that will provide feedback for adaptive management of the management plan.

Management Strategy

The flow regime for the delta will be controlled at the delta pumpback station. Base flows to the delta will be maintained at an average annual minimum of 6 to 9 cfs. The amount, timing and duration of water flows to the delta are the most important aspects of resource management in the delta. Given these considerations and constraints an initial flow schedule was developed. It is important to remember that the Delta Habitat Area must be managed as a wetland with very little control over the water. Although amount and timing of water entering the delta can be regulated, there is very little ability to redistribute water, control water levels, alter drawdown rates or some of the other vegetation and habitat management tools. Essentially the delta is a very passive system.

The MOU provides that the LORP will manage flows in the Owens River to provide minimum flows of about 40 cfs and riparian flows of about 200 cfs, when the runoff to the Owens River watershed is forecasted to be average or above average. In years when the runoff is forecasted to be less than average, the water supply to the area will be reduced in general proportion to the forecasted runoff in the watershed.[296] Even in the driest years, available water will be used in the most efficient manner to maintain the habitat. The Wildlife and Wetlands Management Plan element of the LORP Plan will recommend the water supply to be made available under various runoff conditions and will recommend how to best use the available water in dry years.

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[294] Racine et. al. 1988

[295] MOU 1997

[296] The runoff forecast for each year will be DWP's runoff year forecast for the Owens River Basin, which is based upon the results of its annual April 1 snow survey of the watershed.

Future Water Budget
There are about 1,160[297] acres in the delta with a measurable vegetation cover.

The amount of surface water necessary to maintain and enhance the extent and quality of this habitat is estimated from existing information. Based on this information and the present configuration of delta landforms and vegetation, the amount of water to delta habitat is about 3,080 ac-ft/yr. While this estimate is considered reasonable, it assumes an even distribution of water across the entire 1,160 acres and it assumes that water is available, when and where it is needed. Water distribution will be dictated by the amount and duration of water passing to the delta, topography, landform, and the configuration of the vegetation.

The 3,080 ac-ft/yr. estimate is equivalent to a mean flow of approximately 7 cfs. Therefore, it is necessary to modify this initial estimate to account for uneven distribution, seasonal needs by plants and animals, and to incorporate the long-term viability of the delta system.

Ecosystem resiliency, "the magnitude of disturbance that can be absorbed before the variables and processes that control behavior change"[298], is an important aspect of long-term resource planning. Complex and diverse communities comprised of vegetation types in excellent condition and relativity high structural and floristic diversity are generally more resilient. Many management indicator species and special status wildlife species (e.g., many shorebirds, etc.) depend more on a combination of available water and playa, than vegetation per se. Incorporating period higher flows to the delta will help insure better distribution of water and use that is more efficient. The estimated water budget for long-term viability of the delta is about 5,205 ac-ft/yr.

Irrigation and water spreading flows will occur at about four intervals throughout the year. Generally, flooding targets will include early fall and mid-winter to attract and hold migrant and resident shorebirds, waterfowl and other waterbirds; early spring to maintain and enhance wetlands, maintain the invertebrate food supply for the host of species dependent upon this resource and mid-summer for irrigation and to maintain wetland habitat quality. The exact amount of flows and their timing should be related to annual variation weather patterns such as precipitation and temperature.

The four habitat enhancement flows specified for the delta include:

Period 1: Increase flows to delta for 10-20 days (25 to 10 cfs) at the beginning of the growing season when plants can use it. Increase water availability to vegetation and playa to enhance playa foraging areas and maximize vegetation in the vegetation-playa-water interface (attract migratory species, and irrigate and maintain vegetation).

Period 2: Flows to the delta equal to the amount of water that exceeds (about 150 cfs) the capacity of the pumpback station (river channel maintenance flows).

Period 3: Increase flows to delta for 10-20 days in late summer-early fall, increase water availability to vegetation and playa, (attract early migratory species, and irrigate and maintain vegetation).

Period 4: Increase flows to delta for about 10 days (20 cfs) in fall early winter, increase water availability to vegetation and playa, (attract fall-winter migratory species, and irrigate and maintain vegetation).

Water distribution
Observations of delta flows on many occasions indicate that flow to the secondary channel (east) have changed over the past 8 years. In the past, very little water flowed in the secondary channel at lower flows. When the Keeler gaging station indicated flows greater than about 12 cfs the secondary branch received appreciable water. In the past two years the eastern channel appears to receive considerable water at flows of less then 5-6 cfs. Flows in the secondary channel also appear to be greater 0.5 mile or so below the

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[297] Update: There are approximately 2,250 acres of vegetated land according to last mapping effort by WHA.
[298] Holling 1995

split than at the confluence with the main stem. The reason for this change is probably a combination of ground water levels and changes in the structure and/or capacity of the main channel. Many parts of the main and secondary channels are completely filled in with bullrush and cattails. Although water still flows in both channels, the vegetation is thick enough to walk across.

Implementation of the LORP and a new delta flow regime is expected to facilitate and promote many changes to the physical, chemical and biological structure and function of the area. Many of these changes will be very subtle and take many years to reach a dynamic equilibrium. Other changes will be apparent within a relatively short period. The goal of management is to provide the "system" with resources that will allow it to thrive and improve conditions in the delta over the long-term. Management in the delta must be compatible and complement management throughout the LORP. There is conscious effort to avoid instigating rapid high risk programs with short term benefits and inevitable failure.

Field observations of topography, river flows and vegetation patterns, and interpretation of aerial photography suggests that the main channel of the Owens River was located at least once in the past to the west of its present position. It appears that a branch of the Owens River diverged from the main stem at a point near the "pole-line" road and traversed down the playa toward the area known as GBUAPCD North FIP “Area A”. The property boundary actually follows a similar course. The main point is that change in the delta will continue and in the long-term it is likely to reposition and reconfigure itself many times.

Delta Habitat

The amount, timing and duration of water flows to the delta is the most important aspect of delta resource management. Several periods of higher flows (above baseline) will help insure better distribution and more efficient use of water. Irrigation and water spreading flows will occur at about four intervals throughout the year. The estimated water budget for the delta will actually be about 5,205 ac-ft/yr. The exact amount of flows and their timing should be related to annual variation weather patterns such as precipitation and temperature. Future management will invariably provide for significant direct and indirect benefits to delta habitat and to the myriad of species that occur there.

Habitat in the delta is expected to respond to management changes at several spatial scales including a within-vegetation stand response and as an area-wide or community response. In general, delta vegetation types are in relativity good condition, although most of the riparian vegetation appears to be below their potential. This type is compromised relative to vegetation volume, vertical stratification, age class structure (sustainability), and stand configuration. Future management will have beneficial effects on vegetation types in the following general categories.

Long-term habitat conversion is expected in the delta. Generally, there should be a shift to more mesic conditions that will eventually result in conversion of vegetation types. The relative composition of vegetation types and wet playa is expected to change slightly to favor more mesic types such as transmontane alkali marsh and moist transmontane alkaline meadow (MAM).

Long-term condition/quality of vegetation types will:

- increased productivity;
- increased vigor and productivity;
- increased resiliency to perturbations;
- greater structural richness and diversity;
- higher floristic richness and diversity; and
- increased vegetation type interspersion and richness.

Given the present topography of the delta, the extent of playa supporting vegetation is expected to increase. Bare or very sparsely vegetated playa and transitional meadow zones (DAM) will probably convert to more stabile alkaline meadows (MAM). New transitional or dry alkali meadows (DAM) will be established as bare playa receives more surface and ground water.

Factors for Evaluating Existing and Future Condition and Value:

- Emergent and Herbaceous Wetlands
- Cover, vigor and productivity of perennial grasses (field estimate, index).
- Relative species composition of desired plants within major vegetation layers (field estimate, listing).
- Soil cover to live vegetation and litter (field estimate, index).
- Species richness and diversity (field estimate, index)
- Vegetation structure (field estimate, index)
- Residual vegetation (field estimate, index)
- Extent of contiguous patches and diversity of types (mapping, index)

Evaluation of Riparian

Diversity of wildlife communities in riparian habitat is related to habitat structure (physiognomic characteristics), specific plant associations, and/or other floristic characteristics, high plant productivity, and many other unique resources, all in close proximity.[299] Richness and abundance of wildlife appear to be more dependent on structure and diversity of vegetation communities than on floristic attributes.[300]

Important habitat attributes relate to the available physical space and the array of conditions available to a variety of wildlife species. Generally, the presumption is that, as the number of strata of dense habitat layers increases so does the potential to support a greater variety of wildlife species at higher densities. A diversity of microhabitat features is assumed necessary to provide the highest levels of wildlife richness.

The size, shape, and arrangement of habitat are important considerations for evaluating the relative suitability of any particular area. Habitat block size, interior versus edge habitat, area fragmentation, and habitat connectivity are basic attributes helping define any management area, especially those dominated by riparian/wetland communities.[301]

The association between wildlife using a patch of habitat and the size of an area has significant implications for resource management, both in terms of the richness (number) and the composition of species expected to occur. Generally, the number of different species using a particular patch of habitat will increase with patch size.[302] This relationship, as it is understood, is not typically linear and is known to vary geographically, temporally, and among communities. The likelihood of depredation, parasitism and disturbance is thought to decrease with stand size and distance from edge.

A critical factor in evaluating habitat suitability is habitat sustainability. If a riparian/wetland community and its component vegetation types are not self-sustaining, then resource values that are gained at one point in time are transient. A static system is not preferred, desirable, or even possible. Ecosystems do not exhibit an undisturbed "state" that can be maintained indefinitely. Rather, they exhibit a suite of behaviors over all spatial and temporal scales, and the processes that generate these dynamics should be maintained.[303] Site specific habitat losses and gains will occur. The long term overall net change to the riparian/wetland habitat in the Lower Owens River is a far more important consideration. Measuring and understanding the dynamics of a viable riparian ecosystem is a difficult but necessary undertaking.

Overall extent of riverine wetlands and woody riparian habitats, and size of vegetation patches or stands (mapping).

- Snag-woody debris size class structure (field estimate, measured continuous).
- Relative species composition of desired plants within major vegetation layers (field estimate, listing).
- Number of different structural layers (field estimate, ordinal data with check list).

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[299] Ohmart et al.1977; Fredrickson 1979; Brinson et al. 1981; Ohmart and Zisner 1993; Ohmart et al.1993

[300] Szaro 1989; Brinson et al.1981; Raedeke et al.1988

[301] Christensen, N.L. et al. 1996

[302] MacArthur and Wilson 1967, Galli et al. 1976, Martin 1978, Robbins 1979

[303] Holling 1995

- Relative density (volume) of foliage in different layers (field estimate, measured continuous).
- Relative composition of vegetation types (life form categories) in riverine/riparian habitat (mapping relative).
- Stand canopy closure for woody riparian (field estimate, measured continuous).
- Residual vegetation in herbaceous and shrub/tree vegetation types (field estimate, index)
- Percentage of flood plain width with woody riparian vegetation (mapping, relative index)

Management Issues and Components

The Delta habitat management plan consists of a set of actions or project components that, when implemented, will result in achieving the desired future habitat conditions.

Livestock and Tule Elk
Wetland and riparian vegetation restoration and enhancement is being addressed directly in the livestock grazing plans and several other management plans for the LORP. Condition, health and characteristics of wetlands and riparian areas are expected to improve relative to specific livestock management practices. Changes to grazing leases include improved distribution and utilization, reduction in the number of livestock in a pasture, creation of new pastures, specific utilization guidelines and improved monitoring of range condition.

Evaluation and monitoring of delta wetland and riparian habitat is a critical component of the monitoring plan. If habitat conditions are below expectations or proposed management actions do not result in the expected responses, management actions will be reevaluated through adaptive management, and plans will be reconsidered.

Salt Cedar
While there is some salt cedar in delta, the species is not wide spread or dominant in any areas. The potential risk of infecting new areas with salt cedar or increasing vigor and productivity of existing stands is considered a significant issue in throughout the LORP. As a result, there has been a concerted effort to avoid any activities that will mechanically disturb wetlands. Other management practices that will help circumvent and limit the spread of tamarisk include: (1) provide for good water circulation and drainage in wetlands to minimize accumulation of salts, (2) very limited use of fire for vegetation management, and when fire is used, flushing or leaching along with careful monitoring will follow, and (3) monitoring designed for early detection of tamarisk recruitment.

Disturbance
Refuge and solitude for wildlife is one of the delta's most valuable assets. Many of the areas most unique wildlife species would be adversely impacted if this quality was compromised. Many activities from bird watching to hunting to biological research can potentially have detrimental effects on wetland and playa inhabitants. Since there are not specific disturbance issues associated with the Delta Habitat Area, there are not any proposed recommendations.

There are some land management issues such as clearing and burning hedgerows, removing brush from road sides, clearing the understory from willow thickets, burning areas simply to provide better access that are land management issues not specific to the delta area. These topics will be addressed in the appropriate resources management plan.

Other Management Components

Controlled Burning
Fire can be used to change the pattern, composition, and density of vegetation. Fire removes residual debris, releases nutrients, exposes soils for new germination, and usually creates a landscape mosaic of vegetation favorable to wildlife. Fire is an effective tool to change the structure, composition, and distribution of vegetation,[304] especially when other methods such as water control are not available. Timing of prescribed burns is dependent on dry conditions, fuel availability, and site specific sensitivities, such as “listed” species. Prescribed burns must be carefully planned and executed to meet local, state, and

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[304] Kirby et al. 1988

federal regulations. Small controlled burns for site specific management of emergent vegetation will not be practiced within the riparian corridor.

Beaver Management

Beaver are present in the riparian habitat in the upper portion of the delta. Beaver control in the delta will be consistent with the LORP beaver control program.[305] Appropriate control of the beaver population is important especially in the years following project implementation when riparian and wetland areas are developing rapidly.

Facility Maintenance

Facility maintenance for the Delta Habitat Area will be minor. Maintenance issues will mostly relate to the pumpback station. There will be minor maintenance needs for access roads.

Monitoring

The specific monitoring program for the Owens River Delta Habitat Area will be included in the LORP monitoring program. Monitoring evaluates progress toward meeting management goals and objectives and determines maintenance needs. The complexity and intensity of monitoring will vary depending on the priority, potential, and management opportunities of a site. Specific variables used for monitoring should be derived from specific project goals, acceptable performance objectives set during project planning, and design.

The type and intensity of monitoring is tailored to the particular project. Monitoring is essential in natural resource management to determine if:

- A project was implemented correctly (inspection).
- Goals and objectives are being achieved.
- Maintenance is needed and when.

Monitoring is an important feedback mechanism that provides a basis for adaptive resource management. Analysis, interpretation, and evaluation of monitoring results may suggest modifications to the design, management, goals and objectives, and the monitoring plan.

The degree, frequency, and timing of monitoring are important considerations determined by project goals and deadlines. Monitoring may be conducted frequently in the beginning and less frequently after trends are determined. Frequent monitoring can be used to identify variables that limit restoration to support mid-course corrections. Once it is clear that restoration is proceeding at an acceptable rate, monitoring may be conducted less frequently. The duration of projects monitored should be sufficient to accomplish objectives.

All aspects of the monitoring plan and all results from monitoring must be documented and filed for retrieval. Adequate monitoring, like any other component of a watershed and riparian treatment project, requires a commitment of time and money. Some preliminary monitoring variables for the delta are discussed above under wetland and riparian evaluation. Variables include measures of habitat at a landscape level, standard “within stand” characteristics and information that relate to the sustainability of habitat.

Tule Elk

Goals for the Lone Pine herd include:

- Maintain the elk population within the Lone Pine herd management area in a healthy, self-sustaining condition for the enjoyment of future Californians;
- Protect and enhance tule elk habitat within the Lone Pine herd management area; and
- Manage the tule elk resource to maximize public benefits and minimize conflicts with other land uses by recognizing its value for both consumptive and non-consumptive uses.

Racine et. al. (1988) stated that, "Elk in the Lone Pine, as well as the elk in the other five herds in the Valley, depend on green forage found in irrigated pastures. While the use of irrigated pastures has not been considered depredation in the past, if elk herds in the Valley are allowed to exceed their herd size

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[305] Ecosystem Sciences 1996

objectives, the potential for elk to significantly impact lessees in terms of available forage for livestock exists. If practical, sport hunting programs should be utilized to reduce elk damage."

The Owens River riparian and Delta Habitat Area provide excellent habitat for elk calving and are one of nine areas designated by the BLM and CDFG as an Owens Valley Tule Elk Calving Area.[306]

Tule Elk Issues: Tule elk are generally compatible with a broad range of natural resource management goals. Potential conflicts with other land use goals can occur when the species (elk) is exotic to the management area; when the target resource (wetlands and riparian habitat) has a limited distribution and is in poor condition; when elk populations are allowed to exceed appropriate levels; and, when elk management is not closely coordinated with livestock management.

Domestic Livestock
The Owens River Habitat Area is within the Delta livestock grazing lease managed by LADWP.

Domestic Livestock Issues: In general, livestock grazing is compatible with goals for the Owens River Delta Habitat Area. Livestock impacts riparian vegetation both through direct consumption of plant material and trampling. The latter effects vegetation by compacting soil, resulting in reduced infiltration, percolation, root growth, and plant production.[307] Grazing may be directly detrimental to breeding waterfowl[308], but the impacts on migration and winter habitat are more subtle. Excessive grazing increases runoff and erosion, resulting in excessive siltation, which can destroy valuable shallow-water habitat. Improper management of livestock grazing can have serious adverse effects on wetland-riparian vegetation.

Beaver
Beaver (*Castor canadensis*) is the largest rodent in North America, weighing up to 75 pounds. Beaver are highly specialized obligate riparian/aquatic rodents found in ponds, lakes, rivers and streams. Beavers are generalized herbivores: they consume a wide variety of plants (aquatics, forbs, grasses shrubs, trees), many parts of plants including, leaves, bark, twigs, rhizomes and flowers. While beavers eat a variety of foods, they prefer, and are most dependent on woody riparian species such as aspen (*Populus tremuloides*), willow (*Salix spp.*), cottonwood (*Populus spp.*) and many other tree and shrub species.[309]

Beaver are native to some regions of California west of the Sierra Nevada, but are not native east of the Sierra crest. Beavers were introduced to many locations during the 1930’s and 40’s as part of the Federal Aid in Wildlife Restoration Project California. Beaver in the Owens Valley probably belong to the Idaho subspecies, *Castor canadensis taylori*, Davis.

Beaver Issues: Beaver influence wildlife, water quantity, water quality, fish habitat and fish populations, esthetics, and recreational opportunities, and the relationship of cattle grazing to riparian and streambank condition. Beaver influences interact with other land use and resource management practices along the Lower Owens River. These interactions have had, and will continue to have a major role in the Lower Owens River ecosystem. Consequently, beaver abundance and their distribution throughout the Lower Owens River must be a primary consideration with all ecosystem management plans.

The present condition of the Lower Owens River ecosystem is, in part, a result of beaver impacts. Other interacting influences on environmental conditions include water management and land use practices, domestic livestock grazing and grazing by other large ungulates. One of the primary conditions of

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[306] BLM 1993
[307] Clary 1995, Bryant et al. 1972, Kattelmann and Embury 1996
[308] Kadlec and Smith 1989

[309] see JENKINS,STEPHEN H.AND PETER E. BUSHER. 1979. CASTOR CANADENSIS. MAMMALIAN SPECIES,120 - 1-8.
[2]see HALL, E.R. 1981. THE MAMMALS OF NORTH AMERICA. JOHN WILEY + SONS,
NEW YORK, 2- 1-1181+90.

concern on the Lower River is the widespread paucity of woody riparian vegetation recruitment. Survival and persistence of the numerous sprouts produced each year by willow also appears very low. Furthermore, many of the established shrubs and trees are showing signs of stress and are dying. Beavers are known to over-exploit their food resources causing habitat degradation and starvation of the colony. While we understand that beaver are one of many influences of habitat conditions in the Lower Owens River ecosystem, we expect that given the relatively poor habitat conditions, beaver might suppress or inhibit the pace and magnitude of recovery. In a healthier state, the river system will be more resilient and beaver management will be carried out on a maintenance basis. Generally, beaver appear to have little influence in the Delta.

Salt Cedar

The genus *Tamarix* (common name "tamarisk" or "salt cedar") contains many species (as many as 54 are formally recognized) originating from widely dispersed areas located in arid and semi-arid regions of the Old World. The most abundant and widespread species of salt cedar in the Owens Valley is *Tamarix ramosissima*, which is a deciduous member of the Tamarisk Family (*Tamaricaceae*). It is a glabrous, loosely branched shrub or small tree 1-5 m tall. The flowers are most abundant in the Northern Hemisphere from April to August but may be found most of the year.

Each year salt cedar (Tamarisk) produces many thousands of seeds from April to October. Seeds are viable for several weeks and germinate rapidly on saturated fine substrates. Seedlings can withstand submersion for several weeks and mature plants can withstand even longer periods of water inundation (70-90 days). As a facultative phreatophyte, Tamarix species are capable of extracting soil moisture from less saturated soils in areas with deeper water tables. Saltcedar will grow where the water table is between 1.5 and 6 m from the surface. Saltcedar is not an obligate halophyte but can survive in areas where groundwater concentration of dissolved solids approaches 15,000 ppm[310], but typically occur in areas averaging about 6,000 ppm salt.[311] Saltcedar exudes excess salt crystals from openings in its scale-like leaves.[312] It has been reported to contain 41,000 ppm dissolved solids in the guttation sap.[313] Not only can these glands concentrate salt, but they also secrete various other ions, including boron.[314] These salts are eventually deposited on the soil surface under the plant, sometimes forming a hard crust.[315] Such deposits of salt-encrusted needles can inhibit the germination of other species.[316] Following fire, higher alluvium salinity and elevated concentrations of phytotoxic boron can delay the re-establishment of native trees and shrubs, particularly *Populus* and *Salix*. These areas are very susceptible to invasion by salt tolerance species of *Tamarix*.[317]

In and adjacent to the Blackrock Waterfowl Habitat Area, tamarisk is most abundant along disturbed road sides, flood basins, water conveyance structures, adjacent to off river ponds and lakes, along the 1872 earthquake fault, and in the Owens River floodplain above five culverts (now two culverts). Generally, tamarisk thrives in areas with soil disturbance and highly altered hydrologic regimes.

Salt Cedar Issues: The potential risk of infecting new areas with salt cedar or increasing vigor and productivity of existing stands is considered a significant issue in the Waterfowl Habitat Area.

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[310] Carman and Brotherson 1982
[311] Brotherson and Winkel 1986
[312] Neill 1985
[313] Duncan et al. 1993
[314] Busch and Smith 1993
[315] Kerpez and Smith 1987
[316] Egan et al. 1993
[317] Busch and Smith 1993

2.2.9.11 Tech Memo #19 Riparian Wildlife Management[318]

The purpose of this document is to discuss the primary management concepts and priorities for implementing riparian wildlife management for the LORP. A summary of important management issues, evaluation tools and options is provided.

Importance of Riparian Areas

Riparian areas are one of the most scarce, unique and valuable habitats in the western United States. In California, riparian areas are critical for a greater number of dependent and facultative wildlife species then any other habitat.[319] The loss and degradation of riparian ecosystems has probably been one of the most important factors causing the decline of so many wildlife species in the western United States.

Goals and objectives from MOU

The goal of the LORP is the establishment of a healthy, functioning Lower Owens River riverine-riparian ecosystem, and the establishment of healthy, functioning ecosystems in the other physical features of the LORP, for the benefit of biodiversity and Threatened and Endangered Species, while providing for the continuation of sustainable uses including recreation, livestock grazing, agriculture and other activities. The LORP Action Plan[320] identifies a list of "habitat indicator species" for the riverine-riparian ecosystem. The goal is to create and maintain through flow and land management, to the extent feasible, diverse natural habitats consistent with the needs of the "habitat indicator species." These habitats will be as “self-sustaining as possible."

Management of Riparian Resources

The essence of riparian wildlife management in the LORP is to manage the habitat.[321] By definition, all riparian wildlife depends on the extent and quality of riverine-riparian areas and to a lesser extent on adjacent wetlands and uplands. There are numerous other factors that have both positive and negative influences on local wildlife populations and the long-term viability of a species, but until riparian processes are restored and suitable habitat is reestablished, all other activities are simply stop-gap measures. Riparian wildlife habitat management will consist of two primary components: land use and flow management. Once a functional habitat base is restored then other factors that might provide additional benefits to specific populations can be reevaluated and appropriately addressed. Management of wildlife populations (i.e., tule elk and beaver populations, regulations) is the responsibility of the California Department of Fish and Game.

Wildlife Habitat Relationships

Diversity of wildlife communities in riparian habitat is related to habitat structure (physiognomic characteristics), specific plant associations, and/or other floristic characteristics, high plant productivity, and many other unique resources, all in close proximity.[322] Richness and abundance of wildlife appear to be more dependent on structure and diversity of vegetation communities than on floristic attributes.[323]

Important habitat attributes relate to the available physical space and the array of conditions available to a variety of wildlife species. Generally, the presumption is that, as the number of strata of dense habitat layers increases so does the potential to support a greater variety of wildlife species at higher densities. A diversity of microhabitat features is assumed necessary to provide the highest levels of wildlife richness.

The size, shape, and arrangement of habitat are important considerations for evaluating the relative suitability of any particular area. Habitat block size, interior versus edge habitat, area fragmentation, and habitat connectivity are basic attributes helping define any

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[318] Ecosystem Sciences, Tech Memo 19, 1999.

[319] Knopf et al. 1988, Dobkin 1994, Manley and Davidson 1993, Ralph 1998

[320] MOU 1997

[321] also see Ecosystem Management Plan, Chapter 1, Management Concepts. Ecosystem Sciences 2002.

[322] Ohmart et al.1977; Fredrickson 1979; Brinson et al. 1981; Ohmart and Zisner 1993; Ohmart et al.1993

[323] Szaro 1989; Brinson et al.1981; Raedeke et al.1988

management area, especially those dominated by riparian/wetland communities.[324]

The association between wildlife using a patch of habitat and the size of an area has significant implications for resource management, both in terms of the richness (number) and the composition of species expected to occur. Generally, the number of different species using a particular patch of habitat will increase with patch size.[325] This relationship, as it is understood, is not typically linear and is known to vary geographically, temporally, and among communities. The likelihood of depredation, parasitism and disturbance is thought to decrease with stand size and distance from edge.

A critical factor in evaluating habitat suitability is habitat sustainability. If a riparian/wetland community and its component vegetation types are not self-sustaining, then resource values that are gained at one point in time are transient. A static system is not preferred, desirable, or even possible. Ecosystems do not exhibit an undisturbed "state" that can be maintained indefinitely. Rather, they exhibit a suite of behaviors over all spatial and temporal scales, and the processes that generate these dynamics should be maintained.[326] Site specific habitat losses and gains will occur. The long term overall net change to the riparian/wetland habitat in the Lower Owens River is a far more important consideration. Measuring and understanding the dynamics of a viable riparian ecosystem is a difficult but necessary undertaking.

Habitat Evaluation Tools/Habitat Suitability Index Models

Overview of Principals

Habitat Evaluation Procedures (HEP) is a habitat based evaluation method developed for use in habitat evaluation and monitoring impact assessment and mitigation planning.[327] The method is based on the assumption that habitat value can be numerically described as Habitat Units (HU) which are derived from habitat quality and quantity. HEP uses a few selected evaluation species, in a species-habitat approach, to represent the needs of a broader group of wildlife species in a particular habitat. Habitat quality for a given evaluation species is determined through use of a Habitat Suitability Index (HSI) model.[328] HSI models consist of several habitat variables combined in a manner to approximate and define the most pertinent life requisites for the species or guild. Habitat types are delineated for the study area, and evaluation species are selected for the habitat types. HSI values represent the quality (suitability) of the habitat for the evaluation species. The HSI value multiplied by acres (quantity) of the habitat type equals Habitat Units (HU). HEP analysis uses HUs as the basic numerical unit for quantifying baseline conditions, impact assessments, alternative analysis, and for mitigation planning.

HSI models generally represent habitat suitability of a species as the mathematical result of quantitatively combining two or more environmental variables assumed to most affect species presence, distribution, and/or abundance. Inherent to any model is a generalization and simplification of complex, and usually poorly understood relationships and interactions with environmental factors, interspecific responses and among conspecifics. HSI models can be viewed as hypotheses of species-habitat relationships rather than casual functions.[329] The obvious values of using HSI models include explicit and repeatable means of systematically determining environmental impacts, comparing project alternatives, and tracking mitigation.

HSI models encompass a broad range of models based on the common assumption that wildlife values (e.g., presence, distribution, abundance, species richness, etc.) for an area can be assessed by appraising selected characteristics and the relative abundance of habitat. Models consist of several habitat variables combined in a manner to define and approximate the most pertinent life requisites for the evaluation species, wildlife guild, or management objective. Most habitat variables

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[324] Christensen, N.L. et al. 1996

[325] MacArthur and Wilson 1967, Galli et al. 1976, Martin 1978, Robbins 1979

[326] Holling 1995

[327] USFWS 1980a

[328] USFWS 1980b

[329] Schamberger et al. 1982

used in wildlife-habitat relationship models are actually surrogate or proxy measures of less easily attainable measures or attributes. These are assumed to relate to a limiting, scarce, or preferred resource required by a species. For example, foliage height diversity or foliage volume is assumed to relate to the abundance and availability of invertebrates (seasonal food resource), which is assumed to relate to the abundance and richness of the avifauna. Basic species needs or life requisites are generally grouped as food, cover, water, and spatial requirements, and may be further dissected into seasonal components or an ever-increasing level of resolution. Ultimately, multiplying habitat quality derives habitat value.[330]

Each variable and the resulting Suitability Index (SI) values are scaled from 0 to 1. The overall HSI value also ranges from 0 to 1 and represents the final response of the target species to the combination of variables. HSI models consist of important habitat variables that are organized and combined using simple mathematical functions.

Habitat Characteristics
Most of the habitat characteristics required for the HSI were collected in the field using a variety of direct measurement and visual estimation techniques. Several other measurements of habitat parcel size, configuration, juxtaposition, floodplain width etc., were estimated using a number of GIS procedures. A total of 227 locations, 137 in woody riparian habitat, were sampled during the summer and fall of 1993. Habitat characteristics were used to derive 103 habitat variables used in HSI models.

Evaluation Species Models
Fifteen wildlife evaluation species, guilds, or cover type models were used for the LORP assessment (Table 1 [of Tech Memo 19. Table is not included in this document]). Species for this study were selected, in part, based on discussions with Inyo County, and with wildlife biologists from California Department of Fish and Game (CDFG) and LADWP. All evaluation species were considered important from several perspectives and all were presumed to be responsive to the resource management practices in the Owens Valley.[331]

Wildlife Habitat Indicator Species
The MOU designates several species that will help guide wildlife resource management in riverine-riparian areas. The list of wildlife indicator species for the riverine-riparian areas includes several wetland and riparian dependent species with diverse habitat requirements (Table 2[of Tech Memo 19. Table is not included in this document]).

Recently the Riparian Habitat Joint Venture (RHJV), a collaboration of State, Federal and private organizations developed a draft, Riparian Bird Conservation Plan, "to guide conservation policy and action on behalf of riparian habitat and California’s "landbirds". The Plan identified a group of 14 bird species that are of particular conservation interest and "chosen as focal species representative of the full range of riparian habitats in the state". Most of these species breed and/or use the Owens Valley riparian habitats.

Evaluation and Monitoring Approach
There is extensive overlap between the HSI evaluation species and the MOU riparian indicator species. There is even greater overlap if the habitat requirements of the individual species are considered. Many of these species respond to very similar components of the habitat. Because of the overlap between the HSI and indicator species, no new models will be developed for LORP management. Existing HSI models will be reevaluated, and if necessary models will be altered and refined. If there are important habitat relationships (characteristics) indicator species that are not adequately evaluated and monitored through one or more of the HSI species, than those characteristics should be incorporated in the monitoring program.

The foundation of the riparian/wetland wildlife monitoring plan will be habitat. Characteristics of the riparian habitat that are important and predictive to the HSI and MOU indicator species will be evaluated in baseline surveys

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[330] Hays 1985

[331] also see, Technical Memorandum # 16, Revised Projections of Wildlife Habitat Units for the Lower Owens River Using habitat Suitability Index (HSI) Models

and used for monitored progress of LORP restoration.

The extent of riverine-riparian types and the relative composition of each will be an important group of habitat monitoring variables. This group of "landscape" characteristics provides important information on the quantity, availability and configuration of the LORP now and into the future. Another set of monitoring data provides insight into the "internal" or stand level, structural and floristic characteristics. For example, the number of structural habitat layers and the volume of each layer provide valuable insight into the capability of the habitat to support many of the HSI and MOU indicator species. These habitat characteristics are also expected to change as the habitat develops. A subset of the most important habitat variables will be selected for monitoring. These habitat characteristics will be used to develop "objective statements" for the monitoring plan. Habitat characteristics will be measured using a combination of remote (photo-interpretation and GIS) and field sampling.

Wildlife Surveys

The evaluation and monitoring program will include periodic direct monitoring of several riparian wildlife species. The value of these long term monitoring surveys will be to track the benefits of the LORP through time and to put the value of the Owens River in perspective.

Riparian Characteristics

Lower Owens River riparian habitat is naturally linear and actually consists of an abrupt edge component, i.e., where the floodplain and uplands interface, and several "soft" edge components between riverine, emergent vegetation, woody riparian vegetation, and wet, mesic and dry shrub meadows.

The LORP riverine-riparian area extends for about 57.7 river miles and includes about 5,580 acres of floodplain area. Within the floodplain are a total of about 744 acres (12.7 %) of woody riparian, 293 acres (5.0 %) of riverine wetlands, about 797 acres (13.6 %) of emergent and herbaceous wetlands and about 2,460 acres (42.0 %) of saltbush/alkali meadow (Table 3[of Tech Memo 19. Table is not included in this document]). The future extent of the riparian (willow/cottonwood forest/scrub) is expected to double, comprising about 27.3 percent or 1,598 acres of the project area.

The "Dry" (#2) reach begins at the intake and extends downstream for about 15.6 miles. The mean width of the floodplain is about 119 meters and the mean width of the riparian corridor is only about 11.5 meters. The riparian vegetation is comprised of homogeneous stands of salt cedar (67 acres) and a mixture of salt cedar, Russian olive and tree willow (126 acres). Generally, riparian vegetation patches in this reach are very narrow, very fragmented and disjointed. Large relic willows persist, scattered throughout narrow bands of salt cedar along the main channel and along old oxbows. Canopy closure of the upper canopy is relatively high (36.8 %), where it still exists. Recruitment of woody riparian species is relatively common. Almost all of the new vegetation is salt cedar, and Russian olive with a few willows.

The "Intermediate" (#3) reach starts below the Dry reach at "Five Culverts" and extends for 17.5 river miles to where the channel splits and the "Island" area begins. The mean width of the floodplain is about 146 meters and the mean width of the corridor with riparian vegetation is about 17.6 meters. This reach has the highest riparian plant species richness and the highest percentage composition of the seeding/sapling age class. Mean canopy closure of the upper tree canopy is about 41 percent and the mean height of the upper canopy is 11.4 meters about the same as for the "Beaver" reach (#5). Mean diameter at breast height (DBH) of trees is 32.8 centimeters, slightly less than the "Beaver" reach and the density of snags >15 centimeters DBH is 32.9 snags/hectare. The estimated composition of willows in the overstory is 60 percent. The mean shrub understory layer in this reach is about 2.9 meters in height, comprised of about 80.2 percent willow and other hydrophytic species and has a canopy closure of about 23.5 percent.

The upstream half of this reach is in poor condition relative to the downstream half. The riparian tree canopy in the upper section is narrow with a patchy distribution and open canopy. Generally, the riparian vegetation in the lower section has a contiguous overstory with several well defined understory layers. Cottonwoods are not abundant in the LORP. There appeared to be more cottonwoods in this reach than in any other of the evaluation reaches except the reference reach that was located above Tinemaha Reservoir. Beaver are relatively abundant throughout most of this reach although they do not appear to have the adverse impacts as they do in other reaches.

The "Island" reach (#4) begins at about the point where channel divides into two distinct branches and the floodplain broadens to a mean width of 303 meters (maximum width = 771 m). The mean width of corridor with riparian vegetation is 87.3 meters. This reach extends for about 10.6 miles downstream to the Lone Pine Station Road. The Island reach actually consists of two main sections, the upper section is a very broad reach adjacent to the Alabama Gates and the second area is a very narrow corridor that starts at the point were two channels merge together below the "Island". Mean tree canopy height is 8.9 meters and mean canopy closure is 38.7 percent. Tree willows are the dominant riparian vegetation. Mean diameter at breast height (DBH) of trees is 32.1 centimeters, about the same as the "Intermediate" and "Beaver" reaches. The density of snags >15 centimeters DBH is 20.5 snags/hectare which is less than both the "Intermediate" and "Beaver" reaches. The mean height of the shrub understory layer is about 2.7 meters and has a canopy closure of about 19.5 percent. Shrub canopy closure in the islands reach is less then any of the other evaluation reaches.

The relative abundance of the seeding/sapling age class is lower than any other reach. Conversely, the estimated proportion of decadent woody riparian was very high, similar to the "Beaver" reach. There are several large areas in the "Island" dominated by salt cedar. These areas are mostly located along the western portion of the reach south of Alabama Gates.

The upper section of the "Island" reach is unique to the LORP. This area has the widest riparian corridor along the Lower Owens River and it has the most extensive forested emergent wetland. This wetland is sustained by a combination of river water and water from a complex of springs and seeps that are located along the upper west side of the reach, from Reinhackel Spring in the north, downstream to the Alabama Gates.

Beaver are evident in this upper "Island" area. Since there are several channels weaving through this area and very subtle topography, the rodents have engineered a level ditching system that resembles rice paddies. Beaver have constructed long low dams of emergent vegetation intertwined with small diameter willow branches. These dams snake through riparian/wetland understory. The riparian overstory has a relatively open savanna-like canopy and the middle and upper shrub layer is sparse. Vigor of the woody riparian (willows) is very low in the reach, probably due in part, to the anaerobic conditions from the constant flooding due to beaver dams.

In contrast, most of the riparian corridor along the lower part of the reach is very sparse, narrow and fragmented. A black-crowned night heron roost was located in this reach although its present status is unknown.[332]

The "Beaver" reach (#5) begins at Lone Pine Station Road and extends for about 9.6 miles downstream to a point about 2.5 miles below Keeler Bridge. Generally, the floodplain is confined by bluffs several meters above the river elevation. The mean width of the flood plain is 140.3 meters and the mean corridor with riparian vegetation is about 31.1 meters.

Mean tree canopy height is 11.4 meters and mean canopy closure is 37.8 percent. Tree willow is the dominant riparian vegetation although there are a few small patches of cottonwood. Mean diameter at DBH of trees is 33.4 centimeters, slightly larger than the “Intermediate" and "Island" reaches. The density of snags >15 centimeters DBH is 29.7 snags/hectare. The mean height of the shrub

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[332] Personal communication, Mike Prather

understory layer is about 3.6 meters and has a shrub canopy closure of about 25.3 percent, greater than any other reach. The relative abundance of the seeding/sapling age class is slightly higher than the "Island" reach. The estimated proportion of decadent woody riparian was high and very similar to the "Island" reach.

Wetland type richness and diversity in this reach is very high. The river meanders through the flood plain dominated by salt grass and alkali sacaton. Scattered throughout the floodplain are numerous oxbows of various ages and hydric conditions that concentrate tangles of mast producing shrubs, cattails, tules, reed grass, narrow leaf willow and a diverse variety of emergent and wet meadow plants. Several areas in the reach are presently being converted from riparian forest to shallow emergent wetlands and open water ponds. For example within the past six years there has been a noticeable change to the section of riparian just down stream from the Lone Pine Station Road. Most of this area is now flooded with water ponded behind beaver dams. Many of the tree willows are dead and the remaining trees show signs of stress. The tree and upper shrub canopy is now very sparse.

The "Delta" reach (#6) begins about 2.5 miles south of Keeler Bridge and extends for about 4.4 miles on to the Owens Lake playa. There is about 27.9 acres of riparian vegetation in the Delta but the dominant vegetation type is alkali meadow. Most of the riparian corridor from the delta powerline road upstream to Keeler Bridge is narrow (mean width = 14m) and fragmented with an open canopy and a very sparse understory. There is one exceptional section of the Delta reach that is located just downstream from the powerline road. The riparian corridor expands to about 100 meters for about 1 mile. This area has a mixture of young to older age class trees and shrubs with high volume shrub understory. Below the shrub under story is a patchwork of wet meadows, shallow wetlands and narrow stream rivulets. [333]

Land Use Management

Tule Elk

Although management of tule elk populations is the responsibility of CDFG some general characteristics of the Owens Valley elk herds are discussed because of their potential influence on riparian resources.

Tule elk (*Cervus elaphus nanodes*), formerly a State Endangered species, are a State Harvest Species and are not native to Owens Valley. Tule elk are one of six subspecies of elk in North America and are indigenous to California. In 1933 and 1934, 56 elk were introduced to the Owens Valley in the area around Aberdeen. Today there are six elk herds recognized in the Owens Valley with a total population of about 500 animals. The Owens Valley tule elk herds are very important to the continued recovery of the once endangered species.

Elk require available water, bushy vegetation cover with scattered openings and seclusion from human disturbance for calving. Calving occurs from April to July. Critical areas for tule elk include rutting areas, winter range, calving areas and migration routes. In 1991 the California Department of Fish and Game counted 341 elk during an aerial census of the valley. The recommended maximum herd size for the Owens Valley is 490 animals.[334]

Elk consume a wide variety of forbs, grasses, and herbaceous browse plants. They tend to be quite adaptable and opportunistic, utilizing succulent growth when available. Species such as willow and greasewood are consumed as long as green leaves are available. Other species such as winterfat, shadscale, allscale and big sagebrush provide important winter foods, and are used at times other then their flowering period. Some species such as alkali sacaton and needle grass are used when they are completely cured and are important foods during fall and early winter. Precipitation and

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[333] Other characteristics of the Owens River delta are discussed Technical Memorandum # 8, Owens River Delta Habitat Area, Technical Memorandum # 16, Revised Projections of Wildlife Habitat Units for the Lower Owens River Using habitat Suitability Index (HSI) Models, and Ecosystem Sciences, 1994, Evaluation of Flows on Wildlife Habitat Quality and Quantity for the Lower Owens River Using Habitat Suitability Index (HSI) Models.

[334] BLM 1992

snow depth influence the quality and quantity of available vegetation to tule elk and thus, influence the health of elk herds.

Herd composition, boundaries and overall size is somewhat fluid and variable according to season and local conditions.[335] Most of the tule elk that occur in the LORP are members of two different herds. The Independence herd is the primary herd in the northern portion of the project area and the Lone Pine Herd is the predominant herd in the south.

Resolution

Tule elk are generally compatible with a broad range of natural resource management goals. Potential conflicts with other land use goals can occur especially when the species are exotic to the management area; when the target resource (wetlands and riparian habitat) has a limited distribution and is in poor condition; when elk populations are allowed to exceed appropriate levels; and, when elk management is not closely coordinated with livestock management.

The Lone Pine herd is the most obvious concern, primarily because they rely on the riparian vegetation for food and cover more than the other elk herds. Livestock operations are being modified to help insure establishment of new riparian habitat and to enhance existing riparian and wetland conditions in the LORP. The role of tule elk in this relationship also needs to be factored into future management. As indicated above, CDFG is mandated with the responsibility for directly managing tule elk populations. CDFG's responsiveness and cooperation with management of wildlife populations is critical for the success the LORP, especially with respect to extent and condition of riparian habitat.

Domestic Livestock

Seven livestock leases are within the LORP. All of the leases include at least some riparian habitat. Livestock impacts riparian vegetation both through direct consumption of plant material and trampling. The latter affects vegetation by compacting soil, resulting in reduced infiltration, percolation, root growth, and plant production.[336]

Livestock grazing practices can potentially have a negative affect on the Lower Owens River riparian/wetland community. Potentially, the most important types of impacts from livestock in riparian areas include reduction of survivorship of young stands of woody riparian plants, and reduction of the structural and floristic diversity (i.e., habitat quality) of the under-story vegetation in established stands. Livestock operations near riparian areas can lead to increased nest parasitism and reduced productivity rates for many of the most compromised riparian birds.

Grazing can also be directly detrimental to breeding waterfowl[337], but the impacts on migration and winter habitat are more subtle. Excessive grazing increases runoff and erosion, resulting in excessive siltation, which can destroy valuable shallow-water habitat. Improper management of livestock grazing can have serious adverse effects on wetland-riparian vegetation.

Resolution

Wetland and riparian vegetation restoration and enhancement is being addressed directly in the livestock grazing plans and specific grazing measures are addressed the Land Management Plan. Condition, health and characteristics of wetlands and riparian are expected to improve relative to specific livestock management practices (see Land Management Plan). For example, changes to grazing leases include improved distribution and utilization, reduction in the number of livestock in a pasture, creation of new pastures, specific utilization goals and improved monitoring of range condition, etc. Recognizing the efforts to improve vegetation condition in the delta, there are no specific measures proposed, in this document, to protect and enhance wetlands and riparian areas relative to livestock grazing.

Evaluation and monitoring of riverine-riparian habitat is critical component of the monitoring plan. If habitat conditions are below

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[335] McCullough 1969, Fowler 1985

[336] Clary 1995, Bryant et al. 1972, Kattelmann and Embury 1996

[337] Kadlec and Smith 1989

expectations or proposed management actions do not result in the expected responses than, management actions will be reevaluated through adaptive management, and plans will be reconsidered.

Beaver

Beaver (*Castor canadensis*) is the largest rodent in North America, weighing up to 75 pounds. Beaver are highly specialized obligate riparian/aquatic rodents found in ponds, lakes, rivers and streams. Beavers are generalized herbivores: they consume a wide variety of plants, many types of plants (aquatics, forbs, grasses shrubs, trees), many parts of plants including, leaves, bark, twigs, rhizomes and flowers. While, beavers eat variety of foods they prefer, and are most dependent on woody riparian species such as aspen (*Populus tremuloides*), willow (*Salix spp.*), cottonwood (*Populus spp.*) and many other tree and shrub species.

Beaver are native to some regions of California west of the Sierra Nevada, but are not native east of the Sierra crest. Beavers were introduced to many locations in during the 1930's and 40's as part of the Federal Aid in Wildlife Restoration Project California. Beaver in the Owens Valley probably belong to the Idaho subspecies, *Castor canadensis taylori*, Davis.

Beaver influence wildlife, water quantity, water quality, fish habitat and fish populations, esthetics, and recreational opportunities, and the relationship of cattle grazing to riparian and streambank condition. Beaver influences interact with other land use and resource management practices along the lower Owens River. These interactions have had, and will continue to have a major role in the lower Owens River ecosystem. Consequently, beaver abundance and their distribution throughout the lower Owens River must be a primary consideration with all ecosystem management plans.

Present condition of the lower Owens River ecosystem is, in part, a result of beaver impacts. Other interacting influences on environmental conditions include water management and land use practices, domestic livestock grazing and grazing other large ungulates. One of the primary conditions of concern on the Lower River is the widespread paucity of woody riparian vegetation recruitment. Survival and persistence of the numerous sprouts produced each year by willow also appears very low. Furthermore, many of the established shrubs and trees are showing signs of stress and are dying. Beavers are known over exploit their food resources causing habitat degradation and starvation of the colony. While we understand that beaver are one of many influences of habitat conditions in the Lower Owens River ecosystem, we expect that given the relatively poor habitat conditions, beaver might suppress or inhibit the pace and magnitude of recovery. In a healthier state, the river system will be more resilient and beaver management will be carried out on a maintenance basis. Generally, beaver appear to have little influence in the delta.

Resolution

Beaver are present in the riparian habitat in upper portion of the delta. Beaver control in the delta will be consistent with the LORP beaver control program. Appropriate control of the beaver population is important especially in the years following project implementation when riparian and wetland areas are developing rapidly.

Brown-headed Cowbirds

Among the factors that significantly affect bird reproductive success are high predation rates by mammalian and avian predators and brood parasitism by brown-headed cowbirds. It is generally assumed that predation and parasitism are influenced by the structure and diversity of riparian vegetation and landscape-scale factors, such as the type and configuration of surrounding land use.

Nest parasite (brown-headed cowbird) impacts on riparian bird species productivity is independent of habitat fragmentation.[338] There appears to be a direct relationship between the parasitism pressure on riparian birds and availability of cowbird food and hosts. Thompson (1994) reported that cowbirds move

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[338] Tewksbury et. al. 1998

<1 km between feeding and breeding sites. Recommendations for willow flycatchers suggest that activities that attract cowbirds should be from 2-5 km from suitable flycatcher habitat. Cowbird feeding sites generally include most residential developments, corrals, holding pastures, farm buildings, etc. Nest predation (Black-billed magpies, crows, ravens, etc.) of riparian birds appears to be less predictable, presumably due to the predator specific adaptations.

Along with habitat loss and degradation the range expansion of the brown-headed cowbird and associated increase of brood parasitism and nest predation are identified as a major factor leading to the rapid decline of yellow warblers, Bell's vireos, willow flycatchers, and several other open-cup nesting birds. There have been many cowbird trapping programs implemented throughout the western United States. In the Kern River Preserve a trapping program reduced nest parasitation rates from an average of about 56 to 21 percent, and presumably resulted in increased productivity rates for several species.

Resolution
The potential consequences from both predation and parasitism are reduced by improving habitat quality and providing optimal habitat conditions for riparian species. Once habitat conditions are improved to the extent possible (based on the physical constraints of the individual riparian system), additional benefits to productivity might potentially be gained by managing interspecific relationships (cowbirds and predators). Management of nest parasites can be prioritized from high to low as: (1) manage habitat, (2) cultural or education, (3) manage land use and (4) manage cowbirds directly (trapping). Once a functional riparian community is restored and land use actions have been implemented then the merits of an active cowbird trapping program can reevaluated.

Local conservation organizations may want to organize a volunteer program to trap cowbirds. Any trapping effort will need to be coordinated with CDFG and LADWP. A brief proposal and periodic progress reports should be a minimum requirement for any program. The trapping documentation should include a proposed schedule, trapping effort, trap locations, and trap success, disposition of the cowbirds and incidental observations. It would be prudent for interested organizations to meet with and discuss the proposed program with other members of the community including leaseholders and other land resource management agencies (e.g., USFS, BLM, Inyo County, etc.) in the project area.

Riparian plantings or other habitat augmentations
Thousands of riparian and wetland restoration projects have been implemented throughout the western United States. The majority of these projects have relied on "landscape design" techniques rather than recognizing and working with the physical constraints and natural processes necessary for long-term sustainability.[339] Frequently designers of these projects have unrealistic expectations and attempt to force a system into the "way it should be". Consequently, the success of these projects is very low, especially when tracked for more than five years. Another concern is the functionality and sustainability of "habitat augmentations". Certainly, many wildlife species will use any patch of trees and shrubs that is available, especially in an arid environment. This "patch" will have some inherent value albeit miniscule relative to restored riparian areas.

Resolution
Restoration techniques that include landscape design, tree planting and artificial propagation techniques are outside of the LORP philosophy. Once the project is underway, gathering seed from native riparian trees and augmenting the distribution of that seed in the LORP might be acceptable. These types of actions need to be evaluated as the project and riparian community evolves. This is not to say that there isn't a place for "Riparian plantings or other habitat augmentations". Generally, these techniques are best restricted to urban and park settings, and applied to recreational and flood control projects that have narrowly focused resource objectives. Once flow

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[339] also see Ecosystem Management Plan, Chapter 1, Management Concepts. Ecosystem Sciences, 2002.

management and land use actions have been implemented and a functional riparian community is restored (20 years) then the merits of a "landscape design" approach can be reevaluated.

2.2.9.12 Tech Memo #20 Special Status Wildlife Species Accounts[340]

The purpose of this Tech Memo is to provide some basic information on special status wildlife and plant species with the potential to occur in the LORP. This information is to supplement other Technical Memoranda and the Ecosystem Management Plans.

A review of the literature for special status wildlife and plant species that occur in or adjacent to the LORP was conducted. Wildlife species accounts provide some very basic information regarding the species legal status, their distribution, abundance and occurrence in the State, Owens Valley and the project area, primary habitat associations, and relevant life history information. Specific occurrence information was given when it was available. An evaluation of the expected response of each species to the LORP is provided. This "impact" assessment or species response is relative to existing conditions verses future long-term conditions.

The expected response of a species is based on an assessment of habitat changes and specific land use issues that are addressed and incorporated in the design of the LORP. The actual response of a specific species (frequency of occurrence, abundance and productivity, etc.) to positive environmental changes that will occur in the LORP is a far more difficult prediction. Many of these special status species use vast geographic areas during the course of their annual cycle. The influence of the LORP relative to all other factors is unknown, especially to those species that are somewhat atypical or do not have a strong association to riparian and wetland areas in California, east of the Sierra Nevada. Many sources of information were used for these accounts. The attached list of references is only the primary sources used and/or local sources.

Several of the special status species addressed in this tech memo occur sporadically, very infrequently, or in very low numbers in the LORP. Some of these species are not presently influenced and will not be influenced in the future by the LORP. Some of these species include white-faced ibis (*Plegadis chihi*), Swainson's hawk (*Buteo swainsoni*), prairie falcon (*Falco mexicanus*), American peregrine falcon (*Falco peregrinus anatum*), burrowing owl (*Speotyto cunicularia*), Vaux's swift (*Chaetura vauxi*), brown-crested flycatcher (*Myiarchus tyrannulus*), and bank swallow (*Riparia riparia*).

Another group of special status species only pass through, no longer occur, or infrequently use the margins of the project area and are otherwise not influenced by the LORP. These species are not addressed in this document. They include the least Bell’s vireo (*Vireo bellii pusillus*), California gull (*Larus californicus*), black tern (*Chlidonias niger*), American white pelican (*Pelecanus erythrorhynchos*), and the Virginia warbler (*Vermivora virginiae*).

The most common and significant theme linking all these special status species together is the loss and degradation of their habitat. For the majority of the species, the primary mechanism of endangerment is loss of riparian and wetland areas in California.

Most of the special status species are associated with riparian areas and various types of wetlands, depending on whether the species is nesting, feeding, resting, or attempting to meet some other basic need. A few species are more closely aligned with various types of uplands. All of the special status species that use the LORP are combined in the Ecosystem Management Plan.

The overall management goal for special status species, is to the extent possible, to maintain and enhance habitat conditions for these species to help insure long term viability of populations. Management of special status species incorporates four primary actions: (1) avoiding potential future impacts; (2)

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[340] Ecosystem Sciences, Tech Memo 20, 1999.

enhancements that will increase the extent and quality of habitat; (3) designating specific management zones such as livestock exclosures, special pastures, and management areas, i.e., the Blackrock Waterfowl Habitat Area and the Lower Owens River Delta Habitat Area); and (4) monitoring habitat and species. As pointed out in Chapter 1 of the Ecosystem Management Plan, the two most important management tools for the Lower Owens River ecosystem are stream flow (i.e., the interaction of surface water and groundwater) and land use management.

Detailed species accounts for all special status wildlife species that have potential to use the Lower Owens River Project area are included in Tech Memo 20. Detailed species accounts are not include in this document.

2.2.10 Predicted future vegetation types: Lower Owens River (40/200 cfs scenario)[341]

Future riparian vegetation types along the Lower Owens River were predicted for streamflow scenarios consisting of a 40 cfs base-flow and 200 cfs annual pulse flow. Predicted future vegetation types were based on: 1) results of HEC-2 hydrologic analysis; 2) existing landform and vegetation types mapped from aerial photos; and 3) existing landform attributes measured along cross-channel transects.

Relative to existing conditions, the area of the *playa* vegetation type is not expected to change. Most of the *sandbar* vegetation type will be covered by water. The existing *dikes* and *roads* are not expected to change. The area of *emergent* vegetation type is expected to increase from 442 acres to about 1,032 acres. The area of *alkali meadow* vegetation type is predicted to increase from 863 acres to about 1,182 acres. The area of *riparian woodland* vegetation type is predicted to increase from 685 acres to about 1,288 acres. The area of *tamarisk* vegetation type is predicted to decrease by about 33 acres. *Desert sink shrub* vegetation type is predicted to decrease by about 69 acres and *alkali shrub meadow* is predicted to decrease by about 2,637 acres. The rationale for predicting vegetation types are discussed.

It is expected that predicted future types will be established five to ten years following implementation of the streamflow scenario. Rates of establishment will vary with differences in the degree of wetness and proximity to sources of plant propagules. Shrub and tree dominated vegetation types may approach maturity after about 25 years. While the effects of beaver were not considered, it is likely that they will enhance the dynamic character of predicted stream and riparian habitats.

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[341] Ecosystem Sciences. 1997. Predicted future vegetation types: lower Owens River (40/200 cfs scenario). Prepared for the Department of Water and Power. Boise, ID.

Vegetation types bordering the Lower Owens River between the Los Angeles Aqueduct diversion and Owens Lake were predicted for 6 stream flow scenarios in a report dated September, 1994.[342] Predicted vegetation types were based on information collected in Database and Modeling Results for the Lower Owens River Project[343], including: 1) results of the HEC-2 hydrologic analysis for 3 transects in each of the 24 stations; 2) existing landform and vegetation types mapped from 1:12,000 scale aerial photos; 3) vegetation and landform attributes measured along 10 transects in each of the 28 survey stations; and 4) the author's experience specific to the distribution of riparian vegetation types in response to landforms and ground water geometry. Predictions assumed that impacts from livestock and large ungulates will be minimal. While it is likely that beaver will affect the distribution of vegetation types, the locations and the extent of these effects could not be predicted – predictions do not consider the effects of beaver.

The prediction of vegetation types in the 1994 study[344] entailed five sequential steps:

1. Stream reaches with distinctive geomorphic and hydrologic character were identified and mapped.

2. Existing vegetation types (e.g. *marsh, alkali meadow, willow, alkali shrub meadow*, etc.) and landforms (e.g. channel, floodplain, terrace) along the stream corridor were mapped from aerial photos.

3. The area of stream surface for each flow scenario was projected as a polygon centered on the existing stream channel(s) identified in step 2. The width of the polygon was the average stream width for a given stream reach and discharge predicted by the HEC-2 analysis. Where the existing stream channel was split into more than one channel, the total width predicted using HEC-2 was distributed between multiple channels. The stream widths for two reaches with no HEC2 stations (4 and 8) were projected as the average width for all reaches.

4. The *willow* vegetation type was predicted for the first terrace and lake bottom landforms that were within 20 feet (horizontal distance) of the area flooded by the 200 cfs maintenance flow, but not flooded by the 40 cfs base flow, as predicted by HEC-2 for a specified reach. The water surface widths for two reaches with no HEC-2 stations (4 and 8) were estimated as the average water width projected for all reaches. The underlying assumptions were: a) surface flooding is necessary for willow colonization; b) the surface elevation of channel, levee and floodplain landforms are generally less than the projected stream depth at baseflow and will be too wet to sustain willow communities; and c) the surface elevation of second terrace and alluvial fan landforms, which are significantly higher than predicted stream depth, will be too dry to sustain willow communities.

5. Vegetation types were predicted for combinations of landforms, existing vegetation type and stream reach outside of the areas identified in steps 3 and 4. The key attribute used to project vegetation type was the difference between the maximum height above the channel bottom for combinations of existing landform/vegetation by reach (as measured along cross-channel transects) and stream depth for a given flow scenario (as predicted by HEC2). This difference is an estimate of the elevation of the landform/vegetation surface relative to the projected stream stage. Where the surface was less than 1 foot above projected stream stage, emergent (marsh and wet meadow) vegetation types were predicted; where 1 to 3 feet above projected stream stage, meadow (alkali and mesic) vegetation types were predicted; where greater than 3 feet above projected stream stage, alkali shrub meadow and desert sink shrub vegetation types were predicted.

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[342] White Horse Associates 1994
[343] Hill et al. 1994
[344] White Horse Associates 1994

Results of these preliminary analyses for 5 stream flow scenarios were presented in the 1994 report.[345] Included with the report were maps showing predicted vegetation types for three flow scenarios (15 cfs base flow, 50 cfs base flow and 100 cfs base flow, all with a 200 cfs maintenance flow) and tables showing the extent of predicted vegetation types for each flow scenario. The purpose of this subsequent report is to refine estimates of predicted vegetation types for a single, new flow scenario – 40 cfs base flow with a 200 cfs maintenance flow.

Approach

The approach was similar to that used in the 1994 study[346], with the following modifications:

1. Results of HEC-2 were analyzed for a single flow scenario – 40 cfs continuous base flow with a 200 cfs annual maintenance flow.
2. Statistical measures of variance in both the HEC-2 and transect measurements were considered in predicting vegetation types. Based on these variances, complex map units consisting of two co-dominant vegetation types (i.e. *riparian woodland / emergent, riparian woodland / alkali meadow* and *emergent/riparian woodland*) were predicted for some areas.

HEC2 Data

Results of the HEC-2 modeling for the 40 cfs base flow and the 200 cfs maintenance flow were provided by Karl Gebhardt (1996) and are listed in Table 2.9. The average stream width for 40 cfs flow in each reach was used to project the stream surface for each reach. The difference between the average stream width for 40 cfs and 200 cfs flows for each reach was used, in part, to project the area of seasonally flooded riparian woodland vegetation type. Stream parameters were not modeled for reach 4 and 8. Stream parameters for these reaches were assumed to be the average parameters for all HEC-2 transects, as listed in TOTAL in Table 2.9.

Existing Landforms

Landforms were mapped from 1:12,000 scale aerial photos dated July, 1992. Mapping was conducted using 5X imagery (1:2,400 scale). A legend of landform types is presented in Table 2.10. Landforms are defined in a geomorphic context. The area of landforms is listed by reach in Table 2.10. Maps of landforms presented for each of six 7.5 minute quads are located in Appendix A.[347] An index for landform maps are included in Appendix A.[348]

FLOW	Reach[349]	N[350]	VELOCITY		DEPTH		WIDTH	
			AVG	STD	AVG	STD	AVG	STD
			(ft/sec)		(ft)		(ft)	
40 CFS BASEFLOW								
	1	4	0.2	0	3.8	0.3	81	17
	2	22	0.6	0.2	2.8	0.5	45	17
	3	28	0.2	0.1	4.5	1.8	101	30
	5	9	0.2	0.1	5.9	1.7	99	45
	6	6	0.8	0.5	3.5	0.8	64	25
	7	6	0.3	0.2	5.8	1.2	74	13
	TOTAL	**75**	**0.4**	**0.3**	**4.2**	**1.7**	**78**	**36**
200 CFS FLOW								
	1	4	0.5	0.3	6.3	1.1	119	39
	2	22	1.2	0.4	5.3	0.8	65	22
	3	28	0.4	0.2	8.1	2.4	153	47
	5	9	0.3	0.2	11.4	2.1	163	53
	6	6	1.7	1.2	6.4	1	107	27
	7	6	0.8	0.4	8.4	0.7	98	13
	TOTAL	**75**	**0.8**	**0.6**	**7.5**	**2.6**	**118**	**55**

Table 2.9. HEC-2 summary for 40 cfs baseflow and 200 cfs flow.

Stream reaches were also identified from the 1:12,000 scale aerial photos. Reaches were refined based on a VCR tape of 70 to 100 cfs flows in Owens River on July 15, 1994. Reaches and stations where cross-channel transects were measured are marked on the landform maps. A tabular summary of the

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[345] White Horse Associates 1994

[346] White Horse Associates 1994

[347] Ecosystem Sciences. 1997. Predicted future vegetation types: lower Owens River

[348] Ecosystem Sciences. 1997. Predicted future vegetation types: lower Owens River

[349] Data for two transects in reach 1 (1001 and 1003) were thrown out because of apparently aberrant results; no HEC2 transects were available for reaches 4 and 8.

[350] Number of HEC2 transects

areas of existing landform/vegetation types for each reach is included in Appendix B.[351]

Existing Vegetation Types

Existing vegetation types were mapped from 1:12,000 scale aerial photos dated July, 1992. Mapping was conducted using 5X imagery (1:2,400 scale). Map units are *consociations*, consisting of a single dominant existing vegetation type. Small *inclusions* of vegetation types other than that named are common to all map units. In general, the smaller the delineation, the larger the proportion of inclusions. The proportion of inclusions is low (less than 15 percent) for large polygons. The smallest polygons generally were in the stream channel where the proportion of inclusions is higher (less than 30 percent). Inclusions occur on micro-sites unique to the landform and along boundaries between adjacent vegetation types. Trees and tall shrub vegetation types were delineated based on the tree/shrub canopy, which sometimes shrouded water and emergent vegetation. An existing vegetation type legend presented as Table 2.11.

Preliminary mapping of vegetation types along the Lower Owens River[352] included more classes of vegetation types than listed in Table 2.11. The *emergent* vegetation type includes *marsh, red grass* and *wet meadow* vegetation types for preliminary mapping. *Riparian woodland* is the combined area of *willow/wet meadow, tree willow/wet meadow, willow/mesic meadow* and *tree willow/mesic meadow* vegetation types for preliminary mapping. *Tamarisk/wet meadow* and *tamarisk/mesic meadow* were combined as the *tamarisk* vegetation type. *Mesic meadow* and *saline meadow* from preliminary mapping were combined into the *alkali meadow* vegetation type. Preliminary vegetation types that were expected to respond similarly to anticipated flow in the Owens River were combined as the more inclusive vegetation types listed in Table 2.11.

The areas of existing vegetation types by reach and the areas of vegetation types for all reaches are listed in Table 2.12.[353] A map index and existing vegetation type maps are in Appendix C.[354]

Cross Channel Transect Data

The number of times each landform/vegetation type was encountered along the cross-channel transects in each reach (N) and the total "distance" of the landform/vegetation type measured along the transects in each reach are listed. The average (AVG) "height" of the land surface relative to the adjacent channel bottom and the standard deviation (STD) of the N field measurements, in conjunction with results of HEC-2 modeling and landform/vegetation type mapping, were used to predict future vegetation types.

Predicted Future Vegetation Types

Future vegetation types were predicted based on HEC-2 data, landform mapping, existing vegetation type mapping and cross-channel transect data, as previously discussed. The areas of predicted vegetation types are compared with the areas of existing vegetation types for all reaches in Table 2.11.[355] Predicted vegetation types include three *complex map units*. Complex map units are comprised of two co-dominant predicted vegetation types. Complex map unit names are the two co-dominant vegetation type names separated by a "/". The vegetation type before the "/" is predicted to be dominant and comprise at least 60 percent of the map unit. The second named component is predicted to comprise less than 40 percent of the map unit.

It is expected that predicted future vegetation types will vary with differences in the degree of wetness and distance to sources of plant propagules. Shrub and tree dominated vegetation types may approach maturity after about 25 years. Predictions assume that

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[351] Ecosystem Sciences. 1997. Predicted future vegetation types: lower Owens River

[352] White Horse Associates 1994

[353] Ecosystem Sciences. 1997. Predicted future vegetation types: lower Owens River

[354] Ecosystem Sciences. 1997. Predicted future vegetation types: lower Owens River

[355] See final document for a full discussion of vegetation types not included here. Ecosystem Sciences. 1997. Predicted future vegetation types: lower Owens River

impacts from livestock and large ungulates will be minimal. While it is likely that beaver will affect the distribution of future vegetation types, the locations and extent of these effects could not be predicted – predictions do not consider the effects of beaver. It is likely that beaver will enhance the dynamic nature of predicted stream and riparian habitats. A map index and maps of predicted future vegetation types are presented as Appendix D. [356] The areas of existing versus predicted vegetation types for each reach are listed in Appendix E. [357] Relative to existing conditions, the area of *playa* is not predicted to change in response to future water management. Most of the existing *sandbar* vegetation type will be covered by water. The areas of existing *dike* and *road* are not predicted to change. The *emergent* vegetation type is predicted to increase from its present 442 acres to about 1,032 acres (includes 60 percent of *emergent/riparian woodland complex* and 40 percent of *riparian woodland/emergent complex*). The area of *alkali meadow* vegetation type is predicted to increase from 863 acres to about 1,182 acres (includes 40 percent of *riparian woodland/alkali meadow complex*). The area of *riparian woodland* is predicted to increase from 685 acres to about 1,288 acres (includes 40 percent of *emergent/riparian woodland complex*, 60 percent of *riparian woodland emergent complex* and 60 percent of *riparian woodland/alkali meadow complex*). The area of *tamarisk* is predicted to decrease by about 33 acres. *Desert sink shrub* is predicted to decrease by about 69 acres and *alkali shrub meadow* is predicted to decrease by about 2,637 acres. The rational for predicting vegetation type response to future applied flows is discussed with respect to the stream/riparian zone and specific riparian landforms, respectively.

Stream/Riparian Zones

The stream surface was predicted as an area bordering the center of the existing channel. The width of the stream surface was the average water width predicted by HEC2 (40 cfs flow) for the reach (see Table 2.9). The stream widths for reaches with no HEC2 data (4 and 8) were estimated as the average 40 cfs water width projected for all HEC2 transects.

LANDFORM	DESCRIPTION
Channel:	The area between streambanks that was inundated by moderate to high flow; normally includes the stream, streambars and vertical aspects of streambanks; the area that was flooded for prolonged periods by past flows of the Owens River.
Levee:	Hummocky or undulating surfaces along streams which are normally seasonally flooded; levees dissipate floods through complex drainage networks.
Floodplain:	Smooth, flat surfaces that are typically separated from the stream by levees; surfaces are normally seasonally flooded but less frequently and for shorter durations than levees.
Alluvial fan:	Broadly convex surfaces deposited immediately above a confluence with a higher order tributary or at the base of a mountain slope; they are seldom flooded and groundwater table (if present) is well below the rooting depth of vegetation.
First terrace:	Floodplains that have been left high-and-dry in response to channel incision and broadening; in this case it is an old floodplain of the Owens Rivers.
Second terrace:	Similar to the first terrace but significantly higher and dryer.
Ox-bow channel:	A channel that is now separated form the present main channel in low flows but may carry water at higher flows.
Lake bottom:	Land once covered by Owens Lake (contemporary time), mostly playa.
Canal:	A human-made channel to divert water.

Table 2.10. Landform legend.

A “riparian zone” that will be mostly flooded by the 200 cfs maintenance flow was also generated along the outside border of the predicted stream course. The width of the riparian zone on each side of the predicted stream course was half the difference between the average water width predicted by HEC-2 for 200 cfs and 40 cfs flows for the reach, plus twenty feet to account for an over-story canopy[358]. The width of the riparian zone varied by reach and averaged about 40 feet. Where the riparian zone intersected low-lying channel, levee and floodplain landforms, the *emergent* vegetation type was predicted. Where the riparian zone intersected the first

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[356] Ecosystem Sciences. 1997. Predicted future vegetation types: lower Owens River

[357] Ecosystem Sciences. 1997. Predicted future vegetation types: lower Owens River

[358] The average water width predicted by HEC2 for all reaches was used for reaches where HEC2 data was not available.

terrace landform, the *riparian woodland* vegetation type was predicted.

VEGETATION TYPE	DESCRIPTION
***playa*:**	Non-vegetated, recently exposed Lake bottom (Owens Lake)
***sandbar*:**	Streambar comprised of sandy sediment deposited or scoured by the stream; total vegetation cover is low.
***dike*:**	A human-made feature to divert water.
***emergent*:**	Dominated by cattails, rushes, sedges and/or hydric grasses; includes areas of *riparian woodland* and *water* that were too small to delineate.
***alkali meadow*:**	Dominated by salt grass and/or mesic grasses; inclusions of alkali shrub meadow are common.
***riparian woodland*:**	Willow, tree willow, Russian olive and cottonwoods are dominant in the over-story; under-stories vary from wet to mesic; in the channel, inclusions of water and marsh are common; inclusions of tamarisk are common in all landforms; this map unit was based on the over-story canopy.
***desert sink shrub*:**	Alkali shrubs with a sparse under-story dominated by alkali tolerant grasses and forbs.
***alkali shrub meadow*:**	Alkali shrubs with an under-story dominated by saltgrass.
***road*:**	Major roads crossing the valley bottom.

Table 2.11. Existing vegetation type legend.

Projected Vegetation Type	Existing Vegetation		Predicted Vegetation		Predicted Change	
	(ac)	(%)	(ac)	(%)	(ac)	(%)
Playa	9568		9568		0.0	0.0
Streambar	96	1.1	0	0.0	-96.2	-1.1
Water	41	9.7	640	11.0	599.5	1.3
Dike	5	0.1	5	0.1	-0.3	0.0
Road	7	0.1	6	0.1	-0.6	0.0
Emergent	442	5.0	730	12.5	287.8	7.5
Alkali Meadow	863	13.7	1455	25.0	591.6	11.3
Willow	685	12.8	380	6.5	-304.8	-6.2
Tamarisk	199	3.0	166	2.9	-32.9	-0.2
Desert Sink Shrub	732	12.2	663	11.4	-68.5	-0.9
Alkali Shrub Meadow	2755	42.2	118	2.0	-2636.5	-40.2
Emergent/Willow Complex	0	0.0	445	7.6	445.0	7.6
Willow/Emergent Complex	0	0.0	87	1.5	87.0	1.5
Willow/Alkali Meadow Complex	0	0.0	1129	19.4	1129.0	19.4
Total	**5824**	**100.0**	**5824**	**100.0**	**0.0**	**0.0**

Table 2.12. Areas of existing and predicted vegetation types for all reaches (predicted change calculated as predicted vegetation minus existing vegetation).

Predicted vegetation types for areas outside the stream and riparian zone were based on existing vegetation/landform, <u>or</u> existing vegetation/landform/reach, as discussed below.

Channel Landform

The average surface elevation of channels relative to the channel bottom measured on cross-channel transects was 0.0 feet. Standard deviations were mostly 0.0, except for reaches 2 (sd = 0.8) and 3 (sd = 0.1). Average water depth for 40 cfs predicted from HEC-2 was 4.2 feet. The shallowest average depth (2.8 feet) was predicted for reach 2. Water was predicted in the channel based on water widths predicted from HEC2 and the center line of the existing channel delineated from aerial photos. Water was predicted to cover about 45 percent of the existing channel at 40 cfs flow. The *emergent* vegetation type was predicted for the remaining 55 percent (570 acres) of the channel. About 2 acres (0.2 percent) of existing *roads* and *dikes* were predicted not to change in response to flows.

Levee Landform

A total of 54.7 acres of the levee was mapped from aerial photos. Existing vegetation types on levees included *sandbar, emergent, alkali meadow, riparian woodland, tamarisk* and *alkali shrub meadow*. The average elevation of levees on cross-channel transects relative to the channel bottom was 2.3 feet (sd = 0.4). Levees were only identified along cross-channel transects in reach 2, although levees were mapped in reaches 2, 3, 4, and 5. The average elevation of levees in reach 2 was 2.3 feet and is similar to the average elevation of floodplains measured along cross-channel transects on other reaches. The average water depth predicted for 40 cfs flow from HEC-2 was at least 2.8 feet for all reaches and averaged 4.2 feet. This indicates that levees will be mostly flooded at baseflow.

Water was predicted to cover about 5.7 acres (10 percent) of levees based on water widths projected for 40 cfs flow from HEC-2. The *emergent* vegetation type was predicted for areas of the existing *sandbar* vegetation type (9.6 acres) and the existing *emergent* vegetation type (3.2 acres). The *emergent/riparian woodland complex* was predicted for existing *alkali meadow* (3.6 acres), riparian woodland (27.0 acres), *tamarisk* (3.5 acres) and *alkali shrub meadow* (4.0 acres) vegetation types, with the *emergent* component predicted on lower positions and the *riparian woodland* component predicted on slightly higher surfaces. About 0.1 acres of existing *road* is not expected to change in response to anticipated flows.

Floodplain Landform

A total of 440.1 acres of floodplain was identified. Existing vegetation types on floodplains included *sandbar, emergent, alkali meadow*, *riparian woodland,* and *alkali shrub meadow*. The average elevation of floodplains relative to the channel bottom varied by existing vegetation type and reach (see Table 2.9). The relative elevation of floodplains measured along cross-channel transects exceeded the predicted 40 cfs water depth only for the *tamarisk* vegetation type in reach 2 (3.3 feet relative surface elevation versus 2.8 feet water depth) and *alkali shrub meadow* vegetation type in reach 2 (4.0 feet relative surface elevation versus 2.8 feet water depth). No floodplains were mapped in reach 2 from the aerial photos (the somewhat higher tamarisk and alkali shrub meadows were mapped as terraces). Other vegetation type/reach combinations on floodplains were lower than the projected 40 cfs stream depth. This indicates that floodplains mapped from the aerial photos will be flooded or wet to the surface in response to baseflow (40 cfs).

Water was predicted to cover about 6.9 acres (1.6 percent) of floodplains based on water widths projected for 40 cfs flow from HEC2. The *emergent* vegetation type was predicted for areas of existing *sandbar* vegetation type (0.9 acres) and existing *emergent* (25.8 acres) vegetation types. The *emergent/riparian woodland complex* was predicted for the existing *alkali meadow* (223.9 acres), *riparian woodland* (157.3 acres) and *alkali shrub meadow* (25.3 acres) vegetation types, with the *emergent* component dominant in the lower micro sites.

First Terrace Landform

A total of 3,657 acres of first terrace landform was identified. Existing vegetation types included *sandbar, emergent, riparian woodland, tamarisk, alkali shrub meadow, desert sink shrub, road* and *dike*. Vegetation types were predicted based on the difference between: 1) the relative elevation of discrete combinations of reach and/or vegetation type, as measured along cross-channel transects; and 2) stream depth predicted by HEC2 for 40 cfs and 200 cfs discharge[359]. Not all combinations of vegetation type/reach identified from mapping were encountered along cross-channel transects; other combinations were identified so infrequently that average relative elevations were not reliable; still others reflected atypical situations specific to the vicinity where cross-channel transects were monitored and were not representative of the reach. In these cases, the average relative elevation of the vegetation type for <u>all</u> reaches was used to calculate the difference.

The *desert sink shrub* vegetation type is common on the highest parts of the first terrace and, more commonly, on the second terrace landform. It was not encountered on cross-channel transects. A relative elevation (15 feet) was assumed for the *desert sink shrub* vegetation type mapped on terraces.

The difference between relative surface elevation for vegetation type/reach and stream depth is a measure of the probability of flooding. Where the predicted stream depth is greater than the relative surface elevation, it is likely that some part of the vegetation type/reach will be flooded. Where stream depth is less than the relative surface elevation, the probability of flooding is low. Three situations were identified:

1. **Relative surface elevation is less than stream depth at 40 cfs** – these include areas that will be flooded by 40 cfs flow.[360] A total of 890 acres includes the

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[359] HEC2 analysis was not conducted in reach 4 and 8; the average stream depth for all reaches was used for these reaches.

[360] Ecosystem Sciences. 1997. Predicted future vegetation types: lower Owens River

following existing vegetation types: 1) *emergent* (9.6 acres); 2) *alkali meadow* (37.0 acres); 3) *riparian woodland* (237.2 acres); 4) *tamarisk* (12.4 acres); 5) *alkali shrub meadow* (496.2 acres). No change was predicted for areas of existing *emergent, riparian woodland* and *tamarisk* vegetation types. *Alkali meadow* was predicted to change to the *riparian woodland/emergent complex* with *riparian woodland* on higher positions that will not be flooded by 40 cfs flow. *Alkali shrub meadow*, which typically occurs on somewhat higher surfaces than *alkali meadow*, was predicted to change to *riparian woodland/alkali meadow complex*, with *riparian woodland* on lower positions that will be flooded by both 40 and 200 cfs flows, and *alkali meadow* on higher positions that will not be flooded by 40 cfs flows. It is expected that *riparian woodland* will be the dominant component of these complex map units.

2. **Relative surface elevation is greater than stream depth at 40 cfs, but less than stream depth at 200 cfs** – includes areas that will be flooded by 200 cfs flow, but not 40 cfs flow. A total of 755 acres includes the following existing vegetation types: 1) *emergent* (3.4 acres); 2) *alkali meadow* (126.2 acres); 3) *riparian woodland* (116.7 acres); and 4) *alkali shrub meadow* (508.4 acres). The existing *emergent* vegetation type is believed to be sustained by water sources other than the Owens River – this vegetation type is predicted not to change. *Alkali meadow* was predicted to change to the *riparian woodland/alkali meadow complex*, with *riparian woodland* on lower areas that will be flooded by 200 cfs flows and *alkali meadow* on higher areas that will not be inundated. It is expected that *riparian woodland* will be the dominant component of this complex map unit. Existing *riparian woodland* communities are predicted to remain *riparian woodland* communities. *Alkali shrub meadow* was predicted to change to the *alkali meadow/riparian woodland complex*, with *alkali meadow* on higher areas that will not be flooded by 200 cfs flow and *riparian woodland* on lower areas that will be flooded. It is expected that *alkali meadow* will be the dominant component of this complex map unit.

3. **Relative surface elevation is greater than stream depth at 200 cfs –** includes areas that will not be flooded by 200 cfs flow. A total of 1,940 acres included: 1) *alkali meadow* (1427.0 acres); 2) *tamarisk* (47.6 acres); 3) *alkali shrub meadow* (0.7 acres); and 4) *desert sink shrub* (464.4 acres). Although water tables may be present in response to the 40 cfs flows, they are predicted to be too deep (greater than 3.3 feet below the surface) to significantly effect the distribution of vegetation types. No change was predicted for these existing vegetation types.

Second Terrace Landform

A total of 303 acres of second terrace landform was mapped. Existing vegetation types included minor areas of *water*[361] (0.7 acres), *alkali meadow* (13.8 acres), *riparian woodland*[362](20.7 acres); *alkali shrub meadow* (69.4 acres) and *desert sink shrub* (198.2 acres). The second terrace is above the level that will be influenced by predicted 40 cfs and 200 cfs flows. These communities were predicted not to change.

Ox-bow Channel Landform

A total of 200 acres of oxbow channel landform was mapped. Existing vegetation types included *sandbar* (31.0 acres), *water* (14.0 areas), *emergent* (43.3 acres), *alkali meadow* (60.3 acres), *riparian woodland* (47.5 acres) and *alkali shrub meadow* (3.5 acres). After implementation of the 40/200 cfs stream flow scenario, oxbow channels will become wetter. It was assumed that: 1) existing *sandbar, water* and *emergent* vegetation types will convert to *water*; 2) existing *alkali*

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[361] These are small areas where the buffer used to generate the stream polygon overlap a second terrace landform.

[362] Included are 104 polygons with an average size less than 0.2 acres, mostly corresponding with a single shrub or tree.

meadow will change to the *emergent* vegetation type; 3) existing *riparian woodland* will change to the *riparian woodland/emergent complex*; and 4) existing *alkali shrub meadow* will convert to *alkali meadow*.

Fan Landform

A total of 10 acres of alluvial fan was identified. The relative elevation of this landform is typically above the second terrace and will not be affected by either 40 cfs or 200 cfs flows. Existing vegetation types are predicted not to change.

Residual Landform

A total of only 3 acres of this miscellaneous landform was mapped as *dike*. It was assumed not to change.

Lake Bottom Landform

A total of 9,669 acres of the lake bottom landform was mapped, all of which is in reach 8. It is expected that most of the anticipated flow will be pumped back to the aqueduct above reach 8, but that the reach will be augmented by small amounts of water. Vegetation types mapped were *playa* (9565.4 acres), *water* (0.5 acres), *alkali meadow* (49.0 acres), *riparian woodland* (2.8 acres), *alkali shrub meadow* (2.0 acres) and *desert sink shrub* (49 acres).

Canal

A total of 16 acres of canal was mapped from aerial photos. Existing vegetation types were *water* (4.6 acres), *riparian woodland* (2.8 acres) and *tamarisk* (8.4 acres). It is expected these types will not change in response to projected flows in the Owens River.

2.2.11 LORP Delineation, Prediction and Assessment of Wetland/Riparian Resources[363]

This report addresses riparian/wetland resources in the LORP area. Jurisdictional wetland/water resources are identified. Future conditions resulting from implementation of LORP are predicted. The relative functional qualities of riparian/wetland resources are assessed.

Wetland delineations were derived from inventories of landtype, water regime, and vegetation types (series and association) for the LORP riparian area, DHA, and BWMA (see sections 2.2.11.1, 2.2.11.2, and 2.2.11.3 below). Wetlands are characterized by hydric soils, wetland hydrology and hydrophytic vegetation. Riverine wetland delineations were integrated by reaches distinguished by valley-form, stream channel morphology, and hydrologic character. Reach types correspond with distinctive assemblages of landtypes, water regimes, and vegetation types. Reaches are expected to respond to management in distinctive manners and will serve as an integrated unit for interpretations guiding adaptive management. The DHA was considered a distinctive reach in its entirety. The BWMA was divided into 7 management units defined by hydrologic source and topographic restraints. Wetland/water resources comprise 1,843 acres of the LORP riparian area, 831 acres of the DHA, 1,139 acres of the BWMA, and 3,813 acres of all project areas.

Short-term and long-term future conditions resulting from re-watering the Owens River were predicted for the LORP riparian area. In the short-term, wetlands/water is predicted to increase 1,032 acres, relative to 2000 conditions. Long-term predicted changes in channel morphology towards more graded and aggraded reaches will cause further expansion of wetland/water resources in the LORP riparian area. Conditions that exist in the DHA

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[363] Whitehorse Associates. LORP Delineation, Prediction and Assessment of Wetland/Riparian Resources. 2004

at the time of project implementation are expected to be maintained. Analyses of two water management cycles proposed for the BWMA indicate a net loss of about 122 acres of wetland/water resources. The short-term net gain of wetland/water in the LORP, DHA, and BWMA is predicted to be 910 acres relative to 2000 conditions.

Hydrogeomorphic (HGM) *functional assessments* were compiled for existing and predicted future conditions. Fourteen *hydrologic, biogeochemical* and *habitat functions* were indexed from several dozen *variables* assigned to reach type, landtype/water regime, or vegetation association classes. *Functional indexes* (0-1) weighted by area (acres) of the parcel are the *functional unit*. A functional unit may represent 1 acre of habitat with an optimal functional index (1.0), 2 acres of habitat with a moderate index (0.5), or 10 acres with a low index (0.1).

In the LORP riparian area, hydrologic functional units are predicted to increase 348 acres in the short-term, relative to 2000 conditions. Average biogeochemical functional units are predicted to increase 516 acres. Average habitat functional units are predicted to increase 481 acres. The average of hydrologic, biogeochemical, and habitat functional units is predicted to increase 448 acres. Subsequent long-term expansion of wetland/water resources in response to changes in channel morphology will further increase functional units. Conditions that exist when LORP is implemented will be maintained in the DHA.

A predicted decrease in HGM functions for the BWMA is based on liberal estimates of wetland/water losses in the Waggoner unit. Large expanses of open water created in the Waggoner unit when water was first released in 1986 to supply Goose Lake have been replaced by an expansive marsh with low habitat diversity and edge-ratio, corresponding with a decline in values to waterfowl and shorebirds. The predicted declines in hydrologic function (94 acres for cycle 1 and 72 acres for cycle 2) and biogeochemical functions (124 acres for cycle 1 and 94 acres for cycle 2) may not be germane, since the Waggoner unit is maintained by controlled releases from the Blackrock Ditch and will no longer drain to Goose Lake. Smaller predicted declines in habitat function (58 acres for cycle 1 and 49 acres for cycle 2), estimated based on functional indexes for discrete vegetation associations, are expected to be off-set by factors not considered in the HGM analyses (e.g. habitat diversity, edge-ratios, proximity to open water). The intent of hydrologic management in the BWMA is to create conditions more favorable to waterfowl and shorebirds.

2.2.11.1 Riverine/Riparian 2000 Inventory[364]

The Riverine/Riparian 2000 Inventory analyzes vegetation type, abundance and distribution, as well as hydrogeomorphic (HGM) modeling.

The LORP riparian area follows the Owens River from the Los Angeles Aqueduct diversion to the Delta Habitat Area (DHA) on the Owens Lake bed. The LORP riparian area is 6,437 acres and includes 53.3 linear miles of the Owens River channel. A vegetation inventory was conducted. This vegetation inventory may serve as a baseline for monitoring future changes following implementation of the LORP. Viewed from a historic perspective, the inventory also serves as an integrated expression of past changes that may help to guide future management.

Existing information pertinent to vegetation resources in the LORP area was reviewed and assembled. Mapping was conducted from high-resolution (2 foot pixels) digital orthophotos viewed at 1:1,000 to 1:6,000 scales. Map units denote areas of distinctive soil, hydrologic and vegetative character. Field descriptions of soil, hydrologic and vegetative attributes of 50 parcels in 12 study areas were conducted. Vegetative, soil and hydrologic criteria listed in the Wetland Delineation Manual were used to determine the

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[364] WHA 2004c

wetland status of each map parcel. Jurisdictional wetlands have hydric soil, wetland hydrology and hydrophytic vegetation. The accuracy of mapping was assessed in fall, 2002. This report is compiled as digital WORD (doc) and ADOBE (pdf) files on DVD. ArcView shapefiles, TIFF images, and Access tables are also compiled on the disk.

The LORP riparian area was divided into 4,072 parcels, each consisting of a dominant landtype, water regime and vegetation type. Four landtypes were identified based on soil, morphology and position relative to environmental gradients. The *floodplain landtype* includes land influenced by contemporary stream processes, including channels and ponds; surfaces were typically less than 2 feet above alluvial groundwater level. The *low terraces landtype* includes historic floodplains that have been left high-and-dry by channel incision; surfaces were typically 2 to 5 feet above alluvial groundwater level. *High terraces* were typically greater than 5 feet above alluvial groundwater level. *Eolian land* is characterized by a veneer of loose, wind-blown sand underlain by terrace or floodplain sediments. Hydric soil was evident throughout the floodplain landtype and in isolated depressions on low terraces. Hydric soil was generally not present on convex and even terrace surfaces, nor was it present in eolian land.

Water regimes identified in the LORP riparian area were based on the frequency and duration of flooding, and/or depth to saturated conditions. *Permanently flooded, saturated,* and *high water table regimes* were flooded or saturated near the surface and wetland hydrology is present. *Low* and *very low water table regimes* were not flooded or saturated near the surface and wetland hydrology is absent.

Vegetation types were identified based on community physiognomy and plant species composition. Two levels of vegetation types were identified: 1) Series were identified based on prominent overstory species; 2) associations were identified based on overstory and understory species composition. Major vegetation types include *alkali marsh (bulrush-cattail), wet alkali meadow (saltgrass-rush), alkali meadow (saltgrass), Goodding-red willow (Goodding-red willow/bulrush-cattail, Goodding-red willow/creeping wildrye-saltgrass,* and *Goodding-red willow/scrub), rabbitbrush-NV saltbush (rabbitbrush-NV saltbush/saltgrass-alkali sacaton* and *rabbitbrush-NV saltbush).* Hydrophytic vegetation (albeit sometimes scant) was dominant in all of these major vegetation types. Hydric soil, wetland hydrology and hydrophytic vegetation definitive of jurisdictional wetland were present in about 1,843 acres (28.6 percent) of the LORP riparian area.

The distributions of landtypes, water regimes, and vegetation types are influenced by valley form, channel/floodplain morphology, and hydrologic variables. These three parameters were used to define four reach types in the LORP riparian area: 1) *dry incised floodplain* (Reach 2); *wet incised floodplain* (Reaches 1, 3, and 5), *graded wet floodplain* (Reach 6), and *aggraded wet floodplain* (Reach 4). Reach types corresponded with distinctive assemblages of landtypes, water regimes and vegetation types. Reaches are expected to respond to LORP applications in distinctive manners and will serve as an integrated unit for interpretations guiding adaptive management.

The accuracy of preliminary mapping presented in a draft report dated September 2002 was evaluated. The goal was 95 percent overall accuracy. The accuracy of preliminary mapping was predicted to be 92.5 percent. Preliminary mapping was therefore refined using a high resolution, color infrared, ICONOS satellite image. Most of the typical mapping errors were evident from the ICONOS image. Refined mapping presented in this report is expected to exceed the goal of 95 percent overall accuracy.

2.2.11.2 Delta Habitat Area 2000 Inventory[365]

Delta Habitat Area 2000 Inventory analyzes vegetation type, abundance and distribution, as well as hydrogeomorphic (HGM) modeling.

The Delta Habitat Area (DHA) is in the mouth of the Owens River on the bed of historic Owens Lake and is 3,578 acres. This vegetation inventory serves as a baseline for monitoring changes following implementation of the LORP and as "existing conditions" for assessing impacts of the LORP on wetland resources in the DHA.

Existing information pertinent to vegetation resources in the DHA was reviewed and assembled. Information included hydrologic parameters measured at the Keeler gage, topographic surveys in the DHA, hydrologic modeling, previous mapping studies and historic aerial photos. Mapping was conducted from high-resolution (2 foot pixels) digital orthophotos. Map units denote areas of distinctive landtype/soil, hydrologic and vegetative character. Field descriptions of vegetation, soil and hydrologic attributes of vegetation types in the DHA were conducted May 1-5, 2000. Vegetative, soil and hydrologic criteria listed in the Wetland Delineation Manual[366] were used to determine the wetland status of each site. The accuracy of mapping was assessed in fall, 2002. This report is compiled as digital WORD (doc) and ADOBE (pdf) files on DVD. Arc-View shapefiles and TFF images are also compiled on disks.

Average winter flow at the Keeler gage for the 1927-86 period (22 cfs) was highly variable, ranging from 4 to 214 cfs. In 1986 preliminary release to the Lower Owens River commenced. Average winter flow for the 1986-2001 period (14 cfs) was less variable than the 1927-86 period, ranging from 8 to 21 cfs. Inflow to the DHA is augmented by alluvial groundwater. Assuming 5 inches annual rainfall, direct precipitation provides about 1,491 acre-ft/year to the DHA.

Map units consist of a single dominant landtype, water regime and vegetation type. Four landtypes were identified in the DHA (*floodplain*, *low terrace*, *eolian land*, and *lacustrine land*). Six water regimes were identified in the DHA (*permanently flooded*, *saturated*, *intermittently flooded*, *high water table*, *low water table*, and *very low water table*). Nine vegetation associations and/or more general series were identified: water, alkali marsh (*bulrush/cattail*), wet alkali meadow (*saltgrass-rush*), *Goodding-red willow/bulrush-cattail*, *Goodding-red willow/creeping wildrye-saltgrass*, alkali meadow (*saltgrass*), *Parry saltbush-Torrey seepweed*, dune, and playa. The total area of wetland in 2000 was 824 acres.

A historical perspective of changes in the extent of wetlands in the DHA was developed from aerial photos. Between 1944 and 1967 the extent of vegetated wetlands in the DHA decreased from about 167 to 42 acres, probably a response to negligible summer inflows (< 1 cfs). Since 1993 the extent of vegetated wetland and water increased from 422 to 824 acres in 2000, an increase of about 60 acres per year. The expansion of wetlands corresponds to a subtle rise in the effective water surface. As vegetated wetlands expand, water is spread over a broader area, the amount of water storage in the DHA increases, and the rate of flow-through decreases. When inflow exceeds water storage and plant utilization, the DHA overflows to the brine pool. This overflow to the brine pool is a good indication that the water needs of existing wetland are being met and that storage capacity has been exceeded.

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[365] WHA 2004c

[366] U.S. Army Corps of Engineers 1987

2.2.11.3 Blackrock Waterfowl Management Area 2000 Inventory[367]

Blackrock Waterfowl Area 2000 Inventory analyzes vegetation type, abundance and distribution, as well as hydrogeomorphic (HGM) modeling.

This vegetation inventory of the Blackrock Waterfowl Management Area and vicinity (BWMA) is one component of a more comprehensive inventory of wetland/riparian resources in Owens Valley. It is intended to serve as a baseline and a planning tool for future project implementation and monitoring.

The BWMA is between the Los Angeles Aqueduct and the Lower Owens River riparian corridor. The southern boundary is south of Mazourka Canyon Road, about where drainage through the BWMA and the 1872 fault line intersect the Owens River riparian corridor. The BWMA is 20,461 acres. The BWMA was divided into 7 management units: Twin Lakes (2,901 acres), Drew (827 acres), Waggoner (1,555 acres), Winerton (1918 acres), Thibaut (4,735 acres), Goose Lake (6,789 acres), and Billy Lake (6,789 acres).

Existing information was reviewed and, when appropriate, integrated with the current study. Existing information includes hydrologic data measured by DWP, soil mapping prepared by the NRCS, Greenbook mapping and vegetation characterization, vegetation mapping from 1993 photos, spring mapping conducted by Ecosystems Sciences (ES), Inyo County Water Department (ICWD) vegetation monitoring transects, Type E vegetation monitoring conducted by Resource Consultants, Inc. (RCI), well monitoring conducted by DWP, and vegetation transect data collected by Garcia and Associates (GANDA) for the LORP Monitoring Database.

Vegetation, landtype and water regime were mapped at 1:2,000 to 1:6,000 scales from digital orthophotos dated 2000 and a color infrared (CIR) satellite image provided by Space Imaging. Field reconnaissance and descriptions were conducted. The accuracy of mapping was evaluated. Existing information was integrated as appropriate. The report is provided as both WORD and ADOBE (pdf) files. The pdf file includes numerous links from maps to photographs, other maps, and/or tabular summaries. Access files, images, and shapefiles are also provided.

Four landtypes were identified. The *spring drainage* landtype includes shallow, divergent swales that originate in the vicinity of Blackrock and Little Blackrock Springs. *Fault basins* are narrow depressions that formed along the 1872 fault line, some of which are actively managed to sustain waterfowl habitat. *Lacustrine land* is characterized by flat to broadly concave surfaces with fine-textured, alkali soil. *Eolian land* has a veneer of loose, wind-blown sand ranging from a foot to several meters that overlays fine-textured lacustrine sediment. Landtypes are a principal determinate of hydrologic and vegetative character.

Seven water regimes were identified. The *permanently flooded* regime includes ponds in the BWMA. The *saturated* regime includes marsh vegetation, mostly in spring drainage, fault basin and lacustrine landtypes. *Intermittently flooded* areas are flooded for brief periods in response to local runoff, irrigation runoff, and/or water spreading activities. The *high water table* regime includes areas that, under year 2000 water management, were saturated within the rooting depth of herbaceous vegetation (1 to 2 feet) for at least part of the growing season. The *low water table regime* included areas saturated within the rooting depth of shrubs (2-5 feet). The *very low water table* regime included areas with groundwater below the dominant rooting depth of shrubs (> 5 feet). *Irrigated lands* acres were also identified.

Twenty (20) vegetation and miscellaneous types were distinguished by community physiognomy and species composition. Vegetation types were identified to the association and/or series level. Vegetation and miscellaneous types are: *water, alkali marsh*

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[367] WHA 2004c

series (bulrush-cattail association, wet alkali meadow series (saltgrass-rush association), wet alkali meadow series (reedgrass association), alkali meadow series (saltgrass association), alkali flat series (saltgrass-alkali forb association), pasture series (irrigated meadow association), coyote willow series (coyote willow-rose association), Goodding-red willow series (Goodding-red willow/creeping wildrye-saltgrass and Goodding-red willow/scrub associations), rabbitbrush-NV saltbush/saltgrass-alkali sacaton, Great Basin mixed scrub, desert sink scrub, NV saltbush-rabbitbrush scrub, tamarisk series (tamarisk/alkali flat, tamarisk/saltgrass, and tamarisk/scrub associations, abandoned agriculture, slicks, and *cut/fill*..

Jurisdictional wetlands are areas with hydrophytic vegetation, wetland hydrology and hydric soil. The vast majority of wetland in the BWMA is "man-induced wetland" that is sustained by managed water releases from the aqueduct and Blackrock Ditch. The jurisdictional status of man-induced wetland is dictated by the current Corps regulations and policy and should be determined through consultation with the Corps of Engineers. A preliminary status was assigned to combinations of vegetation type, landtype and water regime. Hydrophytic vegetation was present throughout most of the BWMA. Hydric soil was present in areas with permanently flooded, saturated, high water table and some intermittently flooded regimes. All areas with permanently flooded and saturated regimes, and most areas with a high water table regime were assigned wetland status. Intermittently flooded areas were assigned wetland status only where the flooding was frequent enough to cause a significant change in vegetation towards more hydric components. Intermittently flooded dry alkali meadow in the Thibaut area was assigned wetland status; intermittently flooded desert sink scrub was not. The status of intermittently flooded slicks was "not determined". Some slicks in the Thibaut area are flooded frequently and may merit wetland status; other slicks in the Twin Lakes area are rarely flooded and may not merit wetland status. Areas with low and very low water were assigned upland status. Irrigated areas, mostly in the Thibaut and Billy Lake units were assigned upland status. The area assigned wetland status in the BWMA was 1,138 acres (6 percent); the status of 847 acres (4 percent) was not determined; the remaining 18,567 acres (90 percent) was upland.

The overall accuracy of labels assigned to map units in the BWMA was estimated to be greater than 90 percent. Inclusions of contrasting types are common to all delineations.

2.2.12 LORP Grazing Management Plans and Landuse[368]

Grazing Management Plans for Livestock and Landuse are one of the components required by the Memorandum of Understanding. The goal of the Owens Valley Management Plans is to support the achievement of LADWP's watershed management goals, which are to improve water quality, improve water-use efficiency, maintain compatibility with water gathering activities, and support LADWP's goal of continuing a cost-effective aqueduct operation. Additional goals are to establish a healthy, functioning ecosystem for the benefit of biodiversity and special status species while providing for the continuation of sustainable uses, including recreation, livestock grazing, agriculture, and other activities.[369] LADWP plans to achieve these goals through the implementation of grazing "Best Management Practices" (BMPs), and apply adaptive management to build and maintain a healthy landuse and watershed. BMPs are methods, measures, or land-management practices designed to improve watershed health.

One of the items to be addressed is livestock grazing. In an effort to meet the goals of protecting valuable water resources while

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[368] LADWP, Grazing Management Plans for LORP Leases. Grazing Management Plan summaries and maps are include in the Appendices.

[369] MOU 1997

providing for the continuation of sustainable uses, LADWP, in consultation with Ecosystem Sciences, and the ranch lessees, developed Grazing Management Plans for each of the then 7 ranch leases in the LORP (Table 2.13). These grazing management plans are designed to meet regional water quality regulations by implementing BMPs that address water quality issues and enhance existing conditions. During the development of these plans, staffs from Ecosystem Sciences and the Watershed Resources section of LADWP coordinated closely with the lessees in an attempt to develop plans that are compatible with the lessees' operations yet ensure that watershed and landuse health goals are met.

LADWP also identified the following additional goals for the land management plan of the LORP[370]:

- Maintain and improve aquatic resources
- Improve water use efficiency
- Improve animal distribution
- Work with lessees to develop and implement grazing management practices
- Successfully apply the adaptive management approach to maintain and enhance healthy watersheds
- Maintain compatibility with water gathering activities and cost effective aqueduct operations
- Enhance fisheries and wildlife habitat

Seven major leases and one small lease occur in the LORP planning area. Acreages of individual leases are shown in Table 2.13. Five leases (Twin Lakes, Blackrock, Island, Lone Pine, and Delta) are cow/calf grazing operations, and two leases (Thibaut and Intake) are grazed by horses/mules.

Lease	Current Total Lease Acreage
Twin Lakes	4,912
Blackrock	32,674
Thibaut	5,259
Island	18,970
Lone Pine	8,274
Delta	7,110
Intake	284

Table 2.13 LORP Grazing Management Leases

Several issues were raised during the development of the final drafts of plans for ranch leases that lie within the boundaries of the Lower Owens River Project. These issues included forage utilization rates on upland areas, assessing the condition of irrigated pastures, and critical operational management areas for the leases. In an effort to address these issues, a focus group of ranch lessees met with staff from LADWP in December 2003. The intent was to arrive at solutions that were acceptable to both LADWP and the lessees on these critical issues.

For each of the seven leases, an individual grazing management plan has been developed by LADWP in cooperation with each leaseholder. The methodology used to prepare the grazing management plans included interviewing the lessees on their past livestock grazing practices (number and type of livestock, pasture uses and rotations, etc.). Some of the information obtained during the interviews and documented in the grazing management plans is proprietary, as it relates to marketing strategies and other business management plans of the individual lessees. Lessees agreed to provide the proprietary information to LADWP with the understanding that the information would remain confidential.[371] Therefore, the lease-specific grazing management plans are not available for public review.[372] The information contained in Sections 2.8 and 9 of the FEIR/EIS was excerpted from the LORP Plan (Chapter 4, "Land Management Plan"), which is a public document available for review. Additionally, LADWP completed grazing management plans

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[370] LORP FEIR, 2004. LADWP.

[371] LORP FEIR, 2004. LADWP.

[372] additional information on this confidentiality of these plans was provided, A. Walsh, pers. comm. to L.A. Silver, April 25, 2003

for the LORP leases in 2006 and these Lease Plans/Grazing Management Plans summaries and lease maps can be found in Appendix A.4.

In early drafts of the Grazing Management Plans, irrigated pasture conditions were to be determined occularly and pastures qualitatively rated as being in poor, fair, good, or excellent condition. Pastures rated as either poor or fair would have utilization standards established in an effort to improve their condition rating. In an effort to establish a more quantitative system of rating that would be less susceptible to bias, LADWP staff tested the Natural Resource Conservation Service Guide to Pasture Condition Scoring and determined that the method was quantitative, easy to implement, repeatable, and yielded consistent results among various users. Members of the lessee focus group indicated that the method was acceptable. Beginning in 2004, LADWP and the lessees jointly assessed irrigated pastures on all leases.

Due to the number of irrigated pastures, it was determined that it would not be possible to assess the condition of all irrigated pastures on all leases every year, but a subset of all irrigated pastures will be jointly (LADWP and lessee) evaluated annually. During years of below-normal precipitation and when water allotments for irrigation are reduced, there will be no downgrading of pasture condition. If irrigation reduction lasts for more than one season, however, adjustments in livestock numbers may be necessary to ensure there are no long-term detrimental impacts to irrigated pastures.

Early Grazing Management Plan drafts established upland forage utilization rates at 65 percent as long as there were 31 days of rest for the pasture at some time during the growing season. LADWP staff were concerned that this level of utilization and short rest period would prohibit native grasses from completing seed set and, consequently, result in a decline in the trend of the upland area. More restrictive language setting utilization rates at 50 percent if plants were grazed at anytime during the period from April 2 to September 30 was not acceptable to the rancher focus group because of the restrictions concerning being able to move livestock to other private lands or federal permit areas prior to April 2. As a compromise, 65 percent utilization was established for all upland areas as long as there was a minimum of 60 continuous days of rest for the area during the plant "active growth stage" to allow seed set between June and September. If the pasture does not receive 60 continuous days of rest between June and September, utilization rates will be set at 50 percent. This was acceptable to the lessees and should not prohibit the achievement of LADWP’s goal if adaptive management guidelines are followed.

The final concern that the rancher focus group expressed was that there are portions of their leases that are critical to their ability to operate. These areas include livestock gathering areas, holding areas, and shipping areas. LADWP recognized these needs and agreed that establishment of utilization standards for these areas would not be appropriate.

LORP Grazing Management Plan summaries for the seven LORP leases are included in the Appendices. Detailed descriptions of the monitoring methods for the landuse and grazing management are in Section 4.0.

2.2.12.1 General Land Management Approaches[373, 374]

Currently, LADWP leases within the LORP area do not have formal protocols for quantitative monitoring and evaluation of rangeland conditions and grazing strategies.[375] The proposed actions described below will modify grazing practices on LADWP leases within the LORP area and establish quantitative monitoring of rangeland conditions to complement the habitat enhancements anticipated with the re-watering of the river. Grazing practices under the land management plan will differ from the past in timing of use, intensity, and animal distribution. However, at least initially, the stocking rate (i.e., number of animals) will remain the same as in past years, except for the Thibaut Lease.

General management actions and strategies include the following:

- Establishment of fenced riparian pastures
- Establishment of lease-specific utilization rates and grazing periods
- Establishment of rare plant exclosures
- Improvement of water distribution and stockwater supplies
- Protection of continued recreational access to the river
- Accommodation of elk passage

The lessees are expected to incorporate the changes in management called for in the grazing management plans over a period of 1 to 3 years from the time the plans are signed. The lessees are expected to meet all standards, criteria, and conditions outlined in the plans by the beginning of the fourth year.

Establishment of Fenced Riparian Pastures. Currently, riparian and upland areas within each lease are generally not separated by fencing or other physical barriers. As part of the LORP land management plan, a total of approximately 40 miles of new fencing will be installed primarily on the western side of the river to create fenced riparian pastures. Creation of fenced riparian pastures will allow lessees to rotate livestock between riparian and upland areas and optimize the distribution of livestock within each lease. Grazing in riparian and upland pastures will be managed based on prescribed grazing periods and utilization rates described below.

Establishment of Lease-Specific Utilization Rates and Grazing Periods. Under LORP, lease-specific utilization rates will be established and monitored in both riparian and upland areas to guide grazing strategies. Utilization rate is defined as the proportion of current year's forage production that is consumed and/or destroyed by grazing animals, including livestock, wildlife (e.g., elk), and insects. Utilization rates will be measured by establishing utilization cages and comparing the amount of vegetation biomass outside (grazed) and inside (not grazed) the cages.[376] Utilization rates will be used to monitor and manage the use of vegetation, prevent forage overuse, and maintain the ecosystem health of rangelands.

As part of the LORP adaptive management approach, the initial allowable maximum riparian and upland utilization rates and grazing periods described below may be increased or decreased on a case-by-case basis depending on the changes in rangeland conditions as indicated by monitoring of rangeland "trend".

Riparian Utilization Rates and Grazing Periods. Under LORP, livestock will be allowed to graze in riparian pastures during the grazing periods prescribed for each lease. Livestock will be removed from riparian pastures when the utilization rate reaches 40 percent or at the end of the grazing period, whichever comes first. In general, the

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[373] LORP FEIR, 2004. LADWP. Section 2.8

[374] Ecosystem Sciences, 2002. LORP Ecosystem Management Plan. Chapter 4.

[375] Formal protocols for quantitative monitoring and evaluation of rangeland condition and grazing utilization were established on all LORP leases in 2002.

[376] This has been updated: Utilization cages will not be used for monitoring utilization rates in most cases. See Land Use section and utilization monitoring methodology for more discussion.

prescribed grazing periods for riparian pastures will be several months in the spring (shorter than the existing grazing practice). The beginning and ending dates of the lease-specific grazing period will vary from year to year depending on the conditions such as climate, but the duration will remain approximately the same. The grazing periods and utilization rates are designed to facilitate the recruitment and establishment of riparian shrubs and trees. Forty percent has been selected by the Ecosystem Sciences rangeland management specialist as the initial utilization rate, since livestock are not likely to graze woody species if herbaceous forage utilization stays below 40 percent.

Upland Utilization Rates and Grazing Periods. In upland pastures, the maximum utilization allowed on herbaceous vegetation, in any year, will be 65 percent if grazing occurs between October 1 and April 1. The maximum utilization allowed will be 50 percent if the grazing occurs between April 2 and September 30; however, if all grazing is deferred until after seed-ripe of herbaceous vegetation (i.e., late summer; exact timing depends on precipitation, weather, and other factors), maximum utilization can be increased to 65 percent. If this exception is used, then no additional grazing can occur during any other period of the year on this same upland. If the lessee conducts livestock grazing during both periods (October 1 to April 1 and again from April 2 to September 30), maximum utilization allowed will only be 50 percent. The utilization rates and grazing periods for upland pastures are designed to sustain livestock grazing and productive wildlife through efficient use of forage. If there are upland vegetation types located within fenced riparian pastures, the upland vegetation will be managed using the uplands utilization criteria.

Establishment of Rare Plant Exclosures. New rare plant exclosures will be constructed on Blackrock Lease and Thibaut Lease for populations of Owens Valley checkerbloom and Inyo County star-tulip. In addition, an existing rare plant exclosure for Nevada oryctes located on the Twin Lakes lease will be reconstructed. Monitoring will be conducted at trend plots established in the rare plant populations. The trend plots will be circular areas that are 0.01 acre in size, with a permanent stake at the center. Data on recruitment, persistence, size of individuals and flowering and seed presence will be collected at these trend plots. Additional fencing may be installed around other rare plant populations or sensitive seeps/springs as part of adaptive management if monitoring indicates that livestock grazing is substantially impacting resource values as indicated by excessive trampling, reduction in riparian vegetation, and/or reduction in overall site health.

If noxious weeds are found during monitoring of the rare plants, the survey crew will notify LADWP and appropriate treatment will be administered jointly by staff with expertise in identifying rare plants and staff qualified for noxious weed treatment. Noxious weed treatment in the vicinity of rare plants will be conducted using a weed wipe (equipment designed to apply herbicides only to plants that come into contact with the applicator) or by hand, as necessary, to prevent any adverse effects of herbicide application on the rare plants. This is LADWP’s existing practice for treatment of noxious weeds in the vicinity of rare plants that will be continued under LORP.

Improvement of Water Distribution and Stockwater Supplies. To improve livestock distribution outside the river corridor or within riparian pastures, water gaps will be provided at periodic locations along the river. Water gaps are fenced access points to the river where cattle can use the river for watering, but are restricted to small locations in order to reduce impacts. In addition, new water troughs or stockwater wells will be strategically placed to encourage cattle to use areas outside the river corridor as needed. Salt and supplements will also be used to improve animal distribution.

Protection of Continued Recreational Access to the River. New fences installed for grazing management will maintain existing access to the river for recreationists. In some cases, the type of access may be modified (e.g., from vehicle to foot). Fences will be located on the outside edge of the access roads when possible to maintain access to the river. Cattle guards will be placed on roads that traverse fence lines when needed. “Walk-throughs” or “walk-overs” will be provided in heavy foot-traffic areas. Permanent fences across the river will be designed to avoid interference with boats or other watercraft. Fence wings are rails that are attached to the ends of the fence and project over the edges of the banks. They will be used in locations where the channel is deep enough to prevent livestock from walking around the fence ends. The deep open area between the fence wings will allow for watercraft passage. A channel fence section will be used temporarily (approximately up to 3 months per year) in locations where livestock can enter the stream and walk around the fence ends. Navigation would likely be accommodated by kayaking or canoeing under the channel fence section. Channel fence sections will have smooth and flexible wires at the bottom and reflective strips to make them visible and safe for boaters when they are in place. Once the locations have been determined, this information will be posted on LORP signage. Channel fence sections will be removed when livestock are not present in the nearby pasture.

Accommodation of Elk/Deer Passage. Special fencing will be constructed at known elk/deer trails to allow safe passage and to reduce fence damage from elk/deer-crossing activities.

Alterations Due to Unforeseen Circumstances

In many cases, ranchers who lease LADWP lands also lease federal and other private lands for livestock grazing. If an emergency situation on a lessee’s federal allotment(s) or on the lessee’s deeded private lands results in serious reductions in allowable livestock numbers, Animal Unit Months (AUMs) or duration and timing of grazing, then temporary (one year or less) changes in grazing periods for upland areas within the LADWP lease may be made to help provide the necessary grazing relief to the lessee. Examples of circumstances that may allow changes in upland grazing periods are fire damage, forage loss from high snow years, and forage loss from drought conditions. During the attempt by LADWP to help provide some necessary grazing relief to the lessee, all riparian and upland utilization rates and grazing periods in the riparian areas as stated in the grazing management plans will remain in effect.

2.2.12.2 Land Management Monitoring and Adaptive Management[377, 378]

Monitoring for land management will consist of grazing utilization and trend measurements. The methodologies for monitoring utilization and trend are described below. To collect data on baseline conditions, a rangeland trend monitoring program was initiated in 2002 on all leases within the LORP area using the methodologies described below. Minimally, the first two years of rangeland trend monitoring will be considered baseline.[379] In portions of the leases that overlap with the riverine-riparian area, the Blackrock Habitat Area, or the Delta Habitat Area, additional monitoring for biological resources will be conducted as part of the overall LORP monitoring program.

Unlike the other LORP monitoring and adaptive management activities, LADWP will be solely responsible for funding and for monitoring lease conditions on its leases located wholly or partially within the LORP area. LADWP will report the results of monitoring on these leases, as they apply to achieving LORP goals, as part of the annual report presented to the Technical Group.

The results of utilization and trend monitoring, together with relevant results of other LORP monitoring programs, will be used to determine the need for adaptive management actions. Potential adaptive management actions for the LORP land management plan include:

- Modify utilization rates
- Modify grazing periods
- Modify stocking rate
- Install additional fencing

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[377] LORP FEIR, 2004. LADWP. Section 2.8

[378] Ecosystem Sciences, 2002. LORP Ecosystem Management Plan. Chapter 4.

[379] All rangeland monitoring conducted from 2002-2007 will be considered baseline.

- Install additional or remove existing rare plant exclosures
- Install fences around sensitive seeps/springs
- Install additional stockwater sources
- Modify supplement locations (salt blocks, sweet feeds, etc.)

Utilization Monitoring. Utilization is defined as the proportion of current year's forage production that is consumed and/or destroyed by grazing animals, including livestock, wildlife (e.g., elk), and insects as compared to the amount of forage produced during the same growing year. Utilization rates are measured by establishing utilization cages in pastures and comparing the average height of the key forage species inside the cage (ungrazed) and outside of the cage (grazed).[380] The percent utilization of each key forage species is then determined by using a height-weight curve, which converts the difference in the average height of the grazed and ungrazed plants into percent of biomass removed. These height-weight curves are species-specific curves that represent the mathematical relationship between the height and biomass of a plant based on its dry weight.

Key forage species are species that are preferred by livestock for foraging and are abundant enough to be used to monitor utilization rate. Key forage species that will be used to monitor utilization in the LORP area include: saltgrass (*Distichlis spicata*), sedges (*Carex* spp), alkali muhly (*Muhlenbergia asperifolia*), beardless wild rye (*Leymus cinereus*), creeping wild rye (*Leymus triticoides*), and alkali sacaton (*Sporobolus airoides*). Other forage species may be included on a site-specific basis if they are found to be abundant and grazed by livestock in a particular area.

Utilization cages will be located in key areas identified by LADWP Watershed Resources staff to be representative of a pasture. These cages will be positioned in selected pastures prior to the arrival of livestock. Each utilization cage will be 1.5 meter by 1.5 meter in size. The utilization cages will be moved on an annual or seasonal basis, depending on the specific livestock operations of the lease. This is necessary to ensure that utilization of the forage produced during the same growing year will be measured.

Monitoring of utilization will be conducted by the lessees and LADWP. LADWP will train lessees in how to determine utilization percentages. The utilization rate of a pasture will be measured at least twice during the grazing period. During the initial phases of implementation, utilization may be determined more frequently. Lessees will report to LADWP when the observed utilization rate is approaching the maximum allowable utilization rate. LADWP staff will verify the utilization rate and determine whether the maximum allowable utilization rate has been reached. Following removal of livestock at the end of the use period, the total utilization for a pasture will be determined and documented.

The specific methodology for determining utilization can be found in Appendix G. The utilization methodology presented in Appendix G has been adapted from the Interagency Technical Reference "Utilization Studies and Residual Measurements".[381]

Rangeland Trend Monitoring. The rangeland trend monitoring program will provide vegetation data necessary to evaluate the response of range condition and trend to changes in livestock management practices. Rangeland trend will be monitored annually in non-irrigated lands on all leases. Monitoring of rangeland trend will be conducted at permanent transect locations and will consist of recording:

- Foliar and basal cover for grasses and grass-likes (percent cover by species)
- Foliar cover of shrubs, subshrubs, and annuals (percent cover by species)
- Substrate cover (percent cover bare ground, litter, rock, dung, and cryptogamic crust)

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[380] Updated: Utilization cages will, in general not be used in determining utilization rates. The average height of ungrazed grasses will be measured after the peak of the growing season and prior to entry of livestock, as described in Utilization monitoring section.

[381] BLM et al., 1996b

- Visual obstruction (an index of vertical vegetation structure)
- Age distribution of shrubs

Sampling protocols and data summary will follow procedures outlined in the Interagency Technical Reference “Sampling Vegetation Attributes”.[382] Sampling will be done at the height of the growing season (June – July). Both forage and non-forage species as well as woody vegetation will be included in the trend monitoring.

Permanent sampling transects will be established primarily in vegetation communities classified as Type C in the Green Book[383] (grass-dominated communities, including alkali meadow, alkali seep, rabbitbrush meadow, and Nevada saltbush meadow). These communities were selected for trend monitoring because they would likely be areas of livestock concentration due to forage availability, and be more responsive to changes in management than more xeric communities. A minimum of three transects will be established in each lease, with the exception of the Intake lease, in which only one transect will be established due to its small size. Sampling of rangeland trend will also take place in exclosures along the river designated as reference areas. Trend data collected from grazed areas will be compared to data from the ungrazed reference areas to evaluate the influence of grazing on cover, frequency, and shrub age structure of the vegetation community.

In addition to measuring the trend parameters, general view photos and close-up photos will be taken at each transect location at the height of the growing season (June – July) to provide visual documentation of conditions.

Other Monitoring Activities. Annual field inspections will be conducted every year for the first three years of LORP implementation to inspect the conditions of fences and evaluate the location of salt/supplements and stockwater, etc. After the initial three years, field inspections will be conducted every three years. Field evaluations will be conducted at the end of the grazing period. Inspection visits to visually compare controls with reference pastures (exclosures) will be conducted in years 2, 5, 7, 10, and 15.

Lease plans summaries and maps can be found in Appendix A.4.

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[382] BLM et al., 1996a

[383] LADWP and Inyo County, 1990

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2.3 Baseline Monitoring

A full, long-term monitoring program for collecting and analyzing data on the LORP area was designed and baseline data collected. Future monitoring, conducted after the initiation of river flows and land management practices, will be compared against the baseline to determine if changes resulting from the restoration efforts are consistent with the LORP goals and objectives.

Baseline data using the methods described in this plan (Section 4.0) were collected throughout the LORP in 2002. The data has been compiled, mapped, and/or tabulated and warehoused for future reference. Baseline reports for each LORP grazing lease are currently in development. These baseline reports will present baseline range trend data, range condition scores, pasture condition scores, and information of baseline utilization rates. No analyses have been performed on the baseline data, because analyses will come with the next set of monitoring data.

In its simplest form baseline data is basic site condition information gathered prior to the initiation of an ecological restoration project. Often in river restoration projects baseline data pertains to water quantity and quality, vegetation community acreages and species descriptions, fisheries, avian and terrestrial animal populations and pertinent habitats, and geomorphic conditions. The term "baseline" simply refers to a point in time prior to implementation of the restoration project[384] and should be viewed as current conditions.

The Society for Ecological Restoration[385] states, "it is useful to obtain baseline measurements for a restoration project a year or more prior to initial project installation." Baseline information is then used later-on to provide a comparison for assessing the impact of restoration, as baseline data measurements are repeated throughout the life of the project as part of the monitoring program.

Unanticipated extremes in data can indicate problems that might require mid-course correction, or adaptive management, to prevent the collapse of the project. Additionally, upon project completion, the baseline dataset is assessed to help evaluate the effectiveness of restoration.[386]

Baseline data is collected for three reasons: (1) inventory and document existing site conditions and biota; (2) quantify the degree of degradation or damage; and (3) enable managers to evaluate changes in pre- and post-restoration site conditions and make adaptive management decisions.

Ecological restoration is an intentional activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity and sustainability.[387] Thus, over the course of the restoration project, vegetation communities and habitat will change as the ecosystem recovers from a degraded state. To analyze how much and in what way vegetation and habitat are changing it is imperative to inventory existing site conditions and flora and fauna in a baseline data collection effort. The structure of all component communities should be described in sufficient detail to allow a realistic prediction of the effectiveness of subsequent restoration efforts.[388]

Baseline data is critical for evaluating a restoration project and making decisions to ensure its success. Altering management actions and making management decisions during the course of a restoration project to ensure its success is part of adaptive management. Adaptive management as a restoration strategy is highly recommended, if not essential, because what happens in one

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[384] Busch and Trexler 2003
[385] Clewell et al. 2005
[386] Clewell et al. 2005
[387] SER 2004
[388] Clewell et al. 2005

phase of project work can alter what was planned for the next phase.[389] A restoration plan must contain built-in flexibility to facilitate alternative actions for addressing underperformance relative to objectives. The rationale for initiating adaptive management should be well documented by monitoring data or other observations and is usually based on a contrast, or lack of contrast, from baseline conditions.[390]

This document does not present results from the data collection, but rather describes the methods and criteria (objective and subjective) used to collect and establish the baseline conditions from which to detect, track, and measure trends in ecosystem restoration. These methods will be used to make management decisions and monitor conditions over the 15 years of the LORP monitoring period. The methodologies used were designed to meet the objectives stated in the LORP Ecosystem Management Plan, tech memos, and MOU.

2.3.1 Types of Measures

The LORP baseline data collection consisted of vegetation mapping, soil descriptions, landform mapping, habitat evaluations and quantities, avian census and fisheries inventory, and water quantity and quality.

In addition to flow compliance and water quality, habitat is the focus of monitoring efforts in the LORP. Habitat is directly responsive to changes in ecosystem management; therefore, it is a descriptive and reliable indicator of change over time. Furthermore, management of the LORP ecosystem is keyed to adaptive actions aimed at interventions at the habitat level, and not at the species population level.

Though it is financially and physically impossible to monitor the entire river corridor, wetland, transition zones, and uplands, changes in habitat, nevertheless, will be quite variable from one area to another. In order to detect and quantify habitat changes, or possibly no change in some areas, and make decisions on appropriate interventions, managers must recognize not only how the whole ecosystem is responding to rewatering and land management. Managers must also have reliable and quantifiable information and data to support decisions.

LORP monitoring relies upon habitat mapping from remote imagery and reconnaissance surveys at the macro-scale to observe major habitat changes and early detection of problem areas. Specific habitat features for riparian vegetation, wetlands, fish and wildlife habitat, flow and water quality are measured at the micro-scale that are spatially representative of key ecosystem types (i.e., river, riparian, wetland, and upland habitats throughout the LORP). An adequate number of sites are monitored so that data analysis identifies biologically significant changes.

Macro-scale monitoring can confirm whether changes measured at the micro-scale are indeed representative of the entire LORP; conversely, trends measured at the macro-scale are correlated with and substantiated by micro-scale monitoring. Managers will thereby have a good picture of how the ecosystem is responding through time, and where and what interventions would be most effective.

2.3.2 Geography and Spatial Distribution of Monitoring Efforts

Following are a series of LORP maps that show monitoring locations throughout the project area.

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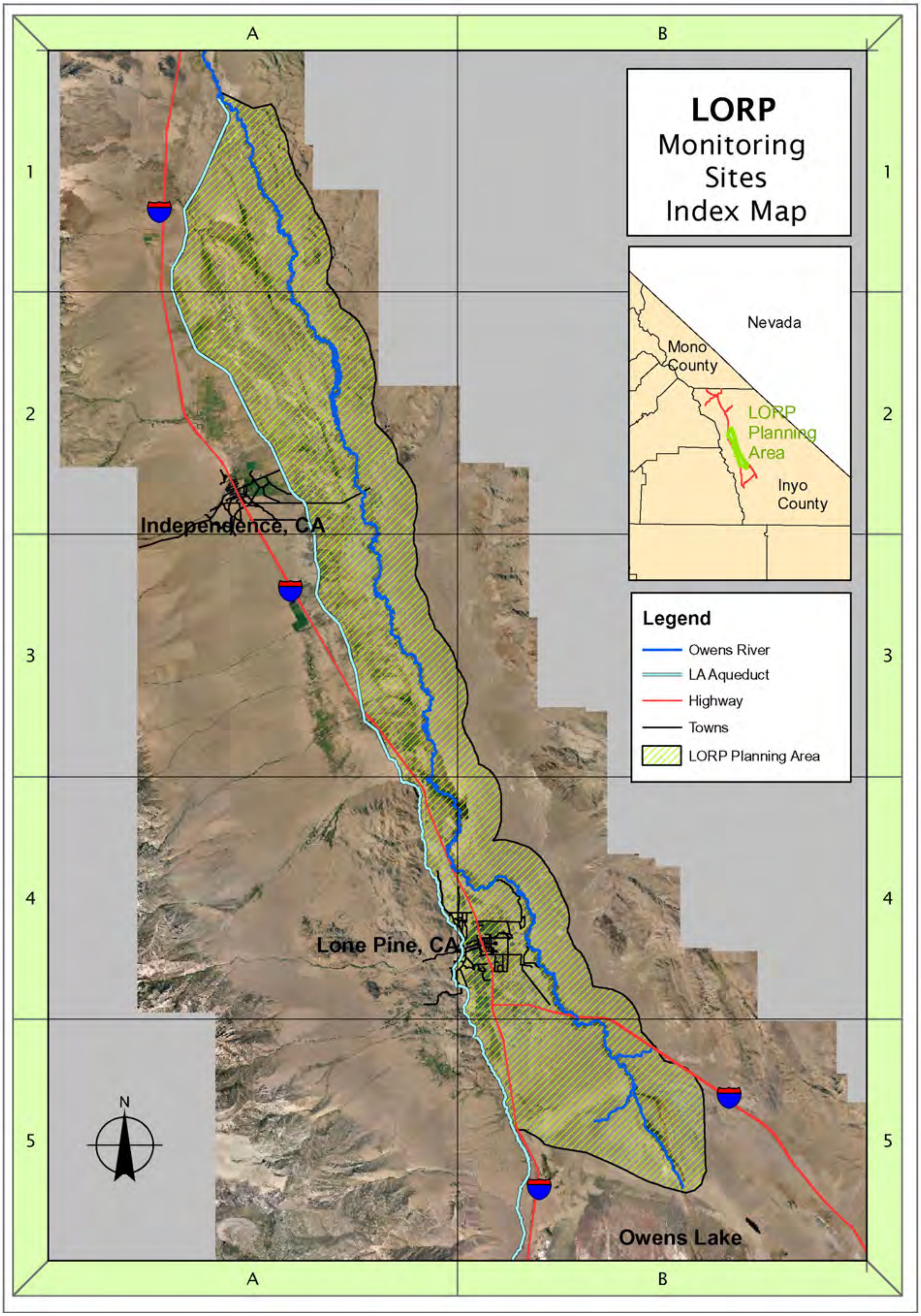
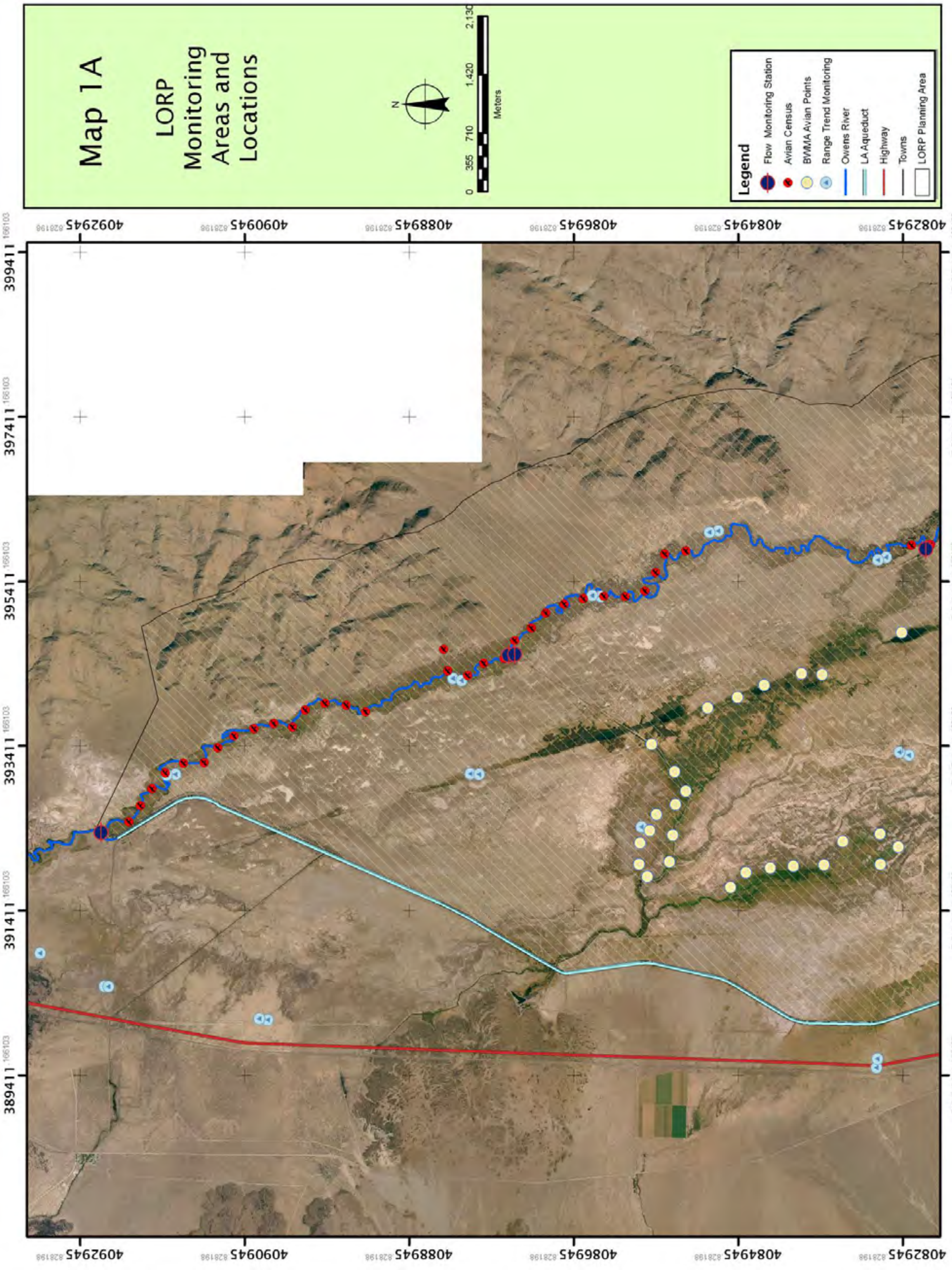
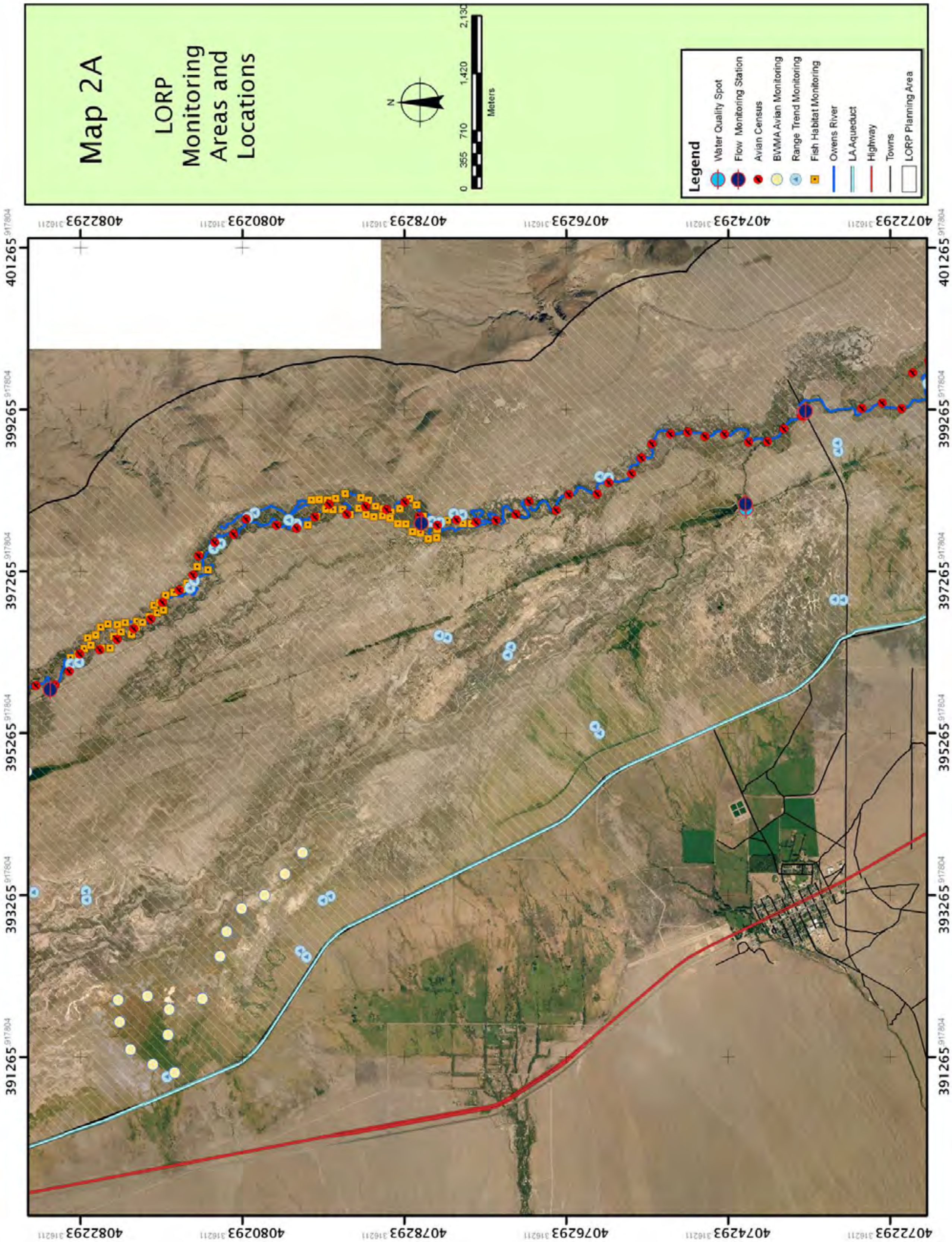
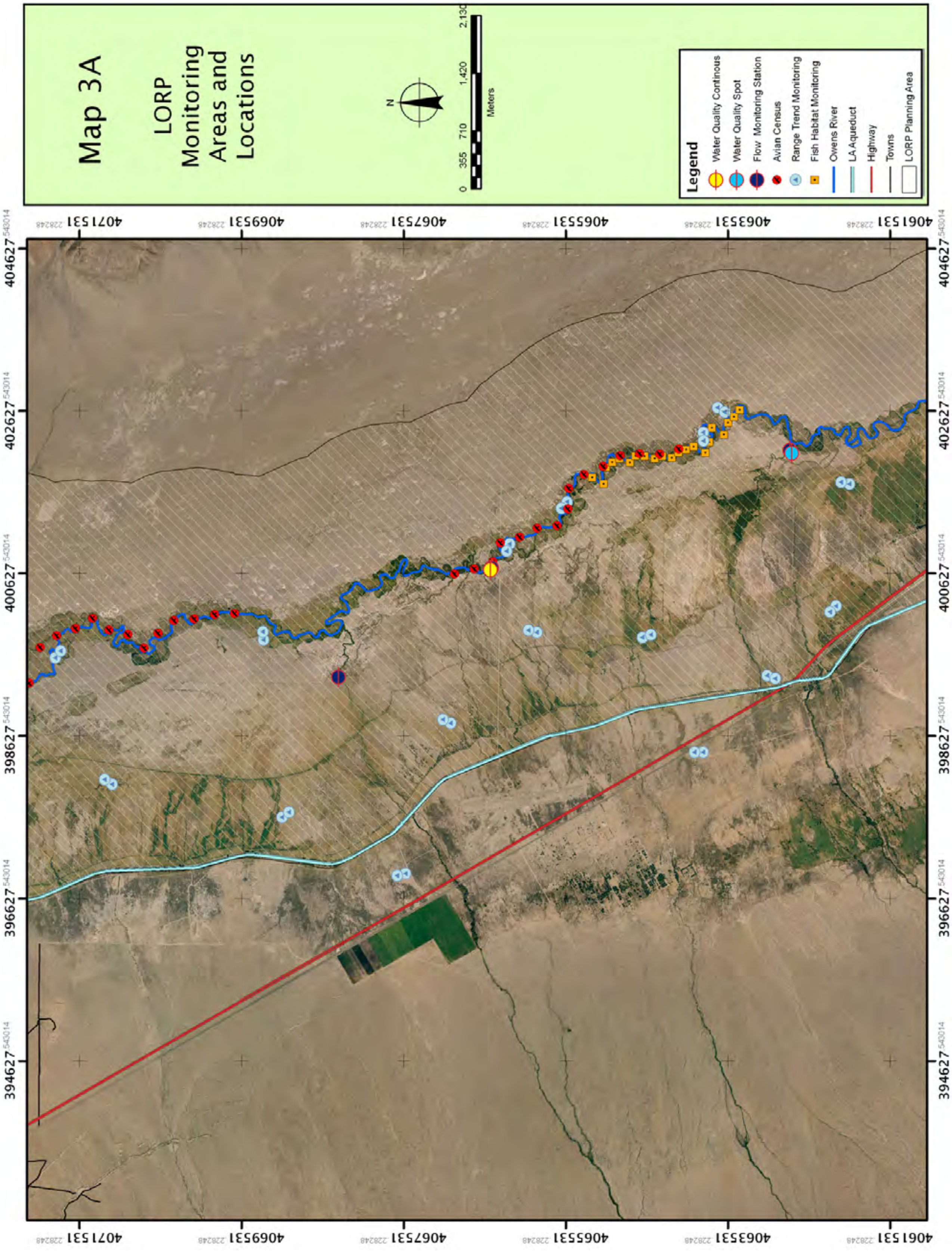
[389] Clewell et al. 2005

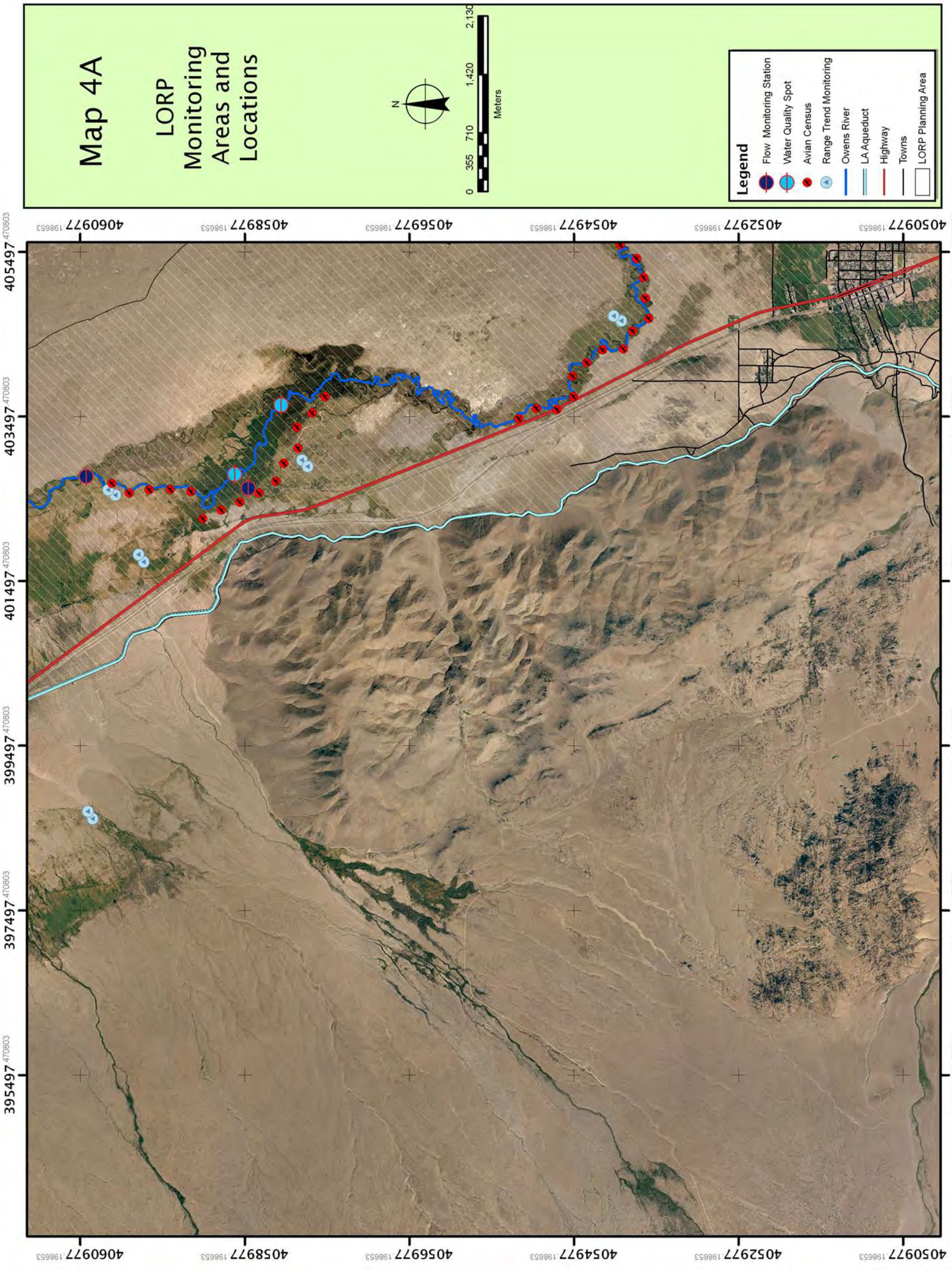
[390] Clewell et al. 2005


A
B
1
2
3
4
5
LORP
Monitoring
Sites
Index Map
Nevada
Mono
County
LORP
Planning
Area
Inyo
County
Legend
Owens River
LA Aqueduct
Highway
Towns
LORP Planning Area
Independence, CA
Lone Pine, CA
Owens Lake
N


Map 1A
LORP Monitoring Areas and Locations
N
0
355
710
1,420
2,130
Meters
Legend
Flow Monitoring Station
Avian Census
BWMA Avian Points
Range Trend Monitoring
Owens River
LA Aqueduct
Highway
Towns
LORP Planning Area
4092945
4090945
4088945
4086945
4084945
4082945
399411
397411
395411
393411
391411
389411


Map 2A
LORP Monitoring Areas and Locations
N
0
355
710
1,420
2,130
Meters
Legend
Water Quality Spot
Flow Monitoring Station
Avian Census
BVMMA Avian Monitoring
Range Trend Monitoring
Fish Habitat Monitoring
Owens River
LA Aqueduct
Highway
Towns
LORP Planning Area
4082293
4080293
4078293
4076293
4074293
4072293
401265
399265
397265
395265
393265
391265


Map 3A
LORP Monitoring Areas and Locations
N
0
355
710
1,420
2,130
Meters
Legend
Water Quality Continous
Water Quality Spot
Flow Monitoring Station
Avian Census
Range Trend Monitoring
Fish Habitat Monitoring
Owens River
LA Aqueduct
Highway
Towns
LORP Planning Area
4071531
4069531
4067531
4065531
4063531
4061531
404627
402627
400627
398627
396627
394627


Map 4A
LORP Monitoring Areas and Locations
N
0
355
710
1,420
2,130
Meters
Legend
Flow Monitoring Station
Water Quality Spot
Avian Census
Range Trend Monitoring
Owens River
LA Aqueduct
Highway
Towns
LORP Planning Area
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4056977
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4052977
4050977
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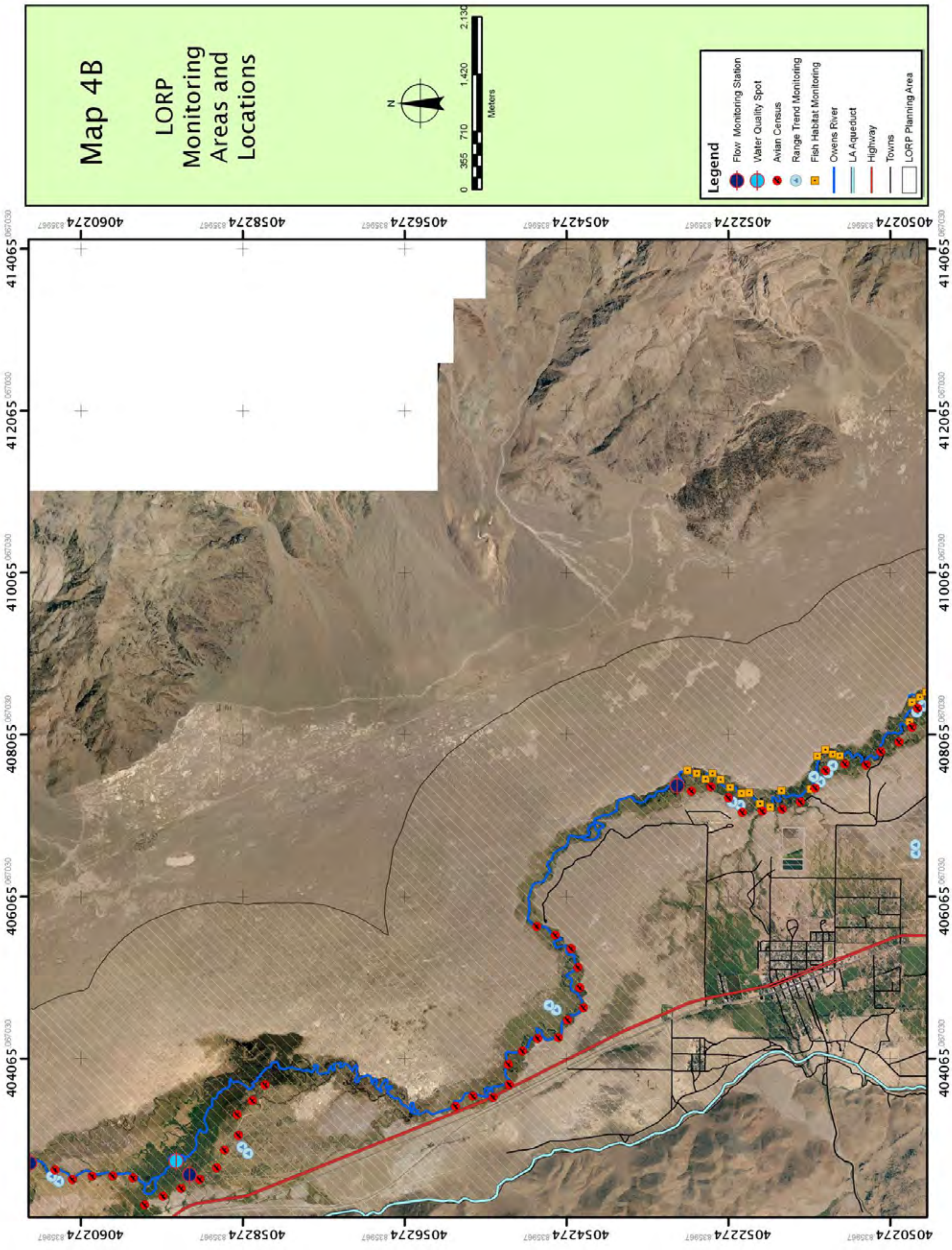
401497
399497
397497
395497


Map 4B
LORP Monitoring Areas and Locations
N
0
355
710
1,420
2,130
Meters
Legend
Flow Monitoring Station
Water Quality Spot
Avian Census
Range Trend Monitoring
Fish Habitat Monitoring
Owens River
LA Aqueduct
Highway
Towns
LORP Planning Area
4060274
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4054274
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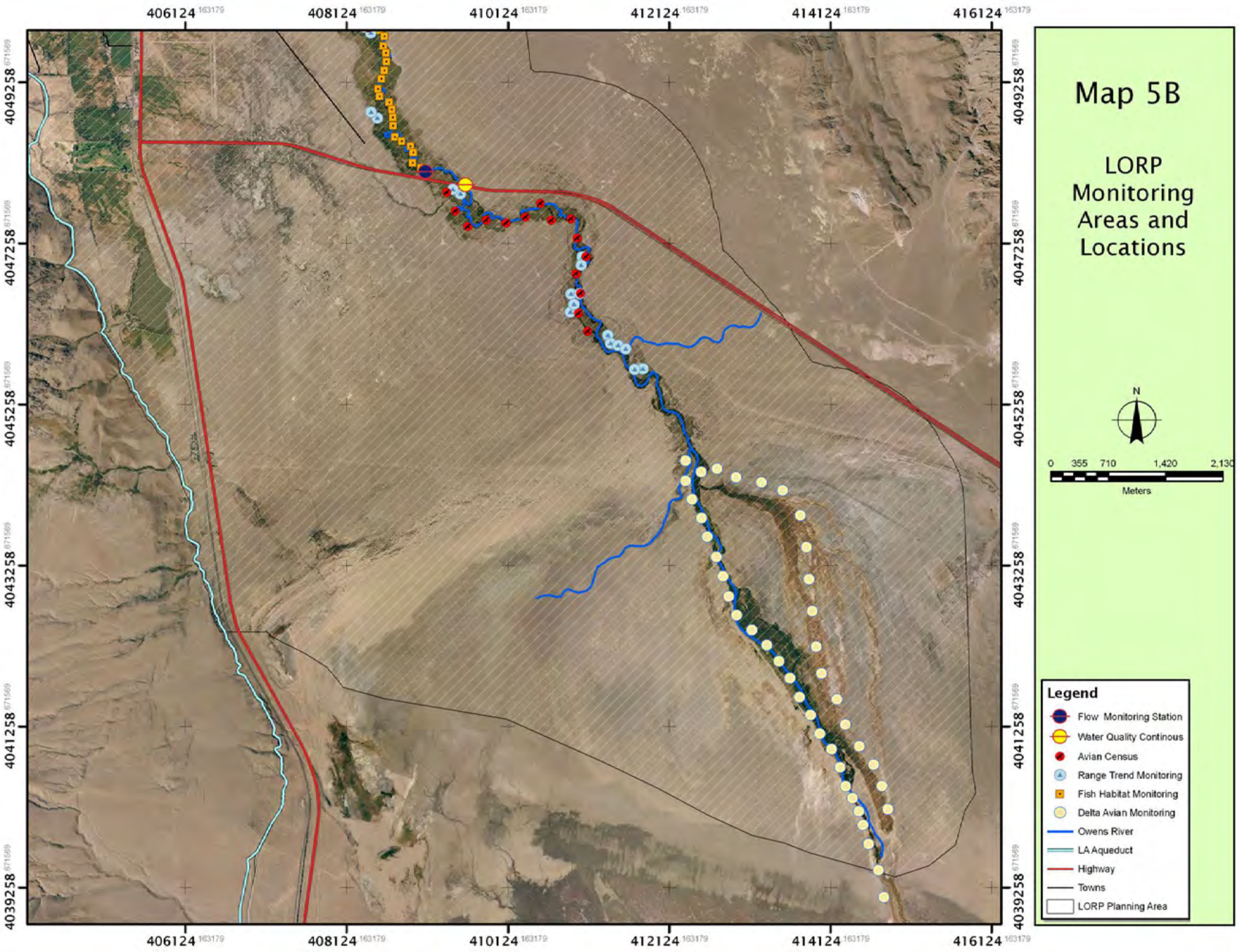
410065
408065
406065
404065


Map 5B
LORP Monitoring Areas and Locations
N
0
355
710
1,420
2,130
Meters
Legend
Flow Monitoring Station
Water Quality Continous
Avian Census
Range Trend Monitoring
Fish Habitat Monitoring
Delta Avian Monitoring
Owens River
LA Aqueduct
Highway
Towns
LORP Planning Area
406124
408124
410124
412124
414124
416124
4049258
4047258
4045258
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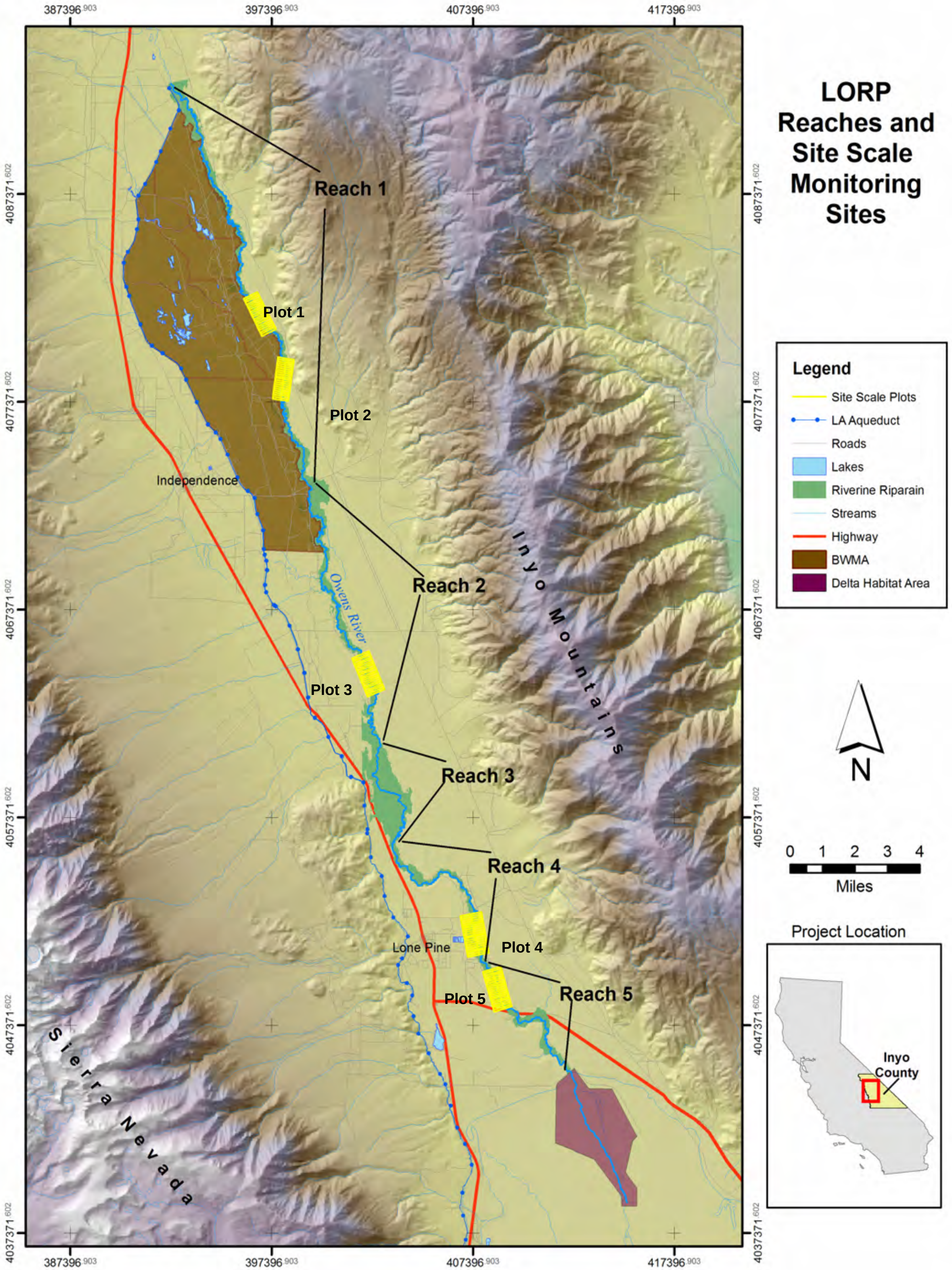
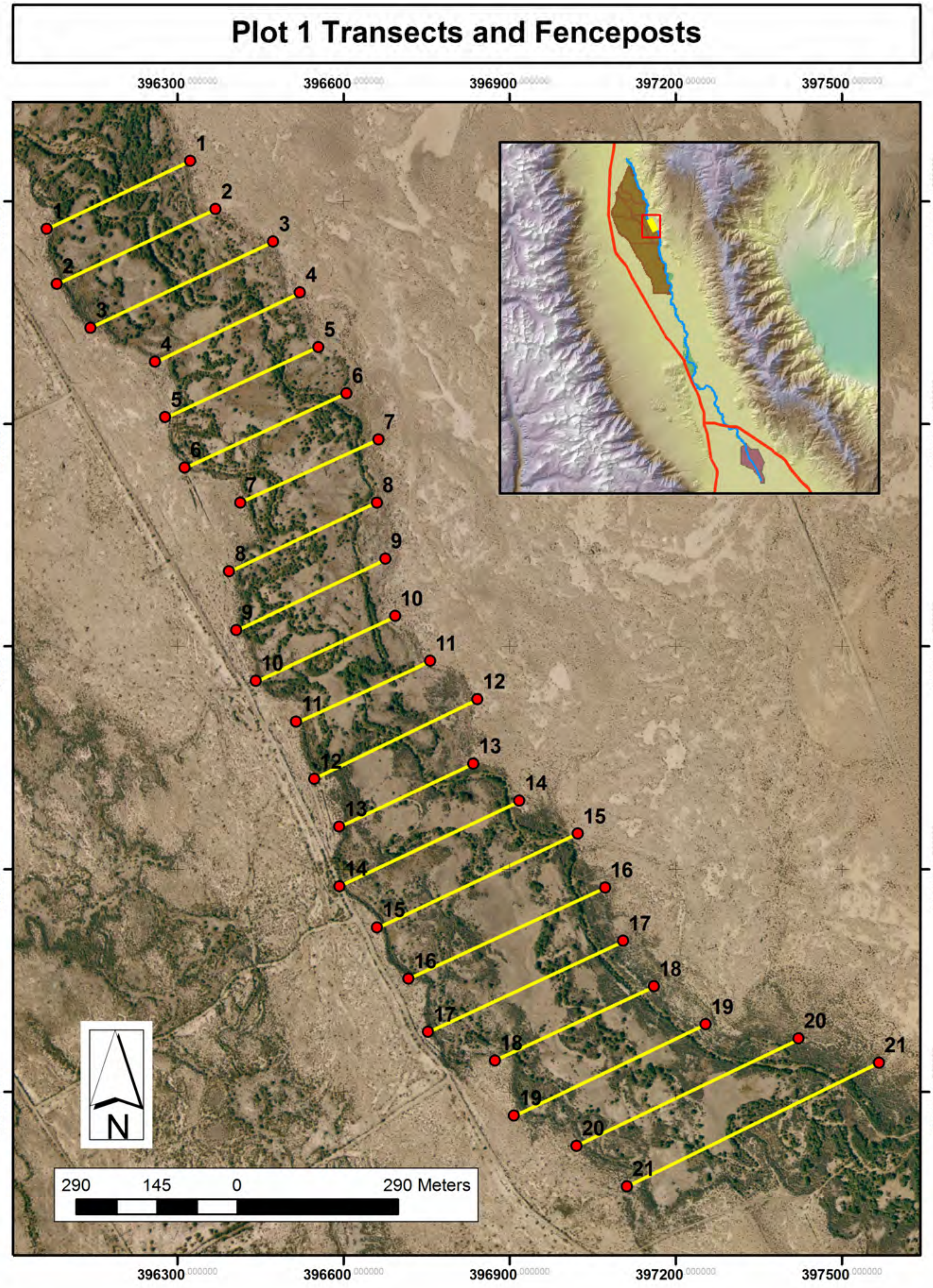
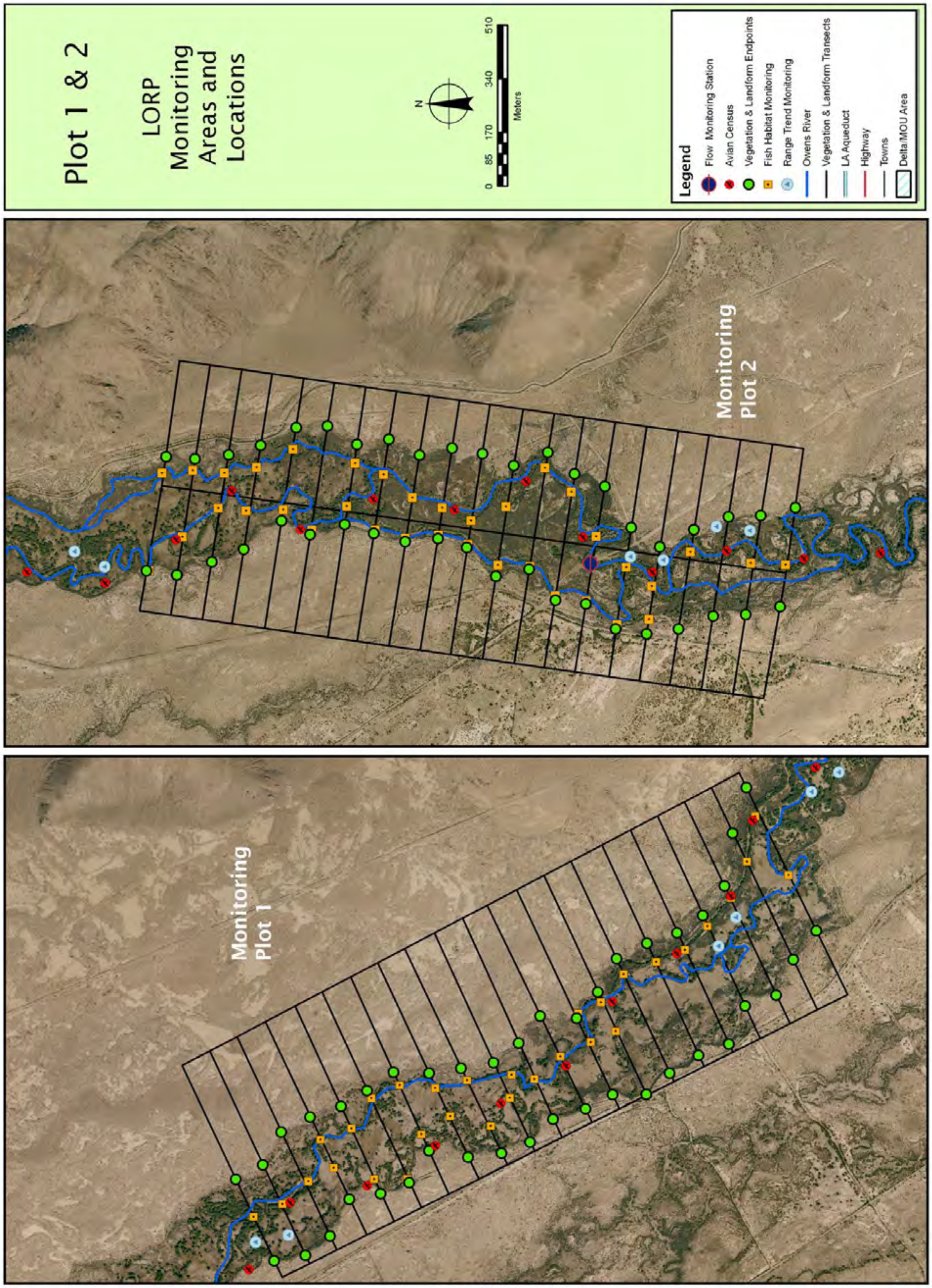
4039258
163179
671569

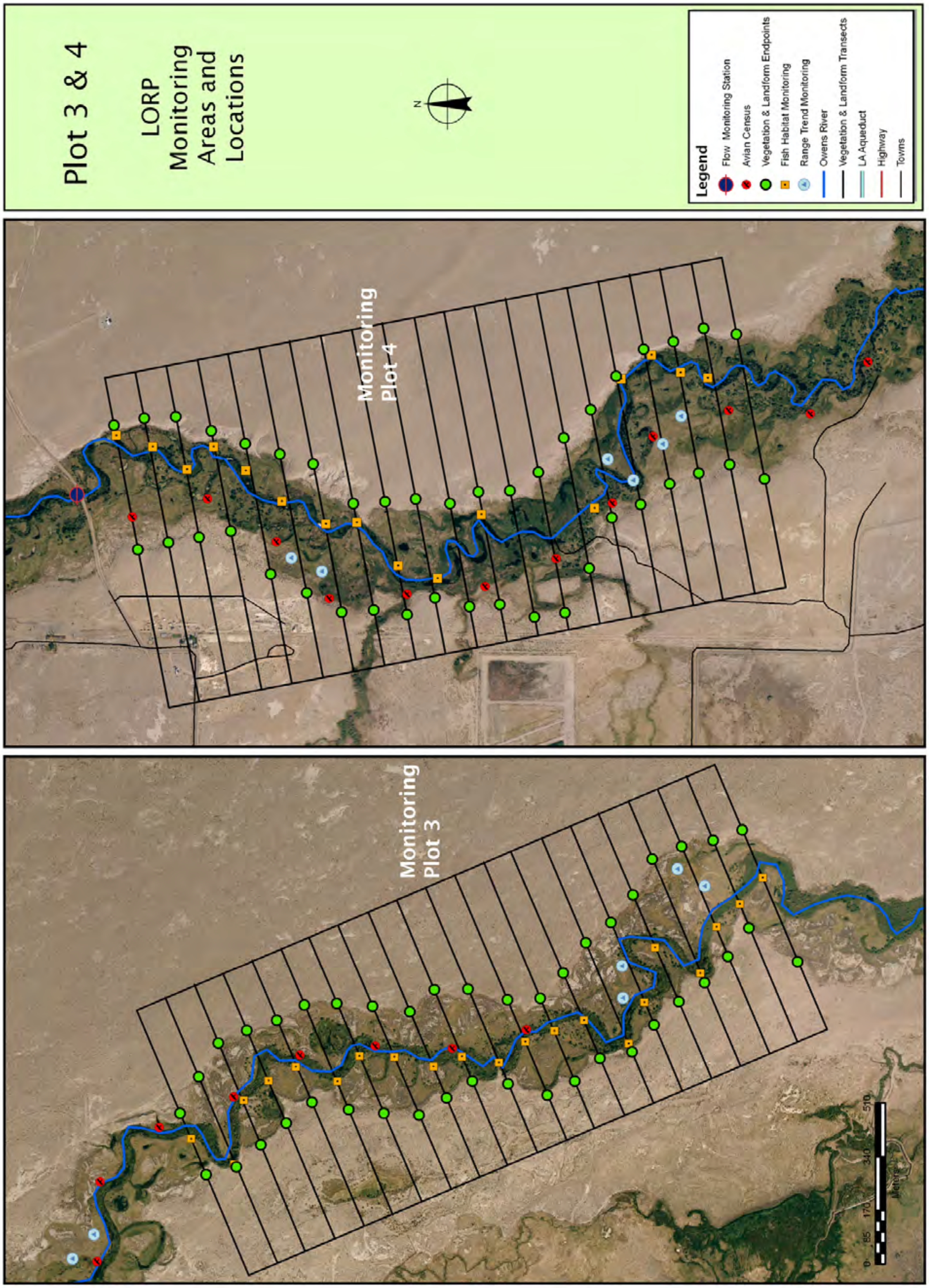


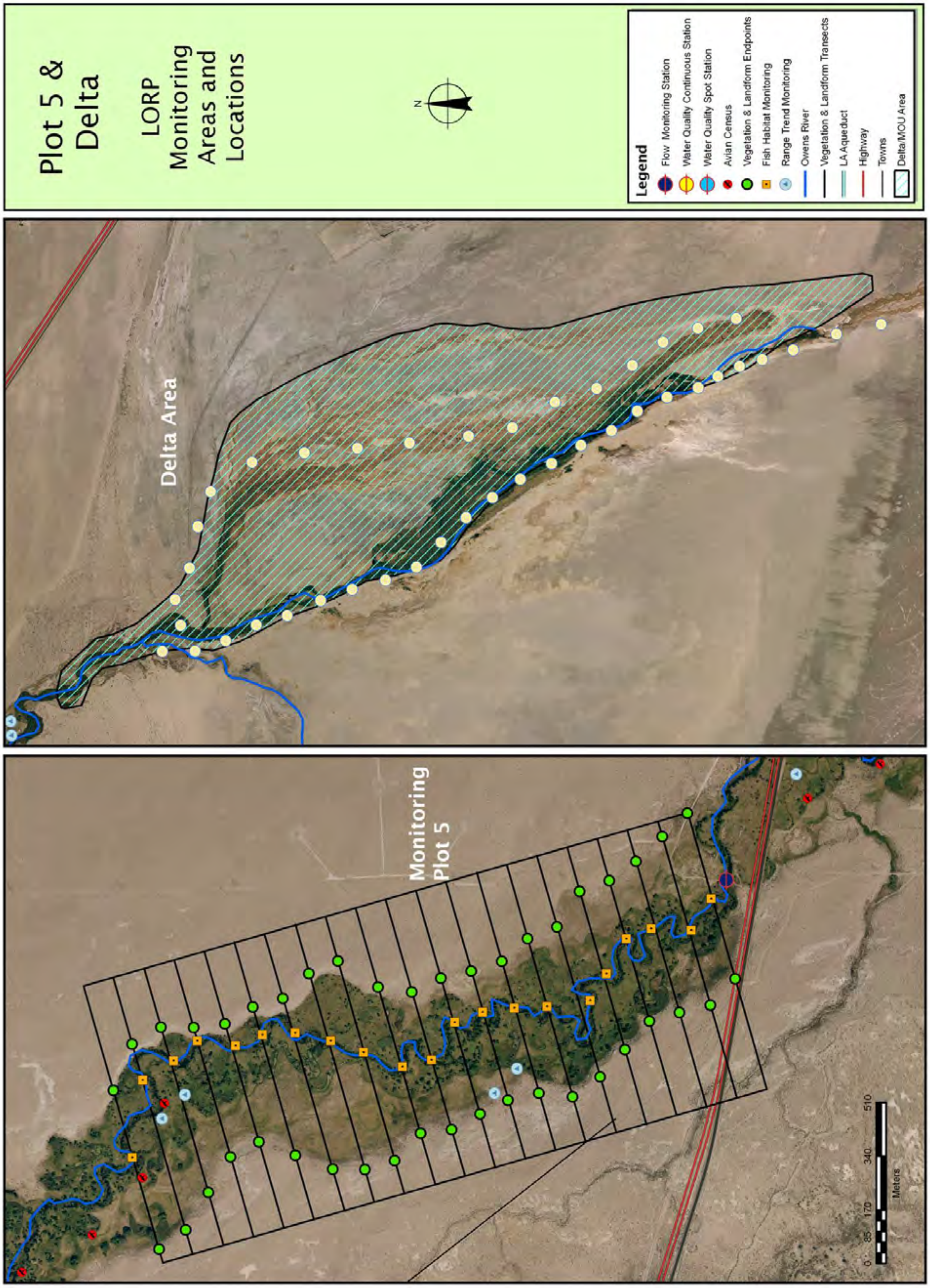
LORP Map with plot locations and river reaches



Example of Transect Layout at Plot 1.


Plot 1 & 2
LORP Monitoring Areas and Locations
N
0
85
170
340
510
Meters
Legend
Flow Monitoring Station
Avian Census
Vegetation & Landform Endpoints
Fish Habitat Monitoring
Range Trend Monitoring
Owens River
Vegetation & Landform Transects
LA Aqueduct
Highway
Towns
Delta/MOU Area
Monitoring Plot 2
Monitoring Plot 1


Plot 3 & 4
LORP Monitoring Areas and Locations
N
Legend
Flow Monitoring Station
Avian Census
Vegetation & Landform Endpoints
Fish Habitat Monitoring
Range Trend Monitoring
Owens River
Vegetation & Landform Transects
LA Aqueduct
Highway
Towns
Monitoring Plot 4
Monitoring Plot 3
0 85 170 340 510
Meters


Plot 5 & Delta
LORP Monitoring Areas and Locations
N
Legend
Flow Monitoring Station
Water Quality Continuous Station
Water Quality Spot Station
Avian Census
Vegetation & Landform Endpoints
Fish Habitat Monitoring
Range Trend Monitoring
Owens River
Vegetation & Landform Transects
LA Aqueduct
Highway
Towns
Delta/MOU Area
Delta Area
Monitoring Plot 5
0
85
170
340
510
Meters

Section 3

Adaptive Management

Lower Owens River in winter, near Lone Pine.

Lower Owens River Project

Monitoring, Adaptive Management and Reporting Plan

April 28, 2008

3.1 Introduction

SECTION
3.0

Adaptive management is widely recognized as an intelligent, if not essential, approach to the management of natural resources under uncertainty.[1] Adaptive management is a common element in many large-scale restoration projects. Adaptive management can be defined as the systematic acquisition and application of reliable information to improve management over time. The MOU defines adaptive management as a method for managing the LORP that provides for modifying project management to ensure the project's successful implementation, and/or the attainment of the project goals, should ongoing data collection and analysis reveal that such modifications are necessary.[2]

Adaptive management is a system in which monitoring measures progress toward goals, increases knowledge and improves management and future plans.[3] Sit and Taylor (1998) define adaptive management as follows:

> *Adaptive management is a systematic process for continually improving management policies and practices by learning from the outcomes of operational programs. Its most effective form – "active" adaptive management – employs management programs that are designed to experimentally compare selected policies or practices, by evaluating alternative hypotheses about the system being managed. The key characteristics of adaptive management include:*
> - *Acknowledgement of uncertainty about what policy or practice is "best" for each particular management issue.*
> - *Thoughtful selection of policies or practices to be applied.*
> - *Careful implementation of a plan of action designed to reveal critical knowledge.*
> - *Monitoring of key response indicators.*
> - *Analysis of the outcome in consideration of the original objectives.*
> - *Incorporation of the results into future decisions.*

An essential idea of adaptive management is to recognize that management policies can be applied as experimental treatments.[4] A crucial implication of this is that monitoring activities must be integrated with management actions to form a single adaptive-management approach.[5]

Adaptive management acknowledges that a complete understanding of ecosystem function does not exist. However, it is designed to support action given the uncertainty associated with limited knowledge and the complexities and stochastic behavior of large ecosystems.[6] Adaptive management aims to decrease this uncertainty over time by informing managers and scientists about ecosystems through management actions and associated monitoring efforts. It aims to create policies that can help organizations, managers and other stakeholders respond to, and even take advantage of,

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[1] Holling 1978, Walters and Holling 1990, Irwin and Wigley 1993, Parma et al. 1998
[2] MOU, Section 1, D
[3] Busch and Trexler 2003
[4] Walters 1997

unanticipated events.[7] Instead of seeking precise predictions of future conditions, adaptive management recognizes the uncertainties associated with forecasting future outcomes and calls for consideration of a range of possible future outcomes.[8]

Fundamental ecological principles show that nature continuously and adaptively responds. Recruitment and adult population patterns are usually mismatched, with recruitment levels often exceeding adult population levels and plant communities developing through several seral stages. Biological conditions at any point in time often do not display or illustrate the unseen biological and social dynamics that create change in the system. Wise management is based upon knowledge and understanding of these dynamics, as well as current conditions, in order to anticipate the dynamics that will determine future biological conditions.

To effectively manage the dynamics of ecosystem restoration, objectives must be adapted over time that cannot be predicted or even adequately anticipated today. Adaptive management is the specified and agreed upon approach for managing the LORP ecosystem in order to reach the desired goals of a healthy and functional ecosystem.

To achieve the goals of the LORP means using management tools over time in unique and flexible ways to adapt to changing ecosystem conditions. It also means adopting new tools and approaches from scientific advances over the course of the restoration process to constantly improve our understanding of ecosystem processes and the effects of management actions.

3.2 Adaptive Management Procedures

The LORP Monitoring, Adaptive Management and Reporting Plan emerges from the constraints and obligations imposed by the MOU, the LORP Ecosystem Management Plan, the FEIR, the Stipulation and Order, as well as fiscal limitations. Within these constraints, however, the plan must also be scientifically sound and provide the necessary data and information from which to intelligently manage the LORP through time. While there are many examples from actual projects and theoretical models, there is no single, perfect monitoring and adaptive management plan that fits all circumstances. All plans must be responsive to specific goals and specific limitations; thus, monitoring and adaptive plans are unique to one degree or another and vary from situation to situation. Nevertheless, there are certain guidelines that are applicable to most plans.

The LORP Monitoring, Adaptive Management and Reporting Plan parallels many of the guidelines described in a USGS document suggested by the CDFG as a useful adaptive management framework[9]. Like the USGS plan, the LORP plan consists of three main monitoring components: implementation (compliance) monitoring, effectiveness monitoring and targeted studies (see Table 3.1).

Implementation (compliance) monitoring tracks the status of plan implementation, ensuring that planned actions are executed. LORP compliance monitoring includes base flow, seasonal habitat flow, water quality, range utilization monitoring, wetland flooding, BWMA flooded extent, Delta flows and habitat area, and off-channel lakes and ponds water surface elevation.

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[5] Wilhere 2001
[6] Holling 1978, National Resource Council (NRC) 2004
[7] Holling 1978, Walters 1986
[8] Walters 1986

[9] Letter from D. Racine, Senior Environmental Scientist, California Department of Fish and Game, IDR. Dated 1/9/08, transmitting a document entitled *Designing Monitoring Programs in an Adaptive Management Context for Regional Multiple Species Conservation Plans.* USGS. 2004. Tech Report, Western Ecol. Res. Ctr., Sacramento, CA.

Effectiveness monitoring evaluates the success of the plan in meeting its stated biological objectives. LORP effectiveness monitoring includes riverine-riparian habitat, riverine flooding extent, rapid assessment surveys, landscape scale vegetation mapping, site scale vegetation mapping, fish habitat survey, fish census, bird surveys, terrestrial habitat, irrigated pasture condition and range trend.

Targeted studies or contingency monitoring are a special subset of effectiveness monitoring. Targeted studies increase the effectiveness of monitoring and management by improving knowledge about the ecological system and about management techniques. Targeted studies may be implemented as short-term studies rather than as long-term monitoring with the intent of resolving critical uncertainties by applying experimental treatments. The monitoring plan includes a pathway for contingency (targeted studies) monitoring in all compliance and implementation monitoring components (see Section 3.6).

As described in the USGS method, monitoring and targeted studies should be designed in an adaptive management context if they are to assist decision making. Adaptive management is an emerging approach to natural resource management that openly acknowledges our uncertainty about how ecological systems function and how they respond to management actions. Under this model, management moves forward in a scientifically-based way that involves monitoring, conducting targeted studies and applying management prescriptions. The results feed back into decision making, reducing uncertainty and improving effectiveness of the program through time.

Some general and specific examples for hypothetical conditions for range conditions or land management are shown in Figures 3.2 and 3.3. These flow charts illustrate how monitoring data is used to analyze conditions, identify problems, make adaptive management recommendations from a range of options, implement the action and then use targeted or contingency monitoring to evaluate response between monitoring years. This is the feedback loop which will essentially be the basis for linking monitoring data with analysis and adaptive management decision-making.

While these charts are hypothetical, they provide insight into how future adaptive management decisions will be made. Given how the monitoring and adaptive management process is linked, this core feedback mechanism will be the template from which all future decisions are determined. While details will vary in time, this feedback mechanism will link monitoring data with results compared to project expectations, what problems are preventing attainment of expectations and the solutions to those problems with adaptive management actions.

3.2.1 Uncertainty

Uncertainty is the key word in the context of monitoring and adaptive management. The LORP was initiated with conceptual models[10] that mathematically summarized ecosystem and community function. Modeling included discharge and scour (HEC-2 and HEC-6); vegetation prediction from the interaction of water regime, geomorphic surfaces and vegetation types; fish habitat (PHABSIM); water quality (QUAL2E), tule development from the interaction of depth, light and velocity; wildlife habitat (HSI); water spreading and channel loss estimates. Conceptual models established the biological "expectations" for the LORP.

As the project proceeds, these models will link objectives (expectations) to causes of change and to adaptive management actions. However, modeling does not eliminate uncertainty in expected outcomes and this is the focus of effectiveness monitoring (described above) in the LORP.

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[10] See Section 2.0, LORP Scientific Background, Studies and Models

Compliance Monitoring	**Monitoring Component**
	Base Flow Monitoring (4.2.1.1)
	Seasonal Habitat Flow Monitoring (4.2.3.1)
	Water Quality Monitoring (4.2.2)
	Flow and Wetland Area Monitoring (4.3.1)
	Delta Flow Monitoring (4.4.1)
	Utilization Monitoring (4.6.2)
Effectiveness Monitoring	**Monitoring Component**
	Seasonal Habitat Flooding Extent (4.2.3.2)
	Rapid Assessment Survey (4.2.5, 4.3.2, 4.4.2)
	Landscape Vegetation Mapping (4.2.7.1, 4.3.4, 4.4.4)
	Site Scale Vegetation Assessment and Landform Elevation Mapping (4.2.7.2)
	Fish Habitat Monitoring (4.2.6.2)
	Habitat Monitoring (4.2.6.1, 4.3.3, 4.4.3)
	Creel Census (4.2.8.2, 4.5.3)
	Avian Census (4.2.8.1)
	Wetland Avian Census (4.3.5, 4.4.5)
	Irrigated Pasture Condition Scoring (4.6.1)
	Range Trend Monitoring (4.6.3)
Contingency Monitoring	Targeted Studies as Needed

TABLE 3.1. Types of monitoring and monitoring components for the LORP.

Because of the uncertainties inherent in predicting ecosystem recovery, monitoring must be robust and sufficiently expansive to capture unpredictable events. LORP monitoring and adaptive management is not research. Ecosystem restoration cannot be evaluated from a limited set of questions for which hypotheses can be assigned and methods employed to test the hypotheses.

As described previously, monitoring is used for evaluating compliance or effectiveness. Compliance monitoring is not performed from a hypothesis statement, but from empirical measurement of an action. Most of the LORP effectiveness monitoring cannot be evaluated through hypothesis testing. Tule control, for example, requires the direct measure of tules where their growth causes a flow problem. A monitoring protocol designed to test a hypothesis about tule growth would be immaterial to the purpose of controlling tules.

The scientific method is a reductionism approach based on controlling variables external to the experiment. Hypothesis testing is not intended as a method to capture unpredictable events. Yet, ecosystem restoration is often driven by unpredictable events. Since uncertainty is the key element in ecosystem recovery, monitoring cannot be based on a rigid experimental design without risk of missing significant changes and events which occur outside the parameters of the hypothesis. Consequently, LORP monitoring methods are not designed to test any particular hypothesis, but to be sufficiently robust to evaluate change and to deal with uncertainty over time.

3.2.2 Thresholds

The USGS monitoring and adaptive management model[11] addresses the idea of thresholds and trigger points.

> "*Management frequently requests a "threshold" or "trigger" point that will trigger a management response if the monitoring variable falls below that level. Such concepts should be used with extreme caution because (1) a great deal of uncertainty exists in establishing appropriate thresholds, (2) managers may assume that no management is required unless this threshold is exceeded, (3) managers may over-react if a threshold is exceeded in times of drought or other natural variation, and (4) managers may be tempted to manage to the threshold, working to maintain abundances at the threshold rather than more biologically-valid goals. Terms such as "confidence limits" or "control limits" are slightly less misleading. However, even if 95% confidence limits for variables are calculated from a baseline data set, the managers must understand that there is nothing "magical" about these numbers. They only tell when current data are different from data collected in the baseline years, not why, or even if this is a concern. These control limits or statistical confidence levels are guides to assist management but do not replace common sense*".

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[11] *Designing Monitoring Programs in an Adaptive Management Context for Regional Multiple Species Conservation Plans.* USGS. 2004. Tech Report, Western Ecol. Res. Ctr., Sacramento, CA.

LORP monitoring and adaptive management will utilize quantative thresholds or triggers for compliance monitoring, but will generally employ descriptive thresholds, i.e., expectations, for effectiveness monitoring.

3.3 Adaptive Management Decision Making

How monitoring will be conducted and adaptive management actions decided upon and implemented is not defined in any detail in the MOU. The MOU alludes to the Standing Committee to determine annual seasonal habitat flows in consultation with the California Department of Fish and Game[12] and simply provides a definition of the Technical Group[13] without any description of its role or responsibility in the LORP.

However, the Stipulation and Order (Section L) and the FEIR (Section 2.10.5) state: "*The Technical Group, Standing Committee and the governing boards of LADWP and the County will make the ultimate decision on implementing adaptive management actions after reviewing the annual report and any other relevant monitoring data.*" The MOU also requires consultation with MOU parties, although such consultation is vaguely defined.

In order to fulfill the obligations of all these mandatory documents, the structure shown in Figure 3.1 will be the decision-making format for LORP monitoring and adaptive management.

A team approach is needed for all phases of monitoring and adaptive management that includes field personnel, lead scientists and, if necessary, outside experts. LADWP, ICWD and the MOU Consultant will be responsible for conducting monitoring, analyzing the data and making recommendations. The first level will be joint staff efforts to collect data under appropriate field supervision for adherence to the protocols and quality control of data. Staff will compile and tabulate the data, forward the data to the MOU Consultant and assist with the preparation and summary of monitoring data.

The Scientific Team will include scientists from the LADWP, scientists from the ICWD and scientists and staff from the MOU Consultant's group. It will be the responsibility of the MOU Consultant to analyze the data between years and baseline conditions and reference sites: to identify problems or conditions which are not meeting goals or expectations; determine if contingency monitoring is needed; determine the most appropriate adaptive management action(s); compile this information and present their conclusions and recommendations to the LADWP and ICWD managers, and oversee the implementation of adaptive management measures. The principle scientists may consult with the CDFG, other agencies or individual experts as needed. This process is further discussed in Section 4.1.

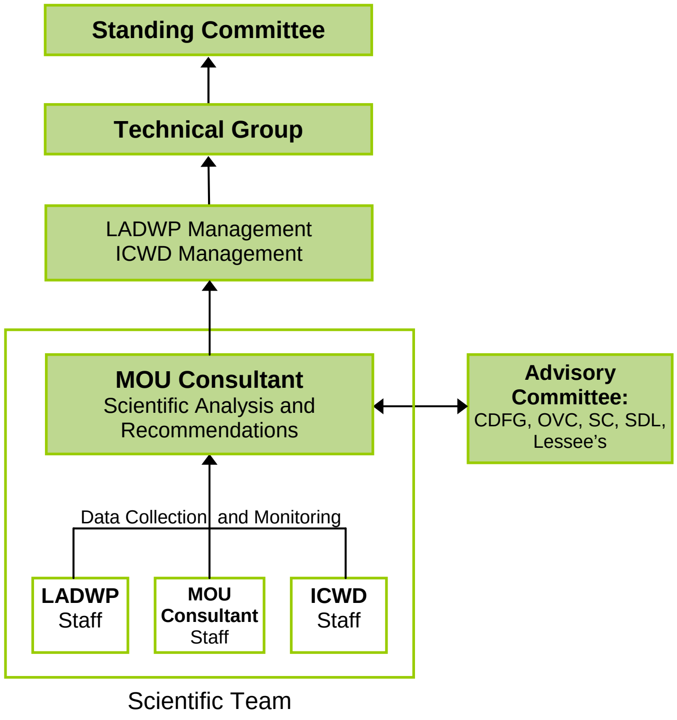

Figure 3.1. Adaptive Management Reporting, Recommending and Decision Making Diagram

The MOU parties will make up an Advisory Committee (individuals with scientific or technical expertise, from each of the MOU

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[12] MOU 1997, Section C part 4, page 17
[13] MOU 1997, Section ID page 5

parties, as appropriate). The Scientific Team will consult with the Advisory Committee at least twice in each monitoring year. The first consultation will occur after the Rapid Assessment Survey to inform the parties and alert them to issues or concerns that will need to be dealt with when making adaptive management decisions. The second consultation will occur once the Scientific Team has drafted its recommendations for adaptive management and compiled monitoring data and analyses.

The Scientific Team will present the reasoning and need for the recommended actions. The Advisory Committee and their consultants can make comments on the recommendations and present their views for the Scientific Team's consideration. After the second consultation, the Scientific Team's recommendations and the summarized data will be forwarded to LADWP and ICWD managers for inclusion in the Annual Report.

The principle scientists will also have overall management and supervisory responsibility for their respective staffs. Prior to each monitoring event, the principle scientists will establish the necessary field teams and assign workloads and schedules. Although each field team will have a supervisor, or task leader, as described in the methods in Section 4, the principle scientists will have overall responsibility as described below.

The USGS model identifies several steps to guide monitoring programs. One of the key steps is completing the adaptive management loop by ensuring effective feedback to decision-making. "*An efficient decision support system that feeds information efficiently back into decision-making requires planning and adjustment as time goes on. Ensuring that the monitoring results appropriately influence management requires consistent effort from an assigned staff, with adequate funding, and a consistent attitude of getting quality information out to be evaluated, peer-reviewed, and into the hands of decision-makers in a timely fashion.*"

The major responsibilities of the principle scientists include the following:

- Manage plan implementation including monitoring, management and targeted studies
- Evaluate implementation of monitoring and management and targeted studies and the quality and scientific rigor of the results and information gained
- Summarize results into formats useful to decision-makers
- Assess how well the program is meeting its objectives; if it is not, then determine why not and what actions should be taken
- Identify emerging issues of concern and appropriate responses
- Revise conceptual models based on new data and make recommendations for changes to management plans and monitoring programs
- Prioritize actions that need to be taken
- Coordinate and integrate external scientific review of the program
- Maintain program momentum/progress.

3.3.1 Reporting

An effective system that reports results from LORP monitoring surveys will be implemented in order to provide for timely adaptive management considerations and responses. The monitoring will be conducted by ICWD, LADWP and MOU Consultant staffs (according to the methods and schedules described under each monitoring method (Section 4). Specific reporting procedures are described in Section 4.0 and under each monitoring method.

The MOU requires that Inyo County and LADWP provide annual reports describing the environmental conditions in the Owens Valley, along with studies, projects and activities conducted under the Inyo-Los Angeles Agreement and the MOU.[14] The LADWP and ICWD will prepare the annual report and include the summarized monitoring data collected, the results of analysis, along with recommendations regarding the need to modify project actions as recommended by the MOU Consultant. Copies of the annual report (to be

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[14] Stipulation and Order (Section L) and the FEIR (Section 2.10.5)

released annually) will be distributed to the other MOU parties (CDFG, California State Lands Commission, Sierra Club, Owens Valley Committee) and made available to the public. Any reports, studies, evaluations and analyses prepared pursuant to the MOU, along with supporting data, will be made available to the public.[15, 16] As draft and final documents and data become available, one copy will be provided to each party; the public will be notified as final documents become available for review and comment.[15]

Other reporting requirements include the publishing of flow data for the public. The LORP reporting requirements are summarized in Table 3.2. Additionally, the *Stipulation and Order* supplementary reporting requirements for flow and hydrologic data are summarized in this table.[16] The entire *Stipulation and Order* is located in Appendix A.7.

3.4 Adaptive Management Measures

Development of LORP monitoring and adaptive management actions has been an iterative process beginning with the 2002 LORP Ecosystem Management Plan. In addition to the constraints and limitations imposed by the MOU, the FEIR, the Stipulation and Order and the LRWCQB 401 Permit, the cost of the long-term monitoring, adaptive management and reporting plan must be reasonable and affordable. Thus, through time, the plan evolved in response to the need to have both a least-cost and a scientifically credible plan.

Adaptive management actions or measures have remained relatively unchanged through the various iterations and permutations of the mandatory documents. The adaptive management measure to modify the magnitude and duration of seasonal habitat flows was a tool originally presented in the LORP Ecosystem Management Plan but was not included in the FEIR or subsequent iterations of the monitoring plan. This is an important adaptive management tool whose implementation will depend upon whether seasonal habitat flows are adequate to meet the predicted habitat and vegetation conditions in the riverine-riparian corridor, especially the lower river channel where flow losses are uncertain.

Type of Report	Frequency	Responsible for Report Preparation	Report Recipients
Annual Report (Summary of data collected for all monitoring tasks, results of analysis, and recommendations regarding the need to modify project actions)	Annually	LADWP & ICWD	▪ Governing boards of LADWP and ICWD ▪ MOU Parties ▪ Interested members of the public
Publishing of real-time flow data on website*	Real-time	Flow Monitoring Task Leader	General public and all parties
Publishing of daily flow data on website*	Daily	Flow Monitoring Task Leader	General public and all parties
Publishing of monthly final archived flow data*	Monthly	Flow Monitoring Task Leader	General public and all parties
Publishing of biweekly Delta outflow data on website*	Biweekly	Flow Monitoring Task Leader	General public and all parties
Hydrologic data for BWMA and Off-River Lakes on website*	To be determined	Flow Monitoring Task Leader	General public and all parties

Table 3.2. Reporting requirements for the LORP

*As directed in the Stipulation and Order, July 11, 2007. See Appendix A.7.

Adaptive management measures can be categorized as (1) compliance requirements to meet water quality or base flow obligations; (2) water management tools such as measures related to modification of seasonal habitat flows; (3) land management tools related to grazing modifications, fencing and utilization; and (4) direct interventions such as plantings, tule control, beaver control, etc. The adaptive management measures are described below and are the tools which will be used to manage the LORP ecosystem through time. Managers today and in the future need to recognize that other adaptive management tools may become necessary.

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[15] MOU 1997, Section III

[16] Sierra Club and Owens Valley Committee vs. City of Los Angeles, et. al. (July 11, 2007). *Stipulation and Order*. Superior Court of the State of California, County of Inyo. Case No. S1CV01-29768.

Simply because the base flows have been codified in the Stipulation and Order does not mean the base flow cannot be modified if all MOU parties agree. For example, the current regime of 40 cfs throughout the river within strictly allowed variations is akin to managing a canal, not a river, and in time, with more knowledge, it may become desirable to redistribute flows seasonally such as 20 cfs for some winter months and 60 cfs for some summer months. Other options may present themselves in time including redistribution of seasonal habitat flows in a more beneficial way. In addition to flows, adaptive management actions other than those listed below may be identified in time. The point is managers need to be amenable to changing or adding adaptive management measures over time.

Adaptive Management Measure:
1. Modify water releases during establishment of base flows

River flows can be augmented with spillgate releases during the initial flow period to prevent or mitigate water quality impacts and to aid in establishing a 40 cfs base flow. Spillgate releases are also a tool for longterm flow management as well as water quality control. Use of spillgate releases will depend upon water quality conditions and the extent of gaining and losing reaches throughout the river to comply with the Stipulation and Order.

Adaptive Management Measure:
2. Modify the timing of seasonal habitat flows

Seasonal habitat flows of up to 200 cfs are intended to promote riparian habitat development. High flows will influence the germination and sprouting of new vegetation; thus, seasonal habitat flows will be released in timing with seed development of existing willow-cottonwood galleries. Seed development will vary from year to year based on ambient temperature and riparian habitat flows will be released at the peak of the annual seed development to maximize seed dispersal and germination. Seasonal habitat flows will also be timed to avoid periods of salt cedar seed drop.[17]

Adaptive Management Measure:
3. Modify the magnitude and/or duration of seasonal habitat flows.

Prediction of vegetation, community and habitat types throughout the riverine-riparian corridor could not account for channel loss uncertainty (e.g., whether lower channel reaches will receive 200 cfs). Monitoring will determine if geomorphic surfaces expected to support riparian vegetation will be inundated and whether vegetation response meets project goals. In the event project goals are not met in lower reaches of the river, augmentation of flows or increased duration of flows will be modified accordingly.

Adaptive Management Measure:
4. Release higher quality water from spillgates during the first three releases of seasonal habitat flows

During the first three releases of the seasonal habitat flow, if necessary, release higher quality water from spillgates. Any such releases from spillgates will continue until (1) the water quality has improved, or (2) the fish are not exhibiting signs of stress.

Adaptive Management Measure:
5. Modify ramping pattern of seasonal habitat flows

Ramping rates and flow duration was originally established using state-of-the-art models from hydroelectric and storage dams. However, scientific research has improved upon those earlier ramping and flow duration models. In the event vegetation and habitat goals are not being met, ramping rates, the peak flow and/or length of time during which seasonal habitat flows are released, can be adjusted using current knowledge.

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[17] Saltcedar (Tamarisk) generally blooms from mid-April to early-November. Seed viability ranges between around 20% in June to around 50% in August (Merkel and Hopkins 1957). Saltcedar seed can germinate over a wide range of constant or alternating temperatures, but has no great advantage over seeds of native woody species in a common riparian environment (Young et al 2004). Native willow and cottonwood seeds have very specific and short seed germination periods (late spring, early summer) and hydrologic requirements that tamarisk seedlings do not have. Native riparian woody species including cottonwood (*Populus deltoides*), Goodings willow (*Salix gooddingii*), and coyote willow (*Salix exigua*) have a rapid growth potential under low environmental stress and are able to competitively exclude saltcedar when seedlings are concurrently established after flooding (Sher et al. 2002).

Adaptive Management Measure:
6. Modify schedules for maintenance and mechanical intervention activities

Construction activities to maintain berms, dikes, roads, or other features throughout the Lower Owens will be scheduled around sensitive periods such as nesting or migration, plant seeding and other factors that would minimize disturbance to the ecosystem and biota by such activities.

Adaptive Management Measure:
7. Plant native vegetation species

The first goal of the project is to encourage natural re-vegetation through land and water management actions. In time, opportunities to encourage vegetation at specific sites through artificial plantings may be identified. Areas disturbed by LORP construction actions such as channel clearing, wetland berms or areas adjacent to the pumpback station will be seeded initially.

Adaptive Management Measure:
8. Conduct exotic plant control activities

One of the primary purposes of the Rapid Assessment Surveys during monitoring is the early detection of invasions of Class A and B noxious weeds[18]. Exotic plants, when few in numbers, are more easily removed and controlled. Exotic plant control may be achieved with removal by hand or with chemical applications. The method of control will depend upon the extent of the problem.

Adaptive Management Measure:
9. Modify tule removal activities

During the initial flow period some tule stands will require breaching to allow flows to pass. This will be achieved with equipment that opens a channel through the stands. In the course of time other areas of dense tule development may require mechanical removal to maintain stream flow. Tule removal will also be performed as necessary to maintain flows into wetlands and off-channel lakes and ponds.

Adaptive Management Measure:
10. Modify beaver and beaver dam control activities

Beaver numbers will be controlled in relation to the stand concentration of willows by trapping (see Table 2.8, Allowable Abundance and Distribution of Beaver by River Reach). Beaver dams will be surveyed annually and new dams or dams that are impacting riparian vegetation development will be removed on an as needed basis.

Adaptive Management Measure:
11. Modify fencing, or addition of new fencing, for riparian and upland pastures

Over 43 miles of new fencing will be built to separate riparian and upland pastures into manageable units. As the project proceeds, additional fencing or moving of fence lines may be necessary to protect sensitive sites or areas of management concern within the riparian and upland pastures. Attainment of utilization rates combined with recruitment of woody riparian vegetation will be the key indicators of where fence changes will be needed.

Adaptive Management Measure:
12. Modify utilization rates and timing within riparian and upland pastures

Specific rates of grazing (utilization) and timing of livestock movement into and out of pastures may be altered to improve recruitment and growth of riparian and upland vegetation. Necessary changes in grazing management will be determined using range utilization, pasture scoring, Rapid Assessment Surveys, habitat assessments and evaluations of range condition.

Adaptive Management Measure:
13. Install grazing exclosures

Several areas within existing pastures will be excluded from further grazing and will serve as control areas for vegetative response. More areas may be excluded from grazing, if necessary, to protect sensitive areas, promote site-specific recovery, or protect threatened and endangered plants.

Adaptive Management Measure:
14. Modify livestock management following wildfire

Wildfires occur sporadically throughout the Lower Owens. Grazing plans for a pasture burned unintentionally may require alteration

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[18] See Table of Noxious Weeds in Appendix A.6

for a period of time to allow the burned pasture to recover. Alterations may include complete rest for a year or more, reduced utilization rate, or change in timing of grazing pattern.

Adaptive Management Measure:
15. Modify the river channel

Flows in the river will be allowed to seek-out and establish a channel without intervention. However, there may be a need to modify the river channel in specific areas to protect property or facilities. One such area is above the Island reach where the channel splits east and west. If too much flow enters the west channel and threatens the highway, the channel may be modified at this juncture to encourage more flow toward the east channel.

Adaptive Management Measure:
16. Modify recreational and human use management

Eco-tourism can result in impacts to the LORP. Recreational activities that result in such impacts as streambank trampling, disturbance during nesting periods, new road cuts and rutting, excessive dust, trash and littering, human waste, target shooting, or user conflicts will be evaluated as the problems arise. Management of recreational activities will be conducted on a case-by-case basis.

Adaptive Management Measure:
17. Modify timing and/or duration of wet/dry cycles in BWMA.

The Blackrock Waterfowl Management Area will be managed through periodic flooding and drawdown to encourage plant diversity and vigor toward meeting the goals of habitat for indicator species. The drying and wetting cycle can be altered as necessary if monitoring indicates shorter or longer cycles are best for management of the wetlands.

Adaptive Management Measure:
18. Use controlled burning

The use of controlled burning in specific areas will be used on a limited basis to improve plant diversity and reduce monocultures.

Adaptive Management Measure:
19. Modify Delta base flow water release in the subsequent years following the first year of project implementation

The average annual flow for the Delta wetlands is 7.13 cfs. In the event this flow is found to be insufficient to maintain the existing acreage of habitat throughout the Delta, the MOU allows for up to 9 cfs average annual flow. Changes in habitat area will be identified in annual mapping, rapid assessment surveys and ground measurements.

Adaptive Management Measure:
20. Modify timing, magnitude and/or duration of Delta pulse flow

The Delta will receive four seasonal pulse flows throughout the year. The timing of flows can be adjusted to meet waterfowl habitat requirements, as well as vegetation growth and vigor. Seasonal pulse flows into the Delta will vary in magnitude. These flows can be adjusted within the limits of the MOU to improve habitat and vegetation conditions. Seasonal pulse flows into the Delta will vary in duration. These flows can be adjusted within the limits of the MOU to improve habitat and vegetation conditions.

Adaptive Management Measure:
21. Berm and/or excavate to direct flow or contain flow in the Delta and BWMA

A minimal amount of construction is planned for the Blackrock Wildfowl Habitat Area to reform berms and dikes. Some excavating may be required to ensure inflow to the management units. Construction activities will be timed to avoid critical nesting or breeding periods. Over time, additional work may be required to maintain wetland berms and dikes or to improve water retention. Pumpback station bypass flows, depending upon their magnitude, can cause inflow to the Delta to jump to either the east or west channel or form new channels in other areas of the wetlands. Some changes in flow through the Delta may be desirable, while other changes may not be. In the event an undesirable flow change occurs, interventions that redirect flows or reset flows into preferred channels with berms or excavation can be examined.

Adaptive Management Measure:
22. Modify water releases to maintain Off-River Lakes and Ponds

A goal of the LORP is to maintain existing off-channel lakes and ponds. This is achieved primarily by maintaining existing water levels. Changes to the inflow to lakes and ponds will be determined from staff gages and habitat mapping of open water areas.

Adaptive Management Measure:
23. Remove critical flow obstructions
Baseflows and seasonal habitat flows will redistribute woody debris throughout the river. Debris jams can occur in time. Other obstructions such as historic rock dams, or extremely dense tule stands may impede flows in the initial years of rewatering. These obstructions will be removed as necessary.

3.5 Adaptive Management by Grazing Lease

In the planning phase for the LORP, the river was segmented into ecological reaches for modeling and mapping purposes. However, adaptive management decisions cannot be made by river reach but must be done lease by lease for the riverine-riparian and adjacent upland areas.

All of the land in the Lower Owens is under some form of lease arrangement with individual grazing management plans for each lease. While one lessee may be doing a good job of grazing management and following prescriptions, an adjacent lessee may not be doing a good job, but both are within the same ecological river reach. An adaptive management action applied to the entire river reach intended to fix a problem caused by the poor performance of one lessee, may punish a good lessee. Consequently, adaptive management will focus on interventions at the lease level, not by river reaches.

There are seven leases within the LORP and within each lease are numerous riparian and adjacent upland pastures. In most cases adaptive management can intervene within a lease at the pasture level. Changes, for example, in utilization, timing, or AUMs within a pasture will have a reverberating effect on adjacent upland pastures; all of which must be taken into account when making adaptive management decisions.

3.6 Analytical Tools

3.6.1 Baseline Data

The monitoring program is based on a pre and post-flow design. The need for adaptive management will be evaluated by comparing conditions before and after flow-implementation. Because restoration efforts of this type, scale and magnitude are rare, there is little information regarding how quickly ecological systems move toward restored conditions. Short-term and long-term management actions will be triggered by either a lack of change in or, in some cases, a decrease in the quality of a monitoring parameter.

Baseline data have been collected using each of the monitoring methods described in Section 4. These data represent the starting point for the project and will serve as the benchmarks from which to assess change.

3.6.2 Reference and Control Sites

Early in the project planning, a Scientific Team searched for appropriate reference sites from below the project to as far north as the Walker River basin. Control sites for uplands, riverine-riparian corridors or wetlands would provide comparative data with which to evaluate trends in the LORP. However, suitable control sites were not found for several reasons. First, land use, primarily grazing, varies considerably throughout the ecoregion and this has an overriding influence of vegetation types, condition and change. Second, as a consequence of elevation there are significant differences in growing season and other factors affecting vegetation and habitat. Third, no other sites in the ecoregion are being “restored” to the extent the LORP is. There were numerous other restrictions related to geologic background, soils, precipitation and other environmental differences.

Although suitable control sites could not be found, the alternative is to use reference sites throughout the project area. Numerous exclosure have been incorporated into the LORP design. These include rare plant exclosures, cattle exclosures and the 850-acre Thibaut Riparian Pasture, which straddles the river and uplands and will exclude grazing for a minimum of 10 years. Exclosures are shown on the lease maps in the appendices and will be monitored, where applicable using the range trend method described in Section 4 (not all exclosures have range trend sites). Monitoring will also include those additional metrics needed for habitat analysis using the CWHR model for indicator species. Most exclosures are free of grazing, recreation and other land use activities that influence restoration trends; thus, exclosures will provide a reference to measure vegetation and habitat changes over time in response to natural variables.

3.6.3 Statistical Analysis

Changes in habitat and other environmental condition over time will be measured with descriptive statistics, displayed with time series plots and the precision summarized by confidence intervals. Baseline data will support evaluation of trends, and reference sites will inform the analysis of trends in the absence of land use activities. Statistical analysis of each monitoring program is described in Section 4 as part of the protocols for each method.

3.7 Adaptive Management Linkages and Feedback Mechanisms

It is impossible to anticipate all potential conditions, events, situations or challenges that will require adaptive management decision-making over the duration of LORP monitoring. The Scientific Team has a responsibility to correctly interpret monitoring data to address problems and decide upon the most appropriate adaptive management intervention. The best this plan, or any plan, can hope for is to provide guidance for current and future scientific teams on how to use the monitoring data to problem solve. The schematics shown in Figures 3.2 and 3.3 illustrate how the scientific team will navigate the monitoring-analysis-decision making pathways that link project goals with monitoring and adaptive management.

In this case (Figures 3.2 and 3.3) two hypothetical examples are considered. One example (Figure 3.2) is a generalized diagram and the other (Figure 3.3) is for range (land management) conditions with hypothetical conditions inserted. The schematics show how monitoring data is used to evaluate:

1. whether the project goals or expectations are being met,
2. comparing the results to expectations,
3. recognizing that a problem exists and why,
4. evaluating the range of adaptive management options that address the problem,
5. recommending the most appropriate actions to solve the problem,
6. consultation on the recommended actions,
7. implementation and additional, contingency monitoring to provide short-term evaluation of the implemented action.

While any future situation will most certainly be different requiring different analysis and adaptive management intervention, this feedback mechanism shown in both schematics (Figures 3.2 and 3.3) will be the template for monitoring and adaptive management linkages and feedback. In other words, the manner in which this plan is designed obligates the Scientific Team to follow this pathway for all analyses of monitoring data and adaptive management decision making.

The charts (3.8 through 3.21) that describe compliance and effectiveness monitoring outline this feedback mechanism in broader terms, but the pathway for linking monitoring data with adaptive management remains the same in all cases.

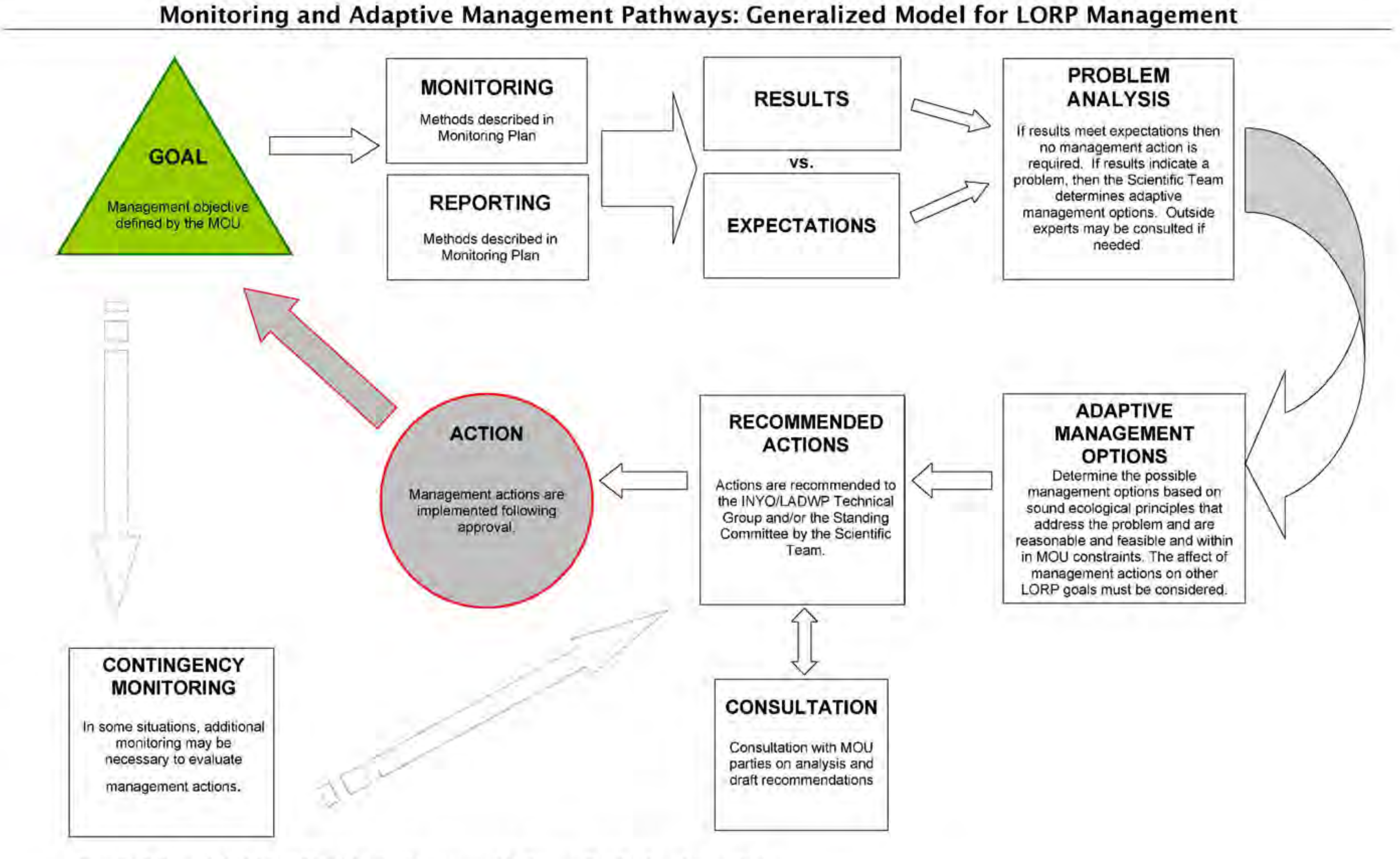
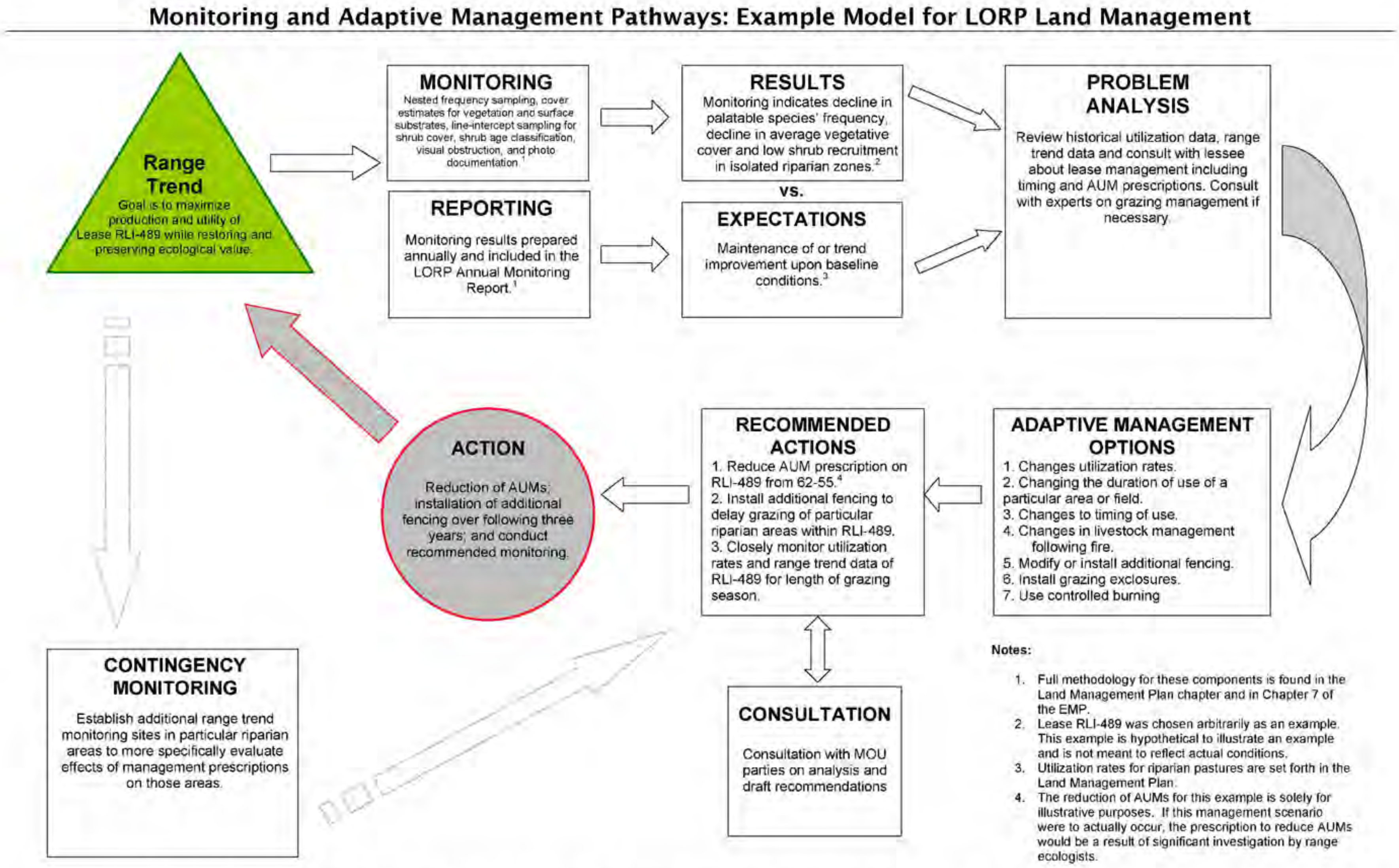


Figure 3.2.General Model for LORP Adaptive Management Pathways, Feedback and Consultation.
This flow chart outlines the general pathways for adaptively managing LORP ecosystem components to meet project goals.



Notes:

1. Full methodology for these components is found in the Land Management Plan chapter and in Chapter 7 of the EMP.
2. Lease RLI-489 was chosen arbitrarily as an example. This example is hypothetical to illustrate an example and is not meant to reflect actual conditions.
3. Utilization rates for riparian pastures are set forth in the Land Management Plan.
4. The reduction of AUMs for this example is solely for illustrative purposes. If this management scenario were to actually occur, the prescription to reduce AUMs would be a result of significant investigation by range ecologists.

Figure 3.3. Example Model of Land Management for LORP Adaptive Management Pathways, Feedback and Consultation.
This flow chart outlines example pathways for adaptively managing LORP ecosystem components to meet project goals.

3.7.1 Adaptive Management Area and Monitoring Components Used during Problem Analysis

Monitoring and adaptive management provide the parameters from which to measure whether or not the MOU goals are being met. The goals established by the MOU must be achieved using monitoring results and analyses to make appropriate adaptive management decisions. Implementation of an adaptive management action must then feedback through monitoring analysis to measure success or failure of the decision, invoking additional contingency monitoring, if necessary.

The following charts for compliance and effectiveness monitoring (3.8 through 3.21) illustrate the feedback mechanisms for using monitoring data to make adaptive management decisions to attain project expectations (thresholds). The text accompanying each chart integrates the mandatory documents with monitoring and adaptive management. These discussions begin with the MOU requirements, summaries of pertinent technical memoranda, the final LORP EIR, Lahontan Regional Water Quality Control Board (LRWQCB) permit requirements and the Stipulation and Order. The deviations or changes that have occurred over time between all these documents are summarized and the superseding project actions, monitoring or management are described. *These charts (3.8 through 3.21) are not all-inclusive and do not describe every possible adaptive management measure that could be employed in the future.* Given the range of possible management responses and conditions that could develop over time, the diagrams provide a detailed, but not all-inclusive adaptive management approach to the LORP.

Table 3.3 illustrates how the various monitoring programs inform adaptive management. The data collected from monitoring in the river, wetlands and uplands will provide the basis for evaluating compliance and effectiveness. The monitoring programs shown in Table 3.3 are described in detail in Section 4. The data from these monitoring programs adequately meet the needs for assessing short-term and long-term trends and adaptively managing flows, water quality, riverine-riparian, wetland, lakes and ponds, upland habitat condition and development and land uses. In addition to being scientifically sound, the monitoring programs are in line with the fiscal constraints and meet the MOU obligations for the LORP.

Adaptive Management Area and Monitoring Components Used during Problem Analysis

1. **Baseflow (3.8)**
   Monitoring Data Used:
   - Base Flow Monitoring (4.2.1.1)
   - Rapid Assessment Survey (4.2.5)

2. **Seasonal Habitat Flows (3.9)**
   Monitoring Data Used:
   - Seasonal Habitat Flow Monitoring (4.2.3.1)
   - Seasonal Habitat Flooding Extent Monitoring (4.2.3.2)
   - Rapid Assessment Survey (4.2.5)
   - Landscape Vegetation Mapping (4.2.7.1)
   - Site Scale Vegetation Assessment and Landform Elevation Mapping (4.2.7.2)
   - Irrigated Pasture Condition Scoring (4.6.1)
   - Utilization Monitoring (4.6.2)
   - Range Trend Monitoring (4.6.3)

3. **Fishery (3.10, 3.11)**
   Monitoring Data Used:
   - Base Flow Monitoring (4.2.1.1)
   - Seasonal Habitat Flow Monitoring (4.2.3.1)
   - Seasonal Habitat Flooding Extent Monitoring (4.2.3.2)
   - Fish Condition Monitoring (4.2.4)
   - Rapid Assessment Survey (4.2.5, 4.3.2, 4.4.2, 4.5.2)
   - Fish Habitat Monitoring (4.2.6.2)
   - Flow and Wetland Area Monitoring (4.3.1, 4.5.1)
   - Creel Census (4.2.8.2, 4.5.3)

4. **Terrestrial Habitat (3.12)**
   Monitoring Data Used:
   - Seasonal Habitat Flooding Extent Monitoring (4.2.3.2)
   - Rapid Assessment Survey (4.2.5, 4.3.2, 4.4.2, 4.5.2)
   - Habitat Monitoring (4.2.6.1, 4.3.3, 4.4.3)
   - Landscape Vegetation Mapping (4.2.7.1, 4.3.4, 4.4.4)
   - Site Scale Vegetation Assessment and Landform Elevation Mapping (4.2.7.2)
   - Avian Census (4.2.8.1)
   - Flow and Wetland Area Monitoring (4.3.1, 4.5.1)
   - Wetland Avian Census (4.3.5, 4.4.5)
   - Irrigated Pasture Condition Scoring (4.6.1)
   - Utilization Monitoring (4.6.2)
   - Range Trend Monitoring (4.6.3)

5. Riverine-Riparian Habitat (3.13)

Monitoring Data Used:

- Base Flow Monitoring (4.2.1.1)
- Seasonal Habitat Flow Monitoring (4.2.3.1)
- Seasonal Habitat Flooding Extent Monitoring (4.2.3.2)
- Rapid Assessment Survey (4.2.5)
- Habitat Monitoring (4.2.6.1)
- Landscape Vegetation Mapping (4.2.7.1)
- Site Scale Vegetation Assessment and Landform Elevation Mapping (4.2.7.2)
- Avian Census (4.2.8.1)
- Utilization Monitoring (4.6.2)
- Range Trend Monitoring (4.6.3)

6. Water Quality (3.14)

Monitoring Data Used:

- Base Flow Monitoring (4.2.1.1)
- Water Quality Monitoring (4.2.2)
- Seasonal Habitat Flow Monitoring (4.2.3.1)
- Rapid Assessment Survey (4.2.5)
- Irrigated Pasture Condition Scoring (4.6.1)
- Utilization Monitoring (4.6.2)
- Range Trend Monitoring (4.6.3)

7. Tule/Cattail Control (3.15)

Monitoring Data Used:

- Base Flow Monitoring (4.2.1.1)
- Seasonal Habitat Flow Monitoring (4.2.3.1)
- Seasonal Habitat Flooding Extent Monitoring (4.2.3.2)
- Rapid Assessment Survey (4.2.5, 4.3.2, 4.4.2, 4.5.2)
- Habitat Monitoring (4.2.6.1, 4.3.3, 4.4.3)
- Landscape Vegetation Mapping (4.2.7.1, 4.3.4, 4.4.4)
- Site Scale Vegetation Assessment and Landform Elevation Mapping (4.2.7.2)

8. Delta Habitat Area (3.16)

Monitoring Data Used:

- Delta Flow Monitoring (4.4.1)
- Rapid Assessment Survey (4.4.2)
- Habitat Monitoring (4.4.3)
- Landscape Vegetation Mapping (4.4.4)
- Wetland Avian Census (4.4.5)
- Utilization Monitoring (4.6.2)
- Range Trend Monitoring (4.6.3)

9. Exotic/Invasive Plants (3.17)

Monitoring Data Used:

- Seasonal Habitat Flow Monitoring (4.2.3.1)
- Seasonal Habitat Flooding Extent Monitoring (4.2.3.2)
- Habitat Monitoring (4.2.6.1, 4.3.3, 4.4.3)
- Rapid Assessment Survey (4.2.5, 4.3.2, 4.4.2, 4.5.2)
- Landscape Vegetation Mapping (4.2.7.1, 4.3.4, 4.4.4)
- Site Scale Vegetation Assessment and Landform Elevation Mapping (4.2.7.2)
- Flow and Wetland Area Monitoring (4.3.1, 4.5.1)
- Utilization Monitoring (4.6.2)
- Range Trend Monitoring (4.6.3)

10. BWMA Wetlands (3.18)

Monitoring Data Used:

- Flow and Wetland Area Monitoring (4.3.1)
- Rapid Assessment Survey (4.3.2)
- Habitat Monitoring (4.3.3)
- Landscape Vegetation Mapping (4.3.4)
- Avian Census (4.2.8.1)
- Utilization Monitoring (4.6.2)
- Range Trend Monitoring (4.6.3)

11. Range Condition (3.19)

Monitoring Data Used:

- Seasonal Habitat Flow Monitoring (4.2.3.1)
- Seasonal Habitat Flooding Extent Monitoring (4.2.3.2)
- Habitat Monitoring (4.2.6.1, 4.3.3, 4.4.3)
- Landscape Vegetation Mapping (4.2.7.1, 4.3.4, 4.4.4)
- Site Scale Vegetation Assessment and Landform Elevation Mapping (4.2.7.2)
- Avian Census (4.2.8.1)
- Irrigated Pasture Condition Scoring (4.6.1)
- Utilization Monitoring (4.6.2)
- Range Trend Monitoring (4.6.3)
- Rapid Assessment Survey (4.2.5, 4.3.2, 4.4.2, 4.5.2)

12. Lakes and Ponds (3.20)

Monitoring Data Used:

- Flow and Wetland Area Monitoring (4.5.1)
- Rapid Assessment Survey (4.5.2)
- Creel Census (4.5.3)

13. Recreation (3.21)

Monitoring Data Used:

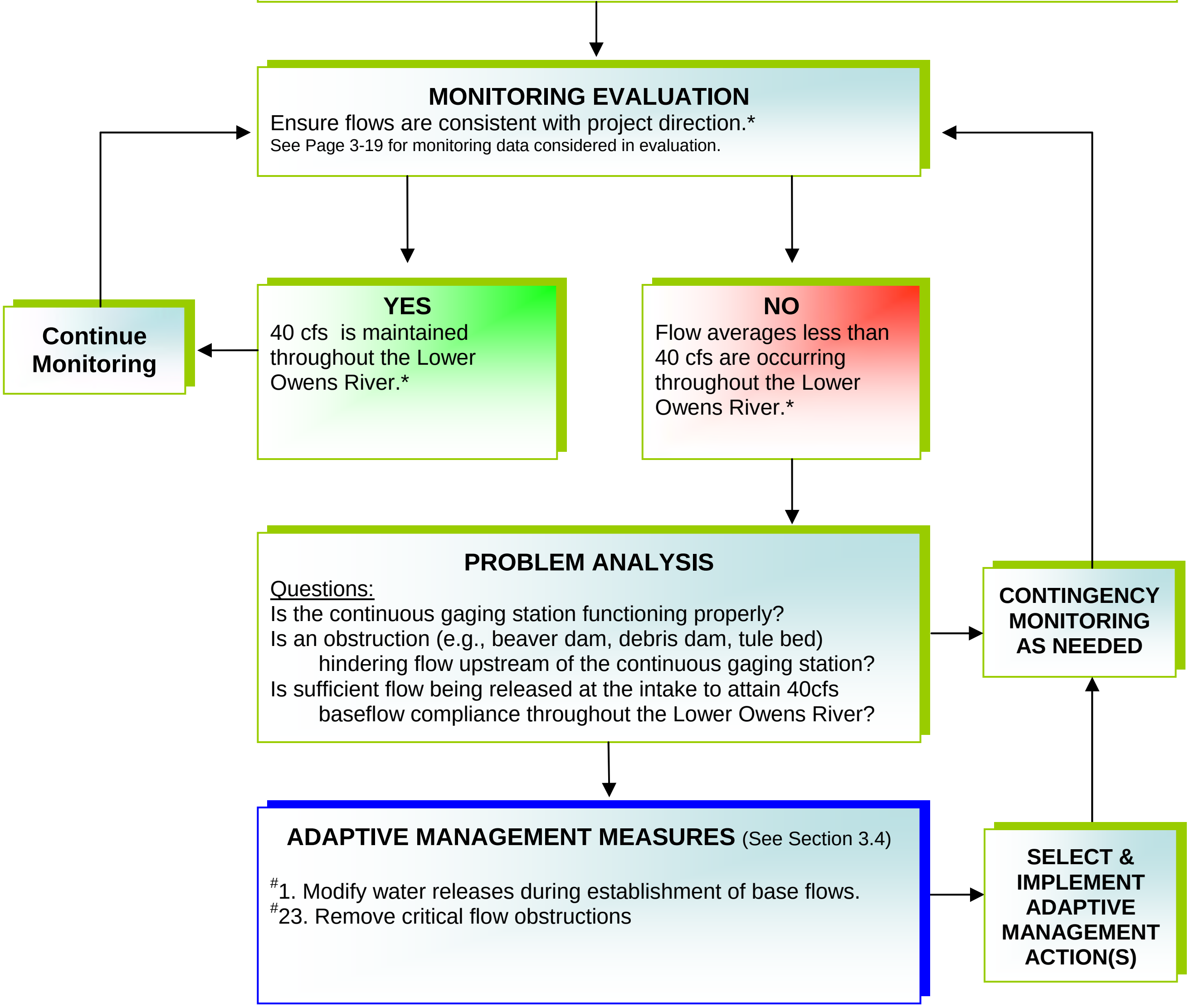
- Rapid Assessment Survey (4.2.5, 4.3.2, 4.4.2, 4.5.2)
- Landscape Vegetation Mapping (4.2.7.1, 4.3.4, 4.4.4)
- Site Scale Vegetation Assessment and Landform Elevation Mapping (4.2.7.2)
- Irrigated Pasture Condition Scoring (4.6.1)
- Utilization Monitoring (4.6.2)
- Range Trend Monitoring (4.6.3)

	Monitoring Data (Section 4.0) used to inform Adaptive Management during Problem Analysis																
Adaptive Management Area Section 3.0	**Baseflow** (Section 4.2.1)	**Seasonal Habitat Flow** (Section 4.2.3.1)	**Water Quality Sampling** (Section 4.2.2)	**Flow and Wetland Area** (Section 4.2.3.2, 4.3.1, 4.5.1)	**Delta Flow** (Section 4.4.1)	**Flow and Wetland Area** (Section 4.5.1)	**Flooding Extent** (Section 4.2.3.2)	**Habitat Assessments** (Section 4.2.6.1, 4.3.3, 4.4.3)	**Rapid Assess. Survey** (Sec. 4.2.5, 4.3.2, 4.4.2, 4.5.2)	**Landscape Scale Vegetation Mapping** (Section 4.2.7.1, 4.3.4, 4.4.4)	**Site Scale Mapping** (Section 4.2.7.2)	**Fish Habitat Survey** (Section 4.2.6.2)	**Creel Census** (Section 4.5.3)	**Avian Census** (Section 4.2.8.1)	**Utilization** (Section 4.6.2)	**Irr. Pasture Condition** (Section 4.6.1)	**Range Trend** (Section 4.6.3)
Base Flow (Section 3.8)	■								■								
Seasonal Habitat Flow (Section 3.9)		■					■		■	■	■				■	■	■
Fishery (Section 3.10, 3.11)	■	■	■	■		■	■	■	■			■	■				
Terrestrial Habitat (Indicator Species) (Section 3.12)				■			■	■	■	■	■			■	■	■	■
Riverine-Riparian Habitat (Section 3.13)	■	■		■			■	■	■	■	■			■	■		■
Water Quality (Section 3.14)	■	■	■						■						■	■	■
Tule Control (Section 3.15)	■	■					■	■	■	■	■						
Delta Habitat Area (Section 3.16)		■		■	■			■	■	■				■	■		■
Exotic/Invasive Plants (Section 3.17)	■	■		■			■	■	■	■	■				■		■
BWMA Wetlands (Section 3.18)				■				■	■	■				■	■		■
Range Condition (Section 3.19)	■	■					■	■	■	■	■			■	■	■	■
Lakes and Ponds (Section 3.20)				■		■		■	■				■				
Recreation (Section 3.21)									■	■	■				■	■	■

TABLE 3.3. Matrix relating LORP adaptive management areas to monitoring data utilized as information basis.

3.8 Base Flow

Compliance Monitoring



OBJECTIVE

A base flow of 40 cfs is occurring throughout the Lower Owens River from the LAA Intake to the Pumpback Station.*

MONITORING EVALUATION

Ensure flows are consistent with project direction.*

See Page 3-19 for monitoring data considered in evaluation.

YES

40 cfs is maintained throughout the Lower Owens River.*

Continue Monitoring

NO

Flow averages less than 40 cfs are occurring throughout the Lower Owens River.*

PROBLEM ANALYSIS

Questions:

Is the continuous gaging station functioning properly?

Is an obstruction (e.g., beaver dam, debris dam, tule bed) hindering flow upstream of the continuous gaging station?

Is sufficient flow being released at the intake to attain 40cfs baseflow compliance throughout the Lower Owens River?

CONTINGENCY MONITORING AS NEEDED

ADAPTIVE MANAGEMENT MEASURES (See Section 3.4)

#1. Modify water releases during establishment of base flows.

#23. Remove critical flow obstructions

SELECT & IMPLEMENT ADAPTIVE MANAGEMENT ACTION(S)

*** Baseflow Compliance** as directed by the *Stipulation and Order* July 11, 2007 (See Appendix A.7)

Baseflows shall be deemed in compliance with this Stipulation and Order as long as each of the following conditions in the Lower Owens River exists:

1. A minimum flow of 40 cfs is released from the Intake at all times;
2. None of the 10 in-river flow measuring stations has a 15 day running average of less than 35 cfs;
3. The mean daily flow at each of the 10 in-river flow measuring stations must be equal or exceed 40 cfs on at least 3 individual days per any continuous 15 day period, except that this requirement shall not apply to the following measuring stations at Reinhackle Springs and Lone Pine Narrow Gage Road between November 1 and April 30 of each runoff year;
4. The 15-day running average of the 10 in-river flow measuring stations is no less than 40 cfs.

3.8 Base Flow

Reintroducing and maintaining base flows in the Lower Owens River will enhance native and game fisheries and riparian habitats along 53.3 miles of the Lower Owens River.

Base Flow Evaluation:
Data Used for Compliance Monitoring

Ensure flows are consistent with project direction. Evaluated by:

- Base Flow Monitoring (4.2.1.1)
- Rapid Assessment Survey (4.2.5)

Project Expectations

Manage the Lower Owens River base flow in accordance with the Stipulation and Order. Flow releases are anticipated to increase the total area of riverine-riparian and wetland habitat areas, increase the size and connectivity of the individual habitat areas, and increase the structural complexity, productivity and diversity of vegetation communities within individual habitat areas.[19]

Feedback Mechanism for
Monitoring and Adaptive Management

Monitor base flows in the Lower Owens River using data collected continuously from automated stream gages. Calculate the mean daily flow, the 15-day running average and daily averages to determine if a continuous flow of 40 cfs is occurring from the Intake to the pumpback station. These data collection protocols are described in Section E of the Stipulation and Order (include in Appendices of this document) and in Section 4 of this monitoring plan. If the base flow requirements are not met, the adaptive management measures include increasing the release rates from the river Intake and/or from spillgates to increase flow in the river to approximately 40 cfs and removing critical flow obstructions.

3.8.1 Document Integration and Direction

MOU

The MOU provides direction for establishing and maintaining base flows in the riverine-riparian area. It designates a base flow of 40 cfs for the river. The MOU requires that a continuous flow of approximately 40 cfs be established and maintained year-round in the river channel from or near the LAA Intake to the pumpback station.

Attachment A of the MOU, the LORP Ecosystem Management Plan Action Plan and Concept Document, reiterates this goal for base flows, stating "the goal of an ecologically healthy Lower Owens River watershed is dependent upon rewatering the channel from the intake to the pumpback station with a multiple flow regime with a base flow of approximately 40 cfs…".[20] It states that monitoring of base flows will be conducted using "…appropriately placed gaging stations in sufficient numbers (to include at least 4 permanent stations) to measure and manage the flow in the river channel…These stations will be sited so that flow can be managed in each of the hydrologically varying sections of the river channel in order to meet the goals and objectives of the LORP."

The MOU states that "Monitoring sites and water flow gaging stations will be identified and a program for data collection, analysis and reporting (which will identify pathways to allow feedback to indicate where adaptive modifications to management are necessary) will be described as part of this plan. Should the reported information reveal that adaptive modifications to the LORP management are necessary to ensure the successful implementation of the project, or the attainment of the LORP goals, such adaptive modifications will be made."[21]

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[19] LORP FEIR, pg. 2-73

[20] MOU, 1997. Attachment A, pg. 3

[21] MOU, 1997. Section II, E

Technical Memorandum #1

Technical Memorandum #1, *Hydrologic Plan for Implementing Initial Maximum and Minimum River Flows* outlines the plan for the initial delivery of water to the Lower Owens River based on results from the controlled flow study described above.[22] It states that "the goal of providing year-around minimum (base) flow to the river is to achieve as close to 40 cfs as possible in all reaches of the river" and "though it is not possible to achieve exactly 40 cfs at all points in the river, it is possible to meet the minimum flow throughout the river with a reasonable amount of variability in time once bank storage and groundwater aquifers are filled in each reach. The initial goal of water delivery must, therefore, be to fill aquifers in losing reaches and adjust discharge as necessary once a predictable minimum flow equilibrium or steady-state condition is attained." By the third year of flow releases, "the focus will be on attaining approximately 40 cfs minimum flow by adjusting the delivery system as needed. This may entail discharge from some spill gates to augment flows in different river reaches."

Adaptive management using stream gage monitoring results will determine the final minimum flow delivery system. For worst-case minimum flow conditions: Adaptive management based on monitoring of river discharge will allow changes in augmentation flow volumes and release points as the river reaches steady-state conditions, but initial efforts will be to allow flows to reach equilibrium and then determine the need for augmentation flows in specific reaches.

Technical Memorandum #11

Technical Memo #11, *Critical Path for Flow Management during the Initial Years*, describes how flows should be ramped and manipulated to meet LORP goals and prevent adverse impacts on key environmental conditions during the first two or three years of flow reintroduction. The goal for the "initial years" is to reach a base flow equilibrium as early as possible. Data gathered through intensive monitoring of initial flows will inform the ramping schedule needed to minimize risk and to protect critical natural resources.

LORP Ecosystem Management Plan

Chapter 2 of the Ecosystem Management Plan, the River Management Plan, contains management objectives for water delivery, which include: (1) recharging aquifers and bank storage, (2) achieving as close as possible to 40 cfs in all river reaches while also protecting water quality and aquatic biota, and (3) maintaining a 40 cfs base flow, or as close as possible, within all river reaches. The plan describes the phases, planned schedules and actions associated with creating and maintaining base flows. Base flows are monitored using data collected from permanent gaging stations.

Following the Phase I and Phase II flow releases and the initial seasonal habitat flow, management will be based on maintaining a 40 cfs base flow, or as close as possible, within all river reaches and annual seasonal habitat flows up to 200 cfs. In the event of natural flow losses (average of 1 cfs/mile), flows will be adjusted with augmentation from spillgates and returns (i.e., Blackrock Ditch, Goose Lake return, Billy Lake return, Locust Spill Gate, Georges Spill Gate and Alabama Gates) to maintain as close to the base flow conditions of 40 cfs as possible throughout the river (pg. 8). Temporary gaging stations will be removed once flow losses are accounted for and a minimum of four permanent gaging stations will be established in the river for continuous monitoring of stream flow.

Final EIR

The Final EIR, like the MOU and LORP Action Plan, states the "overall objective of rewatering the river is to restore aquatic and riparian habitats of the river from the River Intake to the proposed pumpback station, located at the upper end of the Owens River Delta. To achieve this, the FEIR proposes a continuous flow of approximately 40 cfs be established and maintained in the river

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[22] see Appendix 1 of MOU

channel from the River Intake to the LORP pumpback station near the Owens River Delta.

The FEIR states that “Initially, the base flow of 40 cfs will be verified by measurements at the temporary stream gages described in Section 2.3.5.2 (of the FEIR). Once the base flow has been established, the 40-cfs base flow will be verified at a minimum of four permanent stream gages located along the river, as specified in the MOU. The permanent gauging sites will be established before monitoring at the temporary monitoring sites is discontinued” (pg. 4-1, FEIR).

Stipulation and Order

The Stipulation and Order specifies that the maximum flow to be diverted by the pumpback station from the river will be 50 cfs. It also specifies an implementation schedule for the LORP and requires that the base flow of 40 cfs be achieved in the river no later than April 1, 2006 (pg. 7). It includes data reporting requirements that must be adhered to as set forth in Sections G.2.a and G.2.b.

The Order requires that the initial releases of water that will commence the ramping (increasing) of flows specified in the project description in the Final EIR/EIS will be commenced on or before September 5, 2005 (pg. 7). LADWP will ramp the flows as rapidly as possible while attempting to avoid adverse impacts on water quality and fish. The Stipulation and Order also describes the limitations and constraints within which the base flow of approximately 40 cfs must comply.

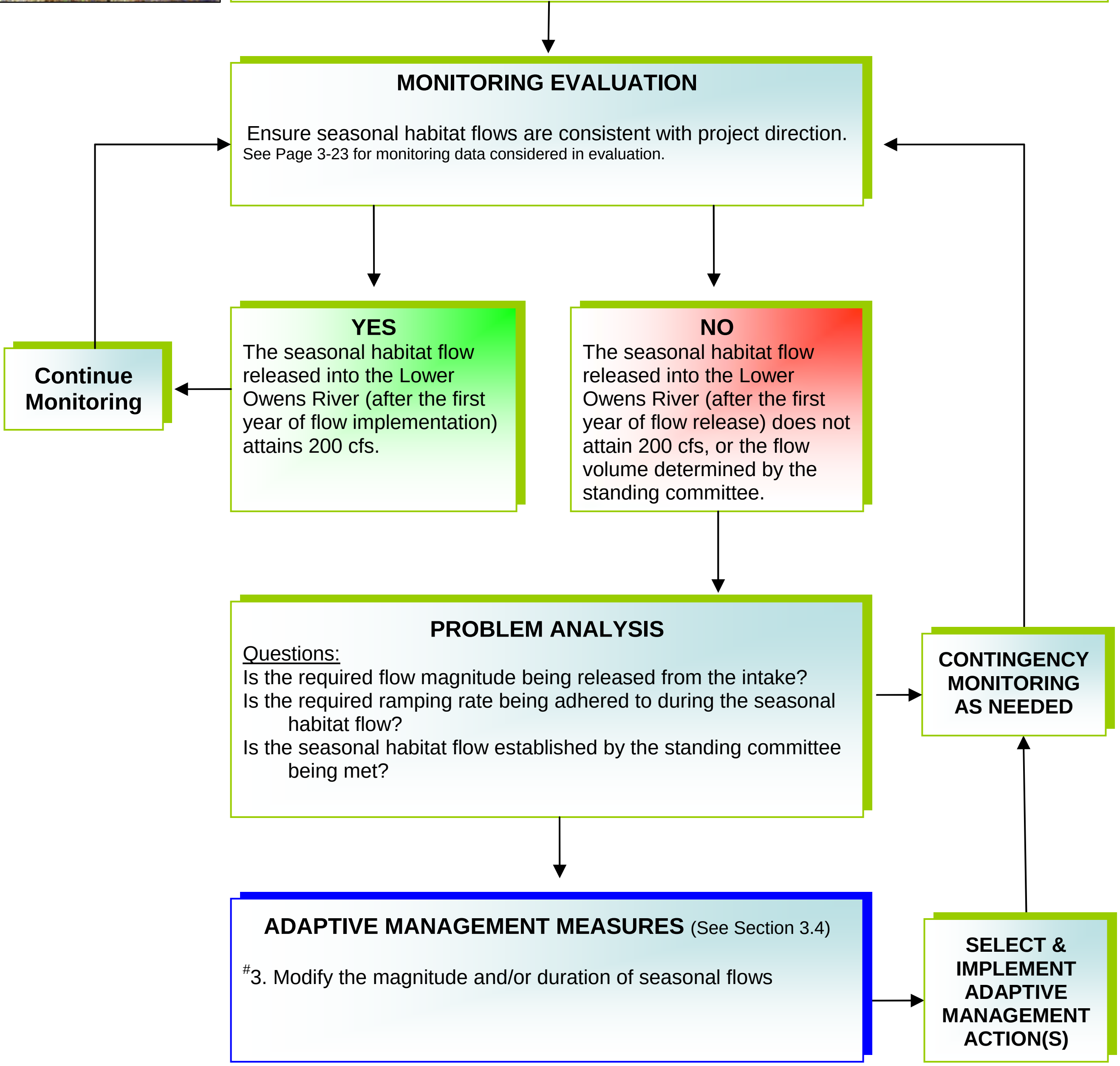
Deviations from Mandatory Documents

Any deviations from the mandatory documents are superseded by the Stipulation and Order base flow requirements.

3.9 Seasonal Habitat Flow

Compliance Monitoring

Average, above average and below average runoff years



OBJECTIVE

The seasonal habitat flow in the Lower Owens River attains a 200 cfs release during average to above average runoff years, or during below average water years, attains the flow determined by the standing committee in consultation with CDFG.

MONITORING EVALUATION

Ensure seasonal habitat flows are consistent with project direction.
See Page 3-23 for monitoring data considered in evaluation.

YES
The seasonal habitat flow released into the Lower Owens River (after the first year of flow implementation) attains 200 cfs.

Continue Monitoring

NO
The seasonal habitat flow released into the Lower Owens River (after the first year of flow release) does not attain 200 cfs, or the flow volume determined by the standing committee.

PROBLEM ANALYSIS

Questions:
Is the required flow magnitude being released from the intake?
Is the required ramping rate being adhered to during the seasonal habitat flow?
Is the seasonal habitat flow established by the standing committee being met?

CONTINGENCY MONITORING AS NEEDED

ADAPTIVE MANAGEMENT MEASURES (See Section 3.4)

#3. Modify the magnitude and/or duration of seasonal flows

SELECT & IMPLEMENT ADAPTIVE MANAGEMENT ACTION(S)

3.9 Seasonal Habitat Flow

Seasonal habitat flows will be used as a management tool for the LORP to create a natural disturbance regime to establish and maintain native riparian vegetation. These flows will provide significant out-of-bank flooding to stimulate germination of riparian vegetation and recharge water tables.

Seasonal Habitat Flow Evaluation:
Data Used for Compliance Monitoring

Ensure seasonal habitat flows are consistent with project direction.
Evaluated by:

- Seasonal Habitat Flow (4.2.3.1)
- Rapid Assessment Survey (4.2.5)

Seasonal Habitat Flow Evaluation:
Data Used for Effectiveness Monitoring

Seasonal habitat flows promote establishment of riparian vegetation and enhance riparian habitat conditions.
Evaluated by:

- Seasonal Habitat Flow Monitoring (4.2.3.1)
- Seasonal Habitat Flooding Extent Monitoring (4.2.3.2)
- Rapid Assessment Survey (4.2.5)
- Landscape Vegetation Mapping (4.2.7.1)
- Site Scale Vegetation Assessment and Landform Elevation Mapping (4.2.7.2)
- Irrigated Pasture Condition Scoring (4.6.1)
- Utilization Monitoring (4.6.2)
- Range Trend Monitoring (4.6.3)

Project Expectations

The Lower Owens River seasonal habitat flows will be managed to meet MOU goals and in accordance with technical memoranda (Tech Memos #1 and #11), the LORP Ecosystem Management Plan, the LORP FEIR and the RWQCB Order #R6V-2005-0020. The project expectations are described in the MOU and include minimizing material that is transported out of the riverine-riparian system; fulfilling the wetting, seeding and germination needs of riparian vegetation; recharging groundwater in the streambanks and floodplain; controlling tules and cattails; enhancing the fishery; maintaining water quality standards and actions; and enhancing the river channel. Project expectations as described in the LORP FEIR include: flow releases will increase the total area of riverine-riparian and wetland habitat areas, increase the size and connectivity of the individual habitat areas, and increase the structural complexity, productivity and diversity of vegetation communities within individual habitat areas.[23] Additionally, in those extremely high water years when it is necessary to manage rapid runoff, rather than spread water as done in the past, every effort should be made to allow excess water to enter the river channel to further the expectations described above.

Feedback Mechanism for Monitoring and Adaptive Management

The seasonal habitat flows will be monitored using data collected from recorders at gaging stations to determine whether flows attain 200 cfs (during average to above average runoff years) or a flow as determined by the Inyo County-Los Angeles Standing Committee, in consultation with CDFG. The monitoring locations and schedules are described in the Regional Water Quality Control Board (RWQCB) Order and in Section 4 of this document. If the flow requirements are not met (compliance monitoring), the measure(s) that will be used include increasing (or decreasing-for below average runoff years only) releases from the Intake. However, the adequacy of the seasonal habitat flows to achieve expected vegetation and habitat outcomes (effectiveness monitoring) will be determined by monitoring flow, flood extent, vegetation, habitat and land use. In the event expectations are not met, seasonal habitat flows may require augmentation from higher intake releases, augmentation from spill

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[23] LORP FEIR, pg. 2-73

gates, or modification of the flow duration and ramping rates.

3.9.1 Document Integration and Direction

MOU

The purpose of the habitat flow, according to the MOU, is to create a dynamic equilibrium for riparian habitat, the fishery, water storage, water quality, animal migration and biodiversity, which results in resilient productive ecological systems. The MOU outlines flow regimes for seasonal habitat flows. For average to above average runoff years, the flow regime includes releasing 200 cfs at the LAA Intake into the Lower Owens River. For below average runoff years, the flow regime includes a reduction from 200 cfs to as low as 40 cfs in general proportions to the forecasted runoff in the watershed.[24] The *Data Base and Modeling Results for the Lower Owens River Project: Controlled Flow Study*[25] identifies freshet flows of up to 200 cfs provide optimum water spreading to create and maintain riparian habitat.

The MOU recommends that habitat flows of sufficient frequency, duration and amount be implemented in order to: (1) minimize the quantity of muck and other river bottom material that is transported out of the riverine-riparian system, but will cause this material to be redistributed on floodplains and terraces within the riverine-riparian system and the Owens River Delta for the benefit of the vegetation; (2) fulfill the wetting, seeding and germination needs of riparian vegetation, particularly willow and cottonwood; (3) recharge the groundwater in the streambanks and the floodplain for the benefit of wetlands and the biotic community; (4) control tules and cattails to the extent possible; (5) enhance the fishery; (6) maintain water quality standards and actions; and (7) enhance the river channel.

The MOU specifies that the amount of annual habitat flow be set by the Standing Committee, "subject to any applicable court orders concerning the discharge of water onto the bed of Owens Lake and in consultation with CDFG, and be based on the Lower Owens River Riverine-Riparian Ecosystem element of the LORP Plan, which will recommend the amount, duration and timing of flows necessary to achieve the goals for the system under varying hydrologic scenarios".[26]

Technical Memorandum #1

Technical Memorandum #1, *Hydrologic Plan for Implementing Initial Maximum and Minimum River Flows*, describes how seasonal habitat flows will be delivered to the Lower Owens River. Data obtained during the 1993 controlled flow study determined that riparian flows should "emulate the natural hydrology to the degree possible (up to a maximum discharge of 200 cfs) so that the lower river experiences the same wet year-dry year cycles as the upper river (above the Intake). The variability of the natural hydrologic cycle in the river below the Intake will be achieved with an analog model that mimics freshet conditions in the river above the Intake." The LADWP prepares runoff forecasts each year to assist in determining the amount of water expected to be available for the aqueduct. The LADWP will use the LADWP Runoff Forecast Model to determine the annual seasonal habitat flow discharge to the Lower Owens River.

The seasonal habitat flows will be timed to enhance willow/cottonwood seed dispersal; annual seed development will vary from the upper reaches of the Lower Owens River to the most downstream reaches, so the timing of the flows should be based on the reach of the river where seed development is latest. The duration of seasonal habitat flows will be determined through adaptive management to attain project goals. With regard to monitoring and adaptive management the technical memo states that "…the flow delivery system will be modified from time

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[24] MOU 1997, Section II, pg. 12

[25] Appendix 2 of the Ecosystem Management Plan, 2002, and the Concept Document, which is Attachment A to the MOU, 1997.

[26] MOU 1997, Section II, pg. 12

to time to improve the efficiency of delivering minimum and maximum flows and the conservation of water resources”.

Technical Memorandum #11

Technical Memorandum #11, *Critical Path for Flow Management during the Initial Years*, details how the base flows and riparian flows will be managed the first few years after implementation. The purpose is to recommend how flows should be managed, ramped and manipulated to meet both LORP goals and prevent adverse impacts on key environmental conditions during the first two or three years of flow reintroduction. This tech memo also recommends water spreading and flows in the island reach of the Lower Owens River.

LORP Ecosystem Management Plan

Chapter 2 of the Ecosystem Management Plan (EMP), the River Management Plan, contains management objectives pertaining to seasonal habitat flows that include releasing habitat flows to the river (the maximum amount will be determined each year based on runoff conditions), and maintaining annual seasonal habitat flows up to 200 cfs. The plan describes the phases, planned schedules and actions associated with creating and maintaining seasonal habitat flows. Annual seasonal habitat flows will be released in May or early June to coincide with seed production by willows and cottonwoods in the floodplain. The initial seasonal habitat flow will be released to the river in late May or early June following the initiation of Phase II flow releases. The seasonal habitat flows will be released from the LAA Intake. Seasonal habitat flows not captured by the pump station will flow to the Delta. The maximum amount of the annual seasonal habitat flow will be determined each year based on runoff conditions. No flows above the 40 cfs base flows will be released from the LAA Intake in years when the runoff is predicted to be 50 percent or less of the annual average. If runoff is greater than 50% of normal, the amount of the flow will increase proportionally in accordance with runoff up to a maximum release of 200 cfs. When runoff is 100% of normal or greater, seasonal habitat flows will be 200 cfs (pg. 6, EMP).

The EMP describes a ramping rate of 25% of the previous day’s flow to the peak for that year and decreasing to the 40 cfs base flow rate of 20% of the previous day’s flow over a 14-day period. This rate was borrowed from state-of-the-art experience below dams and hydroelectric facilities.

Management will be based on maintaining annual seasonal habitat flows up to 200 cfs. Monitoring will involve collecting data from continuous recorders at temporary gaging stations and from permanent stations during subsequent releases.

Final EIR

Like the MOU, EMP and technical memorandums, the Final EIR/EIS states that the overall objective of rewatering the river is to restore aquatic and riparian habitats of the river from the River Intake to the pump station, located at the upper end of the Owens River Delta. A seasonal habitat flow with a total flow ranging from 40 to 200 cfs, depending on the predicted amount of annual Owens Valley runoff, will be released to the river each spring.

The magnitude of the seasonal habitat flows that will reach the Delta will depend on the amount of water released at the River Intake (the first seasonal habitat flow will be 200 cfs at peak flow, regardless of forecasted runoff- subsequent flows will depend upon forecasted runoff conditions). The seasonal habitat flows will be established annually by the Standing Committee in accordance with the provisions of the MOU and based on LADWP’s Runoff Forecast Model for the Owens Valley (pg. 2-19) and in consultation with CDFG.

The first seasonal habitat flow will be released in the winter (i.e., when temperatures are lower) to reduce the potential for substantial decreases in dissolved oxygen and adverse effects on fish health. Subsequent annual seasonal habitat flows will be released in May or early June, to coincide with seed production by willows and cottonwoods in the floodplain. The exact timing will be determined each year based on an assessment of the projected timing of the cottonwood and willow seeding, which varies from year to year depending on temperature, rainfall and other environmental factors (pg. 2-18).

To ensure water releases are consistent with the MOU, the following monitoring will be conducted for the seasonal habitat flows: (1) During the first release of seasonal habitat flows, flow data will be recorded hourly and collected weekly from continuous recorders at temporary gaging stations and permanent gaging stations; (2) During subsequent seasonal habitat flows, data will be recorded hourly and collected weekly from continuous recorders at a minimum of four permanent gaging stations; and (3) For the first five years of seasonal habitat flow releases, an aerial survey will be conducted using a LADWP helicopter to observe and video or photograph seasonal habitat flows at peak flows (Riverine-Riparian System and Delta Habitat Area).[27] Adaptive management measures to ensure compliance with seasonal habitat flows includes releasing higher quality water from spillgates during the first three releases of seasonal habitat flows, modifying the timing of seasonal habitat flows and modifying the ramping pattern of seasonal habitat flows.[28]

Stipulation and Order

The Stipulation and Order contains requirements for in-river flow measuring stations that will accurately measure the full amount of seasonal habitat flows required by the MOU and by applicable permits. It also contains seasonal flow data reporting requirements.

Lahonton Regional Water Quality Board

The 2005 Permit #R6V-2005-0020 issued to LADWP by the Regional Water Quality Control Board (RWQCB)- Lahonton Region requires that LORP flow management comply with water quality provisions, and waste and pollutant discharge requirements pursuant to the Clean Water Act and the Regional Water Quality Control Board's Water Quality Plan (Basin Plan). It contains monitoring requirements (sampling schedules and locations for data collection) for the first winter habitat flow, the Alabama Release, and the initial two spring seasonal habitat flows. It requires that sampling be conducted "commencing on the day of initiating the high-flow releases (>40 cfs); five days per calendar week for two weeks thereafter; at least twice during the first week following cessation of high-flow releases, at a minimum of two-day intervals" (pg. E-9).

It is consistent with the MOU, EMP, Final EIR/EIS, and technical memoranda, and states that: "Seasonal habitat flows will be annual flows of up to 200 cfs, as determined each year based on runoff conditions. The first seasonal habitat flow will be 200 cfs at peak flow, regardless of runoff conditions, and will be released in the winter. Subsequent seasonal flows will be released in May or June to coincide with seed production by willows and cottonwoods in the floodplain" (pg. F-5). The 2005 Order was amended by Order #R6V-2005-0020, which incorporates a Storm Water Pollution Prevention Plan for the LORP.

During the first winter habitat release, the permit requires LADWP to monitor the flow in the Lower Owens River upriver from the Alabama Spillgate (and downriver from the Georges Spillgate), and the release rate from the Alabama Spillgate, to demonstrate that requirements to provide and maintain minimum combined flow rates of 200 cfs for at least 96 hours are achieved in the Lower Owens River immediately below the Alabama Spillgate. The results of the monitoring shall be presented in the first monitoring report due the first day of the second calendar month following the conclusion of the first winter habitat release.

Deviations from Mandatory Documents

No deviations from the mandatory documents were identified. Monitoring of seasonal flows must comply with requirements outlined in the RWQCB Order #R6V-2005-0020 and amended Order #R6V-2005-0020A1.

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[27] FEIR, pg. 2-72

[28] FEIR,pg. 2-79

3.9 Seasonal Habitat Flow

Effectiveness Monitoring

OBJECTIVE

The seasonal habitat flow in the Lower Owens River meets habitat expectations (described in section 3.9), promotes establishment of riparian vegetation and enhance riparian habitat conditions.

MONITORING EVALUATION

Seasonal habitat flows promote establishment of riparian vegetation and enhance riparian habitat conditions.
See Page 3-23 for monitoring data considered in evaluations.

YES
Seasonal habitat flows are meeting expectations.

NO
Seasonal habitat flows are not achieving habitat expectations.

Continue Monitoring

PROBLEM ANALYSIS

Questions:

In average to above average years is the seasonal habitat flow of sufficient magnitude to provide out-of-bank flooding?

Are the timing and duration of seasonal habitat flow sufficient to fulfill the wetting, seeding and germination needs of riparian vegetation primarily willow and cottonwood? (i.e, is recruitment and establishment occurring?)

Does land use monitoring data indicate that grazing prescriptions are enabling the recruitment and establishment of riparian vegetation?

CONTINGENCY MONITORING AS NEEDED

ADAPTIVE MANAGEMENT MEASURES (See Section 3.4)

#2. Modify the timing of seasonal habitat flows
#3. Modify the magnitude and/or duration of seasonal flows
#4. Release higher quality water from spillgates during the first three releases of seasonal habitat flows
#5. Modify the ramping pattern of seasonal habitat flows
#9. Modify tule removal activities
#12. Modify utilization rates and timing within riparian and upland pastures
#23. Remove critical flow obstructions

SELECT & IMPLEMENT ADAPTIVE MANAGEMENT ACTION(S)

3.10 Fishery

Effectiveness Monitoring

OBJECTIVE

Create and sustain a healthy warm water fishery in the Lower Owens River.

MONITORING EVALUATION

After water quality objectives are met, habitat conditions generate a healthy warm water fishery.

See Page 3-29 for monitoring data considered in evaluations.

YES

5 years after water quality standards are met, fish populations and habitat have been maintained or improved compared to baseline conditions.

Continue Monitoring

NO

5 years after water quality standards are met, fish populations and habitat have **not** been maintained or improved compared to baseline conditions.

PROBLEM ANALYSIS

Questions:

Does the fish habitat monitoring data indicate that fish habitat is improving over time?

Does the creel census data indicate that the fishery in the Lower Owens River is trending towards a diverse community or a monoculture?

Does creel census data indicate a limiting condition at the spawning, incubation or rearing life stages?

CONTINGENCY MONITORING AS NEEDED

ADAPTIVE MANAGEMENT MEASURES (See Section 3.4)

$^{\#}$4. Release higher quality water from spillgates during the first three releases of seasonal habitat flows

$^{\#}$9. Modify tule removal activities

$^{\#}$10. Modify beaver and beaver dam control activities

$^{\#}$12. Modify utilization rates and timing within riparian and upland pastures

$^{\#}$15. Modify the river channel

$^{\#}$16. Modify recreational and human use management

$^{\#}$22. Modify water releases to maintain off-channel lakes/ponds

SELECT & IMPLEMENT ADAPTIVE MANAGEMENT ACTION(S)

3.10 Fishery

Fisheries are an integral part of the LORP. In fact, the LORP was initially proposed in the 1991 EIR as an enhancement/mitigation project[29] that would directly impact the Owens River fishery by providing: 1.) water and flow schedules needed to maintain a healthy and productive warm –water fishery in the Lower Owens River and in the off-river lakes and ponds; 2.) locations of ponds, pools and wetlands in and adjacent to the Lower Owens River, and proposed methods to manage these to produce and maintain a viable fishery and waterfowl habitat; 3.) plans for fish stocking.

Subsequent goal refinements for the Lower Owens River Project were made in 1993 while drafting the Study Plan - Identification of River Flow Requirements for Fish, Wildlife and Riverine-Riparian Habitats in the Lower Owens River, California[30] and again in 1997 with the completion of the MOU. As the project evolved fisheries remained an important component of the project. The following sections outline the specific goals and direction related to fisheries in each of the LORP mandatory documents.[31]

Fishery Evaluation:
Data Used for Effectiveness Monitoring

After water quality objectives are met, habitat conditions generate a healthy warm water fishery. Evaluated by:

- Base Flow Monitoring (4.2.1.1)
- Seasonal Habitat Flow Monitoring (4.2.3.1)
- Seasonal Habitat Flooding Extent Monitoring (4.2.3.2)
- Fish Condition Monitoring (4.2.4)
- Rapid Assessment Survey (4.2.5, 4.3.2, 4.4.2, 4.5.2)
- Fish Habitat Monitoring (4.2.6.2)
- Flow and Wetland Area Monitoring (4.3.1, 4.5.1)
- Creel Census (4.2.8.2, 4.5.3)

Native fish are being considered as part of the Owens Valley Habitat Conservation Plan (HCP). This plan is currently being drafted and researched. Native fish species and their habitats in the Owens Valley will be considered for inclusion in the HCP.

Project Expectations

The expectation for fisheries in the LORP is that monitoring results will depict a system in which the fish populations and fish habitat increase in the short term, while populations stabilize and the habitat becomes more diverse in the long term.

Technical Memorandum #14 expects "that all of the above (indicator species) fish species' habitat will be enhanced quantitatively and qualitatively through developments and flows prescribed in the MOU."

The 2002 LORP Ecosystem Management Plan expects, "that as riparian and base flows begin to alter river channel habitat and beaver ponds, game fish will quickly expand into the increasing river habitat as pond habitat declines" (p. 18).

The FEIR explains that, "the LORP was designed to create a wide variety of aquatic habitats that would primarily benefit the existing warm water sport fisheries for largemouth and smallmouth bass, bluegill and catfish. The project will create fish habitats by forming new and expanded open water in the river, maintaining off-river lakes and ponds, and enhancing corridors between off-channel lakes and ponds and the river."

Feedback Mechanism for Monitoring and Adaptive Management

One objective of the LORP is to *create and sustain a healthy warm water fishery*. Evaluation of monitoring (Creel Census and Fish Habitat Surveys) data will inform managers of the need to enact adaptive management measures. Evaluating the success of the LORP hinges on sustaining the existing fishery and creating a new fishery within the dry reach. Achieving the

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[29] 1991 EIR p. 5-22
[30] Hill et al. 1994 – Appendix 1 of the 1997 MOU
[31] i.e. 1997 MOU, Technical Memorandums, 2002 LORP Ecosystem Management Plan, 2004 Final EIR

fishery objective of the LORP not only hinges on creel census and fish habitat survey data but also on water quality, as the FEIR allows for a five year window following water quality improvements (see Table 4.1 Water Quality Fish Condition Thresholds). Successful implementation of the LORP hinges on monitoring data demonstrating that 5 years after water quality conditions have been met, fish populations and habitat have been maintained and improved compared to baseline conditions (see Section 4.5.3, Creel Census). If 5 years after water quality has improved monitoring data indicates that fish populations and habitat have decreased then adaptive management measures must be enacted.

3.10.1 Document Integration and Direction

MOU

MOU page 10 section C.1.a., "the goal of the Lower Owens River Riverine-Riparian System is to create and sustain . . . a *healthy warm water recreational fishery with healthy habitat for native fish species*". Additional direction is given on pages 12-13, section C.1.b. ii., of the MOU which states that, "the purpose of the seasonal habitat flow is the creation of a natural disturbance regime that produces a dynamic equilibrium for . . . *the fishery*. And finally on page 16, section C.3. Off River Lakes and Ponds, the MOU states that, "the goal is to maintain and/or establish these off-river lakes and ponds to sustain diverse habitat for *fisheries*.

Technical Memorandum #14

The purpose of Technical Memorandum #14 is to describe the existing fishery and habitat in the Lower Owens River and future conditions and habitat as a consequence of flow restoration to the channel and adjacent ponds, lakes and wetlands. The document also describes management of the existing and future fishery and habitat.

Technical Memorandum #14 parallels the MOU by reiterating that the goal of the LORP is to, "Establish a healthy warm-water recreational fishery with habitat for native species", and that flows are intended to "enhance the recreational fishery." The document also addresses the habitat indicator species designated in the MOU for the LORP, which are:

1. Largemouth bass (*Micropterus salmoides*)
2. Smallmouth bass (*Micropterus dolomieui*)
3. Bluegill (*Lepomis macrochirus*)
4. Channel catfish (*Ictalurus punctatus*)
5. Owens sucker (*Catostomus fumeiventris*)
6. Owens pupfish (*Cyprinodon radiosus*)
7. Owens tui chub (*Gila bicolor snyderi)*

Technical Memorandum #14 also addresses adaptive management of the LORP for fisheries and directs action for certain agencies. Specifically, fish habitat management, which will include land use and flow management, will be performed as part of the overall LORP management by the LADWP. Fisheries management *per se* (i.e., stocking and regulations) is the responsibility of the CDFG. Both agencies must collaborate to pool and analyze data during the monitoring years to implement adaptive management strategies.

Technical Memorandum #14 describes management of threatened and endangered fish species and the establishment of sanctuaries for the future planning and recovery of Owens pupfish and Owens tui chub.

Technical Memorandum #14 adds that, in the case of fisheries in the Lower Owens River, adaptive management will be the critical tool to reach the desired objective - a healthy warm water fishery. Monitoring of fish habitat improvement as the ecosystem restoration processes continue, will provide the essential feedback from which decisions on game fish and T&E species management can be made. Management decisions over time will undoubtedly include refinement of connectivity and corridors that link habitats, recovery rate and level for reintroducing native fish species; stocking, harvest, access, regulation of angling, and altering actions in relation to land and water uses and events. It will also become apparent in time how species interact spatially and temporally and how fisheries management should proceed when the ecosystem reaches a dynamic equilibrium.[32]

LORP Ecosystem Management Plan

The 2002 Ecosystem Management Plan[33] summarizes the data and concepts presented in Technical Memorandum #14, as well as restating the goals outlined in the 1997 MOU. The document reiterates the need for LADWP and CDFG to work together for monitoring and adaptive management, as LADWP controls the land and water and CDFG manages fish stocking and regulations. Additionally, the Ecosystem Management Plan outlines management objectives, which correspond to the MOU goals (e.g. create and sustain a warm water recreational fishery in good condition) and actions (e.g. maintain as close to 40cfs in all river reaches) that will help achieve those objectives.

The 2002 LORP Ecosystem Management Plan builds on the 1997 MOU and Technical Memorandum #14 by addressing monitoring needs and how monitoring data will inform adaptive management. Specifically, the 2002 Ecosystem Management Plan calls for Angler Surveys (p. 125), or fishing census and fishery habitat surveys (table on p.101 of EMP). The results of these two monitoring tasks will inform managers on whether or not the goal of *"creating and sustaining a healthy warm water recreational fishery"* is being achieved.

Final EIR

Page 2-76 of the 2004 Final EIR/EIS (FEIR) address fisheries as an MOU goal by stating, "the goal for the Lower Owens River Riverine-Riparian System is to create and sustain . . .a *healthy warm water recreational fishery with healthy habitat for native fish species*. Similar to the 2002 LORP Ecosystem Management Plan the FEIR explains that Angling Census (Fishing Census) and Fish Habitat Surveys will be the LORP monitoring components for determining whether a healthy warm water recreation fishery is being achieved.

In terms of setting thresholds and timeframes for adaptive management, the FEIR explains that the temporary adverse water quality conditions during the initial and seasonal flow releases to the river could adversely affect fish due to the depletion of oxygen, and possible increase in hydrogen sulfide and ammonia. Specifically, the poor water quality could cause fish kills along the river downstream of Mazourka Canyon Road. Both the 40 cfs baseflow and the 200 cfs seasonal habitat flow are expected to cause water quality degradation. In time, the fishery is expected to recover once water quality conditions improve (FEIR p. S-8).

The FEIR's acknowledgement that water quality is an important component of a fishery and that it is necessary to allow for water quality to improve and stabilize before adaptive management is enacted, differs from the MOU and Ecosystem Management Plan. For example, the FEIR describes that in the event that "natural re-colonization of the game fishery does not occur within 5 years after water quality conditions have improved, or appears to be occurring at a very slow rate, LADWP shall implement and fund a one-time fish-stocking program (depending on availability of fish stock from state fish hatcheries) in coordination with CDFG (FEIR p. 4-42)." The FEIR goes on to state that the program will be designed to initiate re-colonization and to stimulate population growth to establish game fish populations within 10 years after water quality conditions have improved. Thus, project managers must evaluate the fishery 5 years after water quality conditions have improved. If after 5 years the game fishery has not responded then LADWP and CDFG must implement a stocking program. Following the stocking program managers are allowed another 5 years to demonstrate that game fish populations are established and thriving in the LORP.

Deviations from Mandatory Documents

The FEIR direction for fisheries in the LORP differs from the MOU, Ecosystem

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[32] Tech Memo #14 p.22

[33] Ecosystem Sciences 2002

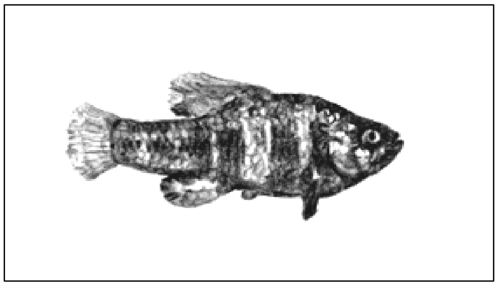
Management Plan, and Technical Memorandum #14. The FEIR is very specific regarding the time frame for making adaptive management decisions and that adaptive management for fisheries is tied to water quality. Thus, the direction for fisheries in the FEIR is adopted for this plan, in which 5 years after water quality improves project managers must demonstrate that *a healthy warm water recreational fishery has been created and sustained.* Subsequent actions related to stocking are also adopted for this plan.

3.11 Native Fish

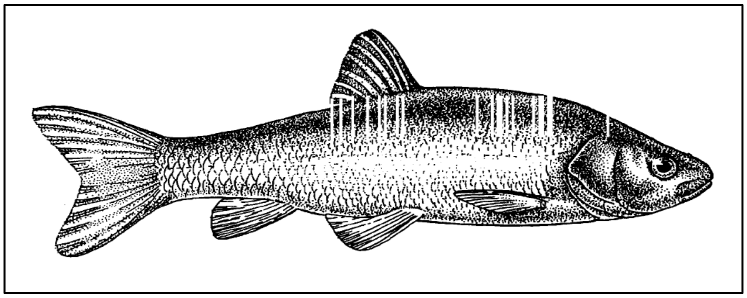
Discussion

A Habitat Conservation Plan (HCP) is being written for Los Angeles Department of Water and Power lands in Mono and Inyo counties. The HCP will include the Owens pupfish, tui chub and speckled dace.

Pupfish



Owens pupfish



Owens tui chub
Image from USFWS 1998

Historical records show that only four species of fish (Owens pupfish, Owens tui chub, Owens sucker and Owens dace) were native to the Owens Valley at the time of European settlement.[34] These species have experienced a rapid decline throughout the twentieth century. Historical records indicate that the decline of the native fish assemblages occurred during the period from 1930 to 1970.[35] The rapid decline of native fish species is attributed to introductions of exotic predatory fishes and loss of habitat.[36]

The rarity of these fish in the Owens Valley prompted the MOU parties to include provisions for native fish in the LORP. Throughout the mandatory documents that integrate to form the basis of the LORP, provisions for native fish and threatened and endangered species are often interchangeable as the Owens pupfish and Owens tui chub are federally listed and the Owens speckled dace is state listed. For the remainder of this section Native Fish refers to the Owens tui chub, Owens pupfish and Owens speckled dace. The Owens sucker is thriving in the Owens River and is not adversely affected by the presence of game fish. In fact the FEIR states that the Owens sucker is the only fish native to the area that can successfully compete with introduced species.[37]

Project Expectations

Habitat suitable for Owens pupfish and Owens tui chub will be maintained and created as a result of the LORP.[38]

The FEIR addresses Threatened and Endangered species expectations in the LORP by stating that ”the various elements of the LORP will improve or create habitats suitable for these (T&E) and other species" (p. 2-51). These actions (implementation of the LORP) are expected to generally benefit listed species. Furthermore, implementation of the project will not cause any adverse

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[34] Draft EIR 1990; Tech Memo #14; Moyle 1976a
[35] Sada 1989
[36] Technical Memorandum #14
[37] LORP FEIR p. 4-35
[38] Ecosystem Sciences, Technical Memorandum 14, 2001

impacts to listed species nor to other species in the LORP area.

The HCP will describe habitat and management provisions for these fish species.

Feedback Mechanism for Monitoring and Adaptive Management

No monitoring or adaptive management provisions for native fish (threatened and endangered) will be addressed in this Plan. As outlined in the FEIR, the management of native T&E fish species will occur under a Habitat Conservation Plan for Los Angeles Department of Water and Power lands in Mono and Inyo County approved by the USFWS. Although the LORP will benefit T&E species already residing within the project area, no provisions to monitor or manage their populations will be addressed in this Plan.

3.11.1 Document Integration and Direction

MOU

The MOU succinctly addresses native fish on page 10 section C.1.a., “the goal of the Lower Owens River Riverine-Riparian System is to create and sustain . . . a healthy warm water recreational fishery with healthy habitat for *native fish species.*” Additional information regarding native fish in the MOU is addressed under Threatened and Endangered Species. Specifically, the MOU directs that, “*Habitat conservation plans for Threatened and Endangered Species will be incorporated if and where appropriate*”.[39] Further description regarding Threatened and Endangered Species appears in attachment A, the Action Plan, of the MOU: “*The plan will identify conservation areas within the planning Area which will be managed to facilitate restoration of threatened and endangered species to viable populations. The intent of this element is ultimately to achieve sufficient recovery of these species to warrant delisting them, while providing for the continuation of sustainable uses, including recreation, agriculture, and aqueduct operations*”.[40]

Technical Memorandum #14

The purpose of Technical Memorandum #14 is to describe the existing fishery and habitat in the Lower Owens River and future conditions and habitat as a consequence of flow restoration to the channel and adjacent ponds, lakes and wetlands.

Pertaining to native species, Technical Memorandum #14 explains that in the past, native fish species management programs have had limited success. One example is the Owens Valley Native Fish Sanctuary where attempts have been made to isolate the native species through the creation of barriers. This attempt at isolation has largely failed due to repeated intentional and accidental introductions of exotic fish species; isolated sanctuaries such as this also encourage genetic introgression and reduced viability for native fish species. Simply isolating T&E species is not enough. Fish sanctuaries should be strategically placed so that once the native species populations have become established and stable, they can then access the greater riparian ecosystem and naturally recolonize by slowly filling niches that afford them protection and rearing habitat.

Technical Memorandum #14 describes the criteria for selecting potential sanctuaries in the LORP. The potential sanctuaries identified in Technical Memorandum #14 are: Little Blackrock Springs, Big and Little Seeley Springs, Artesian Well 368, Hidden Lake Corridor and Reinhackle Spring (TM#14 p.21). The sanctuaries proposed in Technical Memorandum #14 include the Owens sucker. Subsequent mandatory documents do not include the Owens sucker in sanctuaries.

Technical Memorandum #14 also explains some of the required conditions for the

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[39] MOU, 1997. Page 28 Section III B

[40] MOU, 1997. Attachment A, Action Plan p. 6.

sanctuaries. In general, each of the sanctuaries will need to remain predator-free and will require a limited amount of construction to ensure that they remain so. Each sanctuary would also require a small dam with a spillway that would prevent exotic fish from migrating into the sanctuary, yet would allow, in some cases, movement of the native species out of the sanctuary and into habitat below. Since T&E species will be in sanctuaries with existing control structures, or in places where control structures are not needed, fish screens will not be required.[41]

Technical Memorandum #20

Technical Memorandum #20 describes the preliminary goals, objectives and scope of a threatened and endangered species conservation or T & E plan for the Los Angeles Department of Water and Power (LADWP) lands of the Lower Owens River Project area.[42] Technical Memorandum #20 is a qualitative first step in the creation of a habitat conservation plan for the LORP, as it contains an outline for an HCP and some general goals related to T&E species and Species of Concern. Goals pertaining to native fish species in the Owens Valley that are germane to this Monitoring and Adaptive Management plan are: determine need for and location of conservation or sanctuary areas for designated T & Es and the development of management plans for the sanctuaries and the establishment of connective corridors to the larger LORP ecosystem.[43] These goals are consistent with goals outlined in the LORP Ecosystem Management Plan.

LORP Ecosystem Management Plan

The LORP Ecosystem Management Plan (EMP) explains that, "most likely native fish will find refuge in the ditch/canals and fish corridor connections within the LORP. But, these areas will be filled with game fish that prey on the native fish. Therefore, true achievement of the LORP goals regarding native fish is dependent on the creation and maintenance of sanctuaries for native fish." The creation of sanctuaries for native fish is also addressed in the MOU, Technical Memoranda's #14 and #20 and thus, the LORP EMP is consistent with other LORP documents. The LORP EMP differs from Technical Memorandum #14 in the number of sanctuaries required to preserve native fish, as the LORP Ecosystem Management Plan identifies 5 possible sanctuaries for native species: Little Blackrock Springs, Big and Little Seeley Springs, Artesian Well 368 and Reinhackle Spring.[44] The exclusion of the Hidden Lake Corridor as a possible sanctuary is the difference between the Ecosystem Management Plan from Technical Memorandum #14.

Final EIR

The FEIR differs considerably from previous LORP documents in the management of native and Threatened and Endangered fish. Specifically, the FEIR addresses the creation of sanctuaries in the LORP for native fish. The FEIR explains in Section 2.7, "the project (LORP) does not include any actions to create sanctuaries in the river for these species (Native Fish), nor does the project include any deliberate actions to introduce these species (Native Fish) into the river. Any actions to introduce these species and/or to create sanctuaries for these species in the river would only occur under the provisions of an Endangered Species Act Section 10(a) permit and Habitat Conservation Plan ("HCP") approved by the U.S. Fish and Wildlife Service. An HCP and Section 10(a) permit are not proposed as part of the LORP. However, LADWP is planning to prepare an HCP for all LADWP lands in Owens Valley, and seek a Section 10(a) incidental take permit in the near future. Consultation with and approval from the USFWS and CDFG will be required for the HCP (p. 2.27 FEIR)."

The FEIR ties the rationale for excluding sanctuaries as part of the LORP to the overall Habitat Conservation Plan process, by stating that "although the MOU specifies that a Habitat Conservation Plan will be

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[41] Tech Memo #14 p. 21

[42] Tech Memo #20 p. 2

[43] Tech Memo #20 p. 4

[44] LORP EMP p. 76

prepared as one part of the LORP Plan, LADWP has concluded, after conferring with MOU parties, to delay initiating the development of an HCP until the LORP has been approved or implemented (Page S-4)."

Deviations from Mandatory Documents

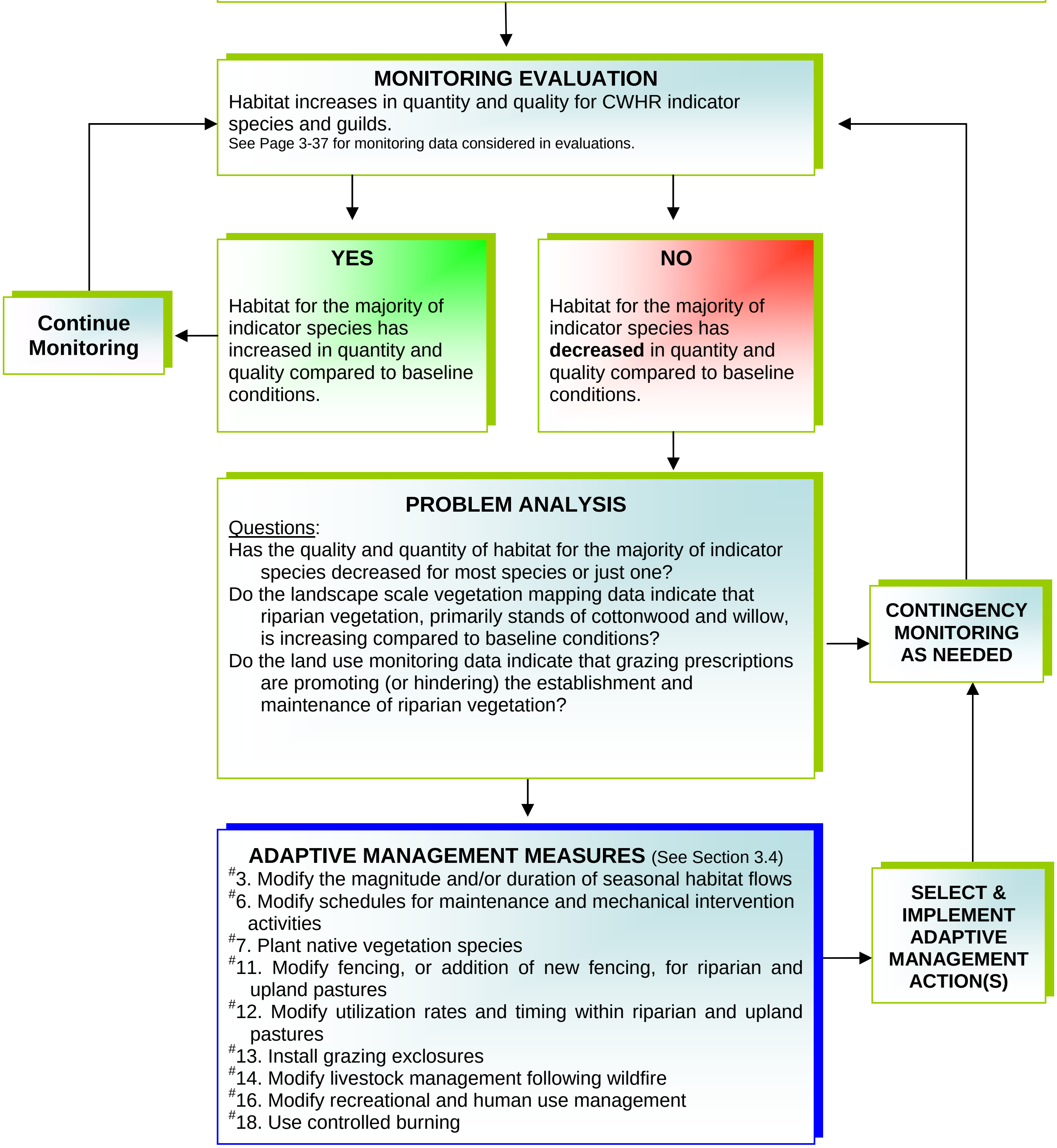
The FEIR's stance on *not* creating sanctuaries for native fish represents a significant deviation from the MOU, LORP Ecosystem Management Plan and Technical Memoranda's #14 and #20. The rationale for not including sanctuaries is sound as the management of Threatened and Endangered Species should "occur under the provisions of an Endangered Species Act Section 10(a) permit and Habitat Conservation Plan approved by the U.S. Fish and Wildlife Service (p.2-51 FEIR)."

3.12 Terrestrial Habitat

Effectiveness Monitoring

OBJECTIVE

Implementation of the LORP is benefiting the majority of indicator species and guilds by increasing the quantity and quality of their habitat (Riverine-Riparian, BWMA, DHA).



MONITORING EVALUATION

Habitat increases in quantity and quality for CWHR indicator species and guilds.

See Page 3-37 for monitoring data considered in evaluations.

YES

Habitat for the majority of indicator species has increased in quantity and quality compared to baseline conditions.

Continue Monitoring

NO

Habitat for the majority of indicator species has **decreased** in quantity and quality compared to baseline conditions.

PROBLEM ANALYSIS

Questions:

Has the quality and quantity of habitat for the majority of indicator species decreased for most species or just one?

Do the landscape scale vegetation mapping data indicate that riparian vegetation, primarily stands of cottonwood and willow, is increasing compared to baseline conditions?

Do the land use monitoring data indicate that grazing prescriptions are promoting (or hindering) the establishment and maintenance of riparian vegetation?

CONTINGENCY MONITORING AS NEEDED

ADAPTIVE MANAGEMENT MEASURES (See Section 3.4)

#3. Modify the magnitude and/or duration of seasonal habitat flows

#6. Modify schedules for maintenance and mechanical intervention activities

#7. Plant native vegetation species

#11. Modify fencing, or addition of new fencing, for riparian and upland pastures

#12. Modify utilization rates and timing within riparian and upland pastures

#13. Install grazing exclosures

#14. Modify livestock management following wildfire

#16. Modify recreational and human use management

#18. Use controlled burning

SELECT & IMPLEMENT ADAPTIVE MANAGEMENT ACTION(S)

3.12 Terrestrial Habitat

Habitat for Terrestrial Indicator Species

In the last couple of decades mammals and birds have increasingly been used as indicators of wildlife habitats and communities by land management agencies and conservation organizations.[45] Particularly with regard to financial and logistical constraints, the indicator species concept appears to offer a practical solution to the problem of meeting the needs of all species in a community without studying each individually.[46]

Indicator species are an integral part of the monitoring and adaptive management of the LORP, and are used to evaluate the habitat conditions for species residing in the Riverine-Riparian, Delta, Off-River Lakes and Ponds and Blackrock management areas. The Ecosystem Management Plan defines indicator species as species that indicate the presence of certain environmental conditions, seral stages or previous treatment.[47]

The Ecosystem Management Plan also acknowledges that the LORP is a habitat based project in which, "management of the Lower Owens River ecosystem will emphasize the "self designing" or "self-organizing" capacity of nature to recruit species and to make choices from those species that have been introduced. Self-design emphasizes the development of *natural habitat*." Additionally, the FEIR states, "under the LORP natural habitats will be created and enhanced consistent with the needs of certain habitat indicator species through the application of appropriate flow and land management practices (FEIR p. S-1)." Again, the basis for decision making is habitat, and indicator species are used to evaluate the suitability of that habitat.

Terrestrial Habitat Evaluation:
Data Used for Effectiveness Monitoring

Habitat increases in quantity and quality for CWHR indicator species and guilds. Evaluated by:

- Seasonal Habitat Flooding Extent Monitoring (4.2.3.2)
- Rapid Assessment Survey (4.2.5, 4.3.2, 4.4.2, 4.5.2)
- Habitat Monitoring (4.2.6.1, 4.3.3, 4.4.3)
- Landscape Vegetation Mapping (4.2.7.1, 4.3.4, 4.4.4)
- Site Scale Vegetation Assessment and Landform Elevation Mapping (4.2.7.2)
- Avian Census (4.2.8.1)
- Flow and Wetland Area Monitoring (4.3.1, 4.5.1)
- Wetland Avian Census (4.3.5, 4.4.5)
- Irrigated Pasture Condition Scoring (4.6.1)
- Utilization Monitoring (4.6.2)
- Range Trend Monitoring (4.6.3)

Project Expectations

In general, all of the documents summarized below recognize that the LORP will benefit the majority of the habitat indicator species. The FEIR is very succinct in describing its expectations of the LORP as it states on page S-30, "the addition of flows to the Lower Owens River is expected to increase extent, quality, and diversity of habitat for wildlife, particularly for birds." Since all but one of the terrestrial indicator species for the LORP are birds, it is expected that the quantity and quality (suitability) of habitat for these species will increase considerably over time.

Feedback Mechanism for Monitoring and Adaptive Management

Changes in habitat quantity and quality (suitability) for indicator species will be analyzed using the California Wildlife Habitat Relationship (CWHR) system. The requisite monitoring components for the CWHR are described in Section 4 of this Plan and include, but are not limited to, vegetation mapping, site scale vegetation mapping, vegetation size (height) and stage (canopy closure) measurements and special

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[45] e.g. Brock and Webb 1984; Landres et al. 1988; Hanley 1993, 1996; Bibby 1999, Loh et al. 1999
[46] Bissonette and Storch2003
[47] EMP p. 130

habitat elements data. Additionally, Point Count data will be used to inform managers of the presence/absence of avian indicator species within the project area. If the Scientific Team deems necessary then Owens Valley vole surveys would be required to document the presence/absence of all terrestrial indicator species within the LORP.

The monitoring data will be entered into BioView, a CWHR habitat suitability software program, which will derive the quantity and quality of habitat within the LORP for indicator species and guilds. Monitoring year to monitoring year changes in the quantity and quality of the habitat within the LORP for each indicator species will be compared. Decreases in the quantity and quality of habitat for a certain indicator species should be compared to other indicator species, as an increase in habitat for one species may mean a decrease in habitat for another species. Such occurrences may not mandate adaptive management action. The Scientific Team will determine whether or not the decrease in one indicator species habitat quantity and quality warrants adaptive management action.

As shown in Figure 3.12, in the event that indicator species habitat quantity and quality decreases significantly from one monitoring year to the next then the diagnostic (evaluation) phase of monitoring will be performed. In addition to the data mentioned above, the Scientific Team’s evaluation could rely upon monitoring data from the range condition, avian census, seasonal habitat flow’s flooding extent, off-channel lakes and ponds water surface elevation compliance, Blackrock flooding extent compliance and Delta habitat flow compliance.

3.12.1 Document Integration and Direction

MOU

In Section II.B of the MOU it is explained that the overall goal of the LORP includes the establishment and maintenance of diverse riverine, riparian and wetland habitats in a healthy ecological condition. The LORP Action Plan identifies a list of "habitat indicator species"[48] for each of the areas associated with the four physical features of the LORP. Within each of these areas, the goal is to create and maintain through flow and land management, to the extent feasible, diverse natural habitats consistent with the needs of the "habitat indicator species." These habitats will be as self-sustaining as possible. Indicator species are identified as a monitoring component for the Riverine-Riparian area, the Delta, the Off-River lakes and Ponds and Blackrock.[49]

Technical Memorandum #16

Technical Memorandum #16 quantifies projections of wildlife habitat units for the Lower Owens River using habitat suitability index (HSI) models. The HSI models were built for two reasons; to aid in quantifying the flow regime of the LORP and to project future habitat (quantity and quality) conditions in the LORP for selected species. Technical Memorandum #16 does not address every indicator species with an HSI model. For example, the document models only 5 of the of the 18 terrestrial Riverine-Riparian indicator species (Yellow warbler, Southwestern Willow Flycatcher, Yellow-billed cuckoo, Belted kingfisher and Marsh wren). Additionally, HSI models were not run for the Blackrock Waterfowl Management Area. Technical Memorandum #16 does not contain any reference to monitoring and adaptive management.

Technical Memorandum #19

The purpose of Technical Memorandum #19 is to discuss management concepts and priorities for implementing riparian wildlife management in the LORP. The document provides a summary of important management issues, evaluation tools and options. Technical Memorandum #19 is germane, solely, to the Riverine-Riparian area of the LORP. The document also

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[48] Table 1, Attachment A, MOU 1997

[49] MOU 1997, Sections C.1.a, C.2, C.3, and C.4

explains that management of beaver and tule elk populations is the responsibility of the California Department of Fish and Game.

Technical Memorandum #19, similar to Technical Memorandum #16, does not address all the riverine riparian indicator species. The document explains the omission by stating, that “there is extensive overlap between the HSI evaluation species and the MOU riparian indicator species. There is even greater overlap of the habitat requirements of the individual species that are considered. Many of these species respond to very similar components of the habitat (p.4-5).” Essentially, Technical Memorandum #19 uses a subset of the riverine-riparian indicator species to evaluate habitat for all of the indicator species.

The document addresses future HSI development for the LORP by stating, “because of the overlap between the HSI and indicator species, no new models will be developed for LORP management. Existing HSI models will be reevaluated, and if necessary models will be altered and refined. If there are important habitat relationships (characteristics) for indicator species that are not adequately evaluated and monitored through one or more of the HSI species, than those characteristics should be incorporated in the monitoring program (p. 5).”

Technical Memorandum #19 explains future monitoring by stating, “The foundation of the riparian/wetland wildlife monitoring plan will be habitat. Characteristics of the riparian habitat that are important and predictive to the HSI and MOU indicator species will be evaluated in baseline surveys and used for monitoring progress of LORP restoration (p. 5).” Such reliance on habitat as the evaluator of the LORP for indicator species is consistent with all other documents. The document further explains that monitoring will be done at two scales; the landscape scale which defines extent of habitat types within the LORP and, stand-level which describes the floristic and structural composition of habitat types. Habitat characteristics will be measured using a combination of remote (photo-interpretation and GIS) and field sampling.[50]

LORP Ecosystem Management Plan

The LORP Ecosystem Management Plan is consistent with the goals of the LORP identified in the MOU regarding habitat indicator species. The Ecosystem Management Plan[51] states, that the goal of the LORP is to “create and maintain healthy and diverse riverine, riparian and wetland habitats through flow and land management, to the extent feasible, consistent with the needs of the “habitat indicator species” for the river.”

Additional direction is given for each physical environmental feature (Riverine-Riparian, Delta, Blackrock and Off-River Lakes and Ponds) of the LORP. The direction given for each area is consistent with the MOU except that the Ecosystem Management Plan describes management objectives for each area. For example, the Wetland Management Plan for the LORP covers two distinct areas, the Blackrock Waterfowl Habitat Area and the Owens River Delta Habitat Area. Specific objectives for the Blackrock Waterfowl Habitat Area include the following: (1) provide a reliable and dependable source of water and wetland habitat that will attract resident and migratory waterfowl and shorebirds, the MOU indicator species for this project element.[52] The management objectives for the Blackrock and the Delta will create, enhance and sustain a diverse and productive "managed wetland" community for resident and migratory species, management indicator species and special status species.[53]

In terms of monitoring and adaptive management the Ecosystem Management Plan describes management objectives, as mentioned above, and actions. These actions relate to adaptive management decisions regarding the use of fire, ratio of emergent wetland to open water, connectivity, and the

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[50] Tech Memo #19 p. 5
[51] EMP, Table p. 99
[52] EMP, p.28
[53] EMP, p.33

use of monitoring to assess project success. For example, the Ecosystem Management Plan recommends for monitoring that managers measure trends in habitat characteristics that relate to the "habitat indicator species" and to special status wildlife species.[54] Monitoring habitat for the indicator species is consistent with previous documents.

Final EIR

Indicator species are mentioned throughout the FEIR, most often while restating the goals of the MOU for the four management areas. Section 2.10 Adaptive Management, references indicator species and how they will be used to monitor and adaptively manage the LORP. For example, on page 2-66 the FEIR states that, "because of the large scale and complexity of the LORP and inherent unpredictability of biological systems, the proposed method for ecosystem restoration is not to duplicate a particular ecological model, but to use monitoring and adaptive management to create desirable habitat for habitat indicator species." The FEIR also mentions the duration of habitat monitoring; habitat monitoring for the LORP will be conducted for the first 15 years.[55]

Germane to the adaptive management process, the FEIR explains the rational for not using numeric thresholds to enact adaptive management. On page 2-74, the FEIR explains;

"Numeric objectives or performance criteria such as acreages of habitat types or values of measurable habitat parameters have not been established to assess the project's success or as triggers for adaptive management actions for several reasons. First, the habitat needs of specific species or guilds are known in general terms, but the optimal conditions are difficult to express in quantitative terms in most cases. Second, different species have different and often competing habitat needs. A change in a habitat variable that is desirable for one habitat indicator species may be undesirable or irrelevant to another habitat indicator species. Third, ecological systems are dynamic by nature, and biological conditions at one point in time often cannot predict or illustrate the unseen dynamics that create change in the system. Area specific changes in habitat attributes from one year to another may become irrelevant when put in the context of the long-term net changes in the overall LORP area. Therefore, establishing numeric objectives or performance criteria for multiple species in the large, complex, and dynamic ecosystem of the LORP is not proposed."

Thus, no monitoring threshold is identified for terrestrial indicator species. Rather the FEIR focuses on specific habitat characteristics that may influence the quality (suitability) of the habitat for indicator species. The FEIR explains, "if insufficient increases in the following parameters are observed, this would indicate habitat trends that are inconsistent with project goals and could necessitate adaptive management actions:

- Development of middle and understory foliage
- Vertical structure with clear stratification
- Development of live herbaceous and residual biomass
- Plant species richness (combined with dominance by a few species such as exotics)
- Age structure complexity and vegetative and/or new regeneration
- Success rate of new and vegetative recruits
- Vigor and vitality coupled with poor reproductive potential and resiliency
- Development of the woody riparian canopy (width)
- Connectivity between and among river reaches, their tributaries and associated springs, seeps and wetlands
- Development of stand size and fragmentation of interior habitat

Such habitat characteristics will be collected through the monitoring of habitat for indicator species. If the quality (suitability) of habitat for an indicator species or guild decreases over time, it may be one of the

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[54] EMP, Table p. 110

[55] LORP FEIR, P. 2-66

characteristics mentioned above that is the cause of the deterioration.

Deviations from Mandatory Documents

Indicator species habitat quantity and quality (suitability) will be assessed using the California Wildlife Habitat Relationship system (CWHR). The CWHR is a California specific Habitat Evaluation Procedure. Habitat Evaluation Procedures (HEP) are a mode of evaluating habitat for a specific species, taxa or guild. The CWHR was derived for habitats in California and is widely used and accepted throughout the state. Using the CWHR as a method to monitor the quantity and quality (suitability) of habitat for indicator species in the LORP is a major deviation from the mandatory documents that constitute the LORP. For example, Technical Memoranda's #16 and #19 quantify existing and future habitat for some indicator species using species specific HSIs (habitat suitability indices).

Additionally, the LORP Ecosystem Management Plan recommends that managers develop native riparian and wetland habitats consistent with the suitability curves for 14 habitat characteristics important to the "habitat indicator species" and special status species.[56] Although monitoring using CWHR protocols will capture changes in the habitat characteristics important to the indicator species, the existing suitability curves referenced in Technical Memoranda #16 and #19 will not be compared to future conditions. Rather, species and guild specific CWHR suitability indices will be derived to monitor changes in the quantity and quality of habitat for indicator species. The change from species specific HSI's to the CWHR is a result of: (1) Not all indicator species had an HSI built for them thus future monitoring would only evaluate a subset of the LORP indicator species, (2) Future monitoring of the LORP indicator species will be using a widely accepted approach (CWHR) that is easily repeatable, (3) LADWP and ICWD are familiar with the CWHR and expressed interest in using it rather than relying on old HSI information.

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[56] EMP, Table p. 99

3.13 RIVERINE-RIPARIAN HABITAT

Effectiveness Monitoring

OBJECTIVE

Implementation of the LORP (base flow and seasonal habitat flow compliance) is resulting in new recruitment of riparian vegetation (habitat), primarily willow and cottonwood.

MONITORING EVALUATION

Riverine-riparian habitat increases in quantity and quality.

See Page 3-43 for monitoring data considered in evaluations.

YES

Implementation of the LORP is resulting in an increased acreage of Riparian Habitats, primarily willow and cottonwood, compared to baseline conditions.

Continue Monitoring

NO

Implementation of the LORP is **not** resulting in an increased acreage of Riparian Habitats, primarily willow and cottonwood, compared to baseline conditions.

PROBLEM ANALYSIS

<u>Questions</u>:

In average to above average years is the seasonal habitat flow of sufficient magnitude to provide out-of-bank flooding?

Does the Rapid Assessment Survey for the riverine-riparian area demonstrate that tamarisk is being controlled to the extent possible?

Does the land use monitoring data indicate that grazing prescriptions are enabling (or hindering) the recruitment and establishment of riparian vegetation?

CONTINGENCY MONITORING AS NEEDED

ADAPTIVE MANAGEMENT MEASURES (See Section 3.4)

#2. Modify the timing of seasonal habitat flows
#3. Modify the magnitude and/or duration of seasonal habitat flows
#7. Plant native vegetation species
#8. Conduct exotic plant control activities
#9. Modify tule removal activities
#10. Modify beaver and beaver dam control activities
#11. Modify fencing, or addition of new fencing, for riparian and upland pastures
#12. Modify utilization rates and timing within riparian and upland pastures
#13. Install grazing exclosures
#15. Modify the river channel
#16. Modify recreational and human use management

SELECT & IMPLEMENT ADAPTIVE MANAGEMENT ACTION(S)

3.13 Riverine-Riparian Habitat

Habitat is defined as, “The area or environment where an organism or ecological community normally lives or occurs.”[57] This very broad definition is limited in this section to riverine-riparian habitat, especially willow and cottonwood, as the habitat these species create is specifically mentioned in the mandatory documents described below.

Riverine-Riparian Habitat Evaluation: Data Used for Effectiveness Monitoring

Riverine-riparian habitat increases in quantity and quality. Evaluated by:

- Base Flow Monitoring (4.2.1.1)
- Seasonal Habitat Flow Monitoring (4.2.3.1)
- Seasonal Habitat Flooding Extent Monitoring (4.2.3.2)
- Rapid Assessment Survey (4.2.5)
- Habitat Monitoring (4.2.6.1)
- Landscape Vegetation Mapping (4.2.7.1)
- Site Scale Vegetation Assessment and Landform Elevation Mapping (4.2.7.2)
- Avian Census (4.2.8.1)
- Utilization Monitoring (4.6.2)
Range Trend Monitoring (4.6.3)

Project Expectations

As mentioned above, the MOU states that habitat flows must “fulfill the wetting, seeding, and germination needs of riparian vegetation, particularly willow and cottonwood” (page 15). Therefore it is expected that the seasonal habitat flow will result in willow and cottonwood recruitment. Riparian tree recruitment is a sporadic and stochastic event, and cannot be expected every season. However, over time, willow and cottonwoods are expected to develop within the riverine-riparian corridor.

The FEIR both clarifies and specifies these expectations. In relation to temporal expectations, on page 2-66 the FEIR reiterates that habitat development will require long periods of time; “Fifteen years is widely accepted to be the amount of time generally needed for an ecosystem to approach a steady state.” The FEIR specifies expected acreages for vegetation types, including willow, cottonwood and wet meadow vegetation types.

Specific predictions contained in the FEIR include:

- Over time, the rewatering of the river is predicted to convert about 2,343 acres of alkali scrub/meadow (an upland vegetation) and 531 acres of alkali meadow (upland phase) to various wetland and riparian vegetation types due to inundation effects and altered hydrologic conditions along the river (page S-21).
- The rewatering of the river will increase the amount of wetlands along the river by about 3,000 acres. Wetlands to be created include riparian forest, alkali meadow and marsh/alkali wet meadow (page S-29)
- Existing herbaceous wetland vegetation types (marsh/wet alkali meadow and alkali meadow) would increase substantially due to greater availability of water from flooding and lateral diffusion. The area of herbaceous wetland was predicted to increase from 559 acres to 2,631 acres (page 4-30).
- New riparian forest would be created as willows and cottonwood colonize barren streambars, mostly in the dry reach above Mazourka Canyon Road and, less extensively, existing wetlands and riparian habitats along the wet reach of the river to the south. It was estimated that an additional 854 acres of riparian forest will be created over time (page 4-30).

However, the FEIR cautions that these predictions are imprecise and that some estimates may be larger than will be possible, “given the extensive existing and future flooding and the absence of streambars necessary for establishing new riparian forest in the Lower Owens River,

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[57] ("habitat." *The American Heritage® Dictionary of the English Language, Fourth Edition*. Houghton Mifflin Company, 2004. 17 Jan. 2008. <Dictionary.com http://dictionary.reference.com/browse/habitat>.)

these estimates may be optimistic" (page 4-30).

Feedback Mechanism for Monitoring and Adaptive Management

If monitoring shows that willow and cottonwood recruitment is not occurring, then modifications to flow and land management may be undertaken. Riparian mapping and habitat transects should show riparian shrub and tree development following several years of habitat flows. If recruitment is not occurring, then changes in flow timing and ramping rates may be examined, as well as land management, because domesticated livestock graze native willow and cottonwood seedlings and may hamper proper riparian habitat development. In the tables on page 100 of the EMP, it states that riparian habitat development specifically that of willow, cottonwood and wet meadow vegetation will be mapped and large-scale trends in habitat extent identified. Tule development, beaver dams and open water areas will also be documented.

The FEIR (section 2.10.1) identifies the following monitoring scales and elements to evaluate riparian habitat:

1. Macro-scale monitoring (to observe major habitat changes, enable early detection of problem areas, and assess whether changes measured at the micro-scale are representative of the overall LORP area)
   - Rapid Assessment Surveys
   - Habitat Mapping

2. Micro-scale monitoring (to identify biologically significant changes by measuring specific habitat features and to substantiate changes measured at the macro-scale), and indicator species analysis using CWHR.

3.13.1 Document Integration and Direction

MOU

The MOU identifies the creation of riverine-riparian habitat as a goal of the LORP in Section II.B.1 (p. 8), "Establishment and maintenance of diverse riverine, riparian . . . habitat in a healthy ecological condition." These habitats will be created "through flow and land management, to the extent feasible" and be "consistent with the needs of "habitat indicator species" (p.9). Because terrestrial indicator species habitat is covered under Section 3.12, this section addresses riverine-riparian habitat as limited to willow and cottonwood recruitment as Section II.C.1.b.ii of the MOU states that flow management must "fulfill the wetting, seeding, and germination needs of riparian vegetation, particularly willow and cottonwood" (p. 15).

Technical Memorandum #19

Technical Memorandum #19, *Riparian Wildlife Management Summary of Management Concepts and Priorities*, identifies habitat goals as detailed in the MOU, and discusses management concepts and priorities for implementing management actions. Technical Memorandum #19 does not address adaptive management.

LORP Ecosystem Management Plan

Page 14 of the EMP identifies the importance of riparian habitat, stating "The heart of an ecologically healthy watershed is the riparian habitat." It also lays out specific objectives for habitat, with specific reference to willow and cottonwood development. The riparian habitat management objective is to develop a lateral and longitudinal corridor of native riparian plant communities throughout the river by using annual seasonal habitat flows of up to 200 cfs. Riparian habitat should be dominated by willow, cottonwood and wet meadow vegetation that exhibit healthy age structure developing toward late seral stages.

The EMP presents the following possible adaptive management actions in relation to riparian habitat:

- Action 1-2: Seasonal habitat flows alone will not determine vegetation trends, therefore land management and grazing strategies will be used to enhance and influence riparian zones. Land and water management will be constantly coordinated through monitoring feedback to ensure that riparian habitat is developing a healthy age structure, diversity and trend toward late seral stages (page 14).

- Action 1-3: Active interventions, such as planting of riparian and upland vegetation, can be employed if adaptive management indicates such actions would be beneficial. Specific areas of the river or uplands where planting and vegetating efforts could be performed will require time to identify and assess after first allowing water and land management efforts to show positive results before intervening in other ways (page 14).

Beaver control is also identified as an adaptive management action designed “to protect the development and sustainability of riparian vegetation, particularly willow and other shrub species” (page 26). Beaver control is the responsibility of the CDFG; however, removal does not have to be conducted by the CDFG.

Final EIR

The FEIR identifies the goals for the LORP riverine-riparian system on page S-3,”The goal for the Lower Owens River Riverine-Riparian System is to create and sustain healthy and diverse riparian . . . habitats.” Other references to riverine-riparian habitat goals in the FEIR are quoted directly from or comport with those detailed in the MOU and Ecosystem Management Plan.

The FEIR identifies several situations in which monitoring data could result in adaptive management actions relating to riverine-riparian habitat in Table 2-19, beginning on page 2-79. These include:

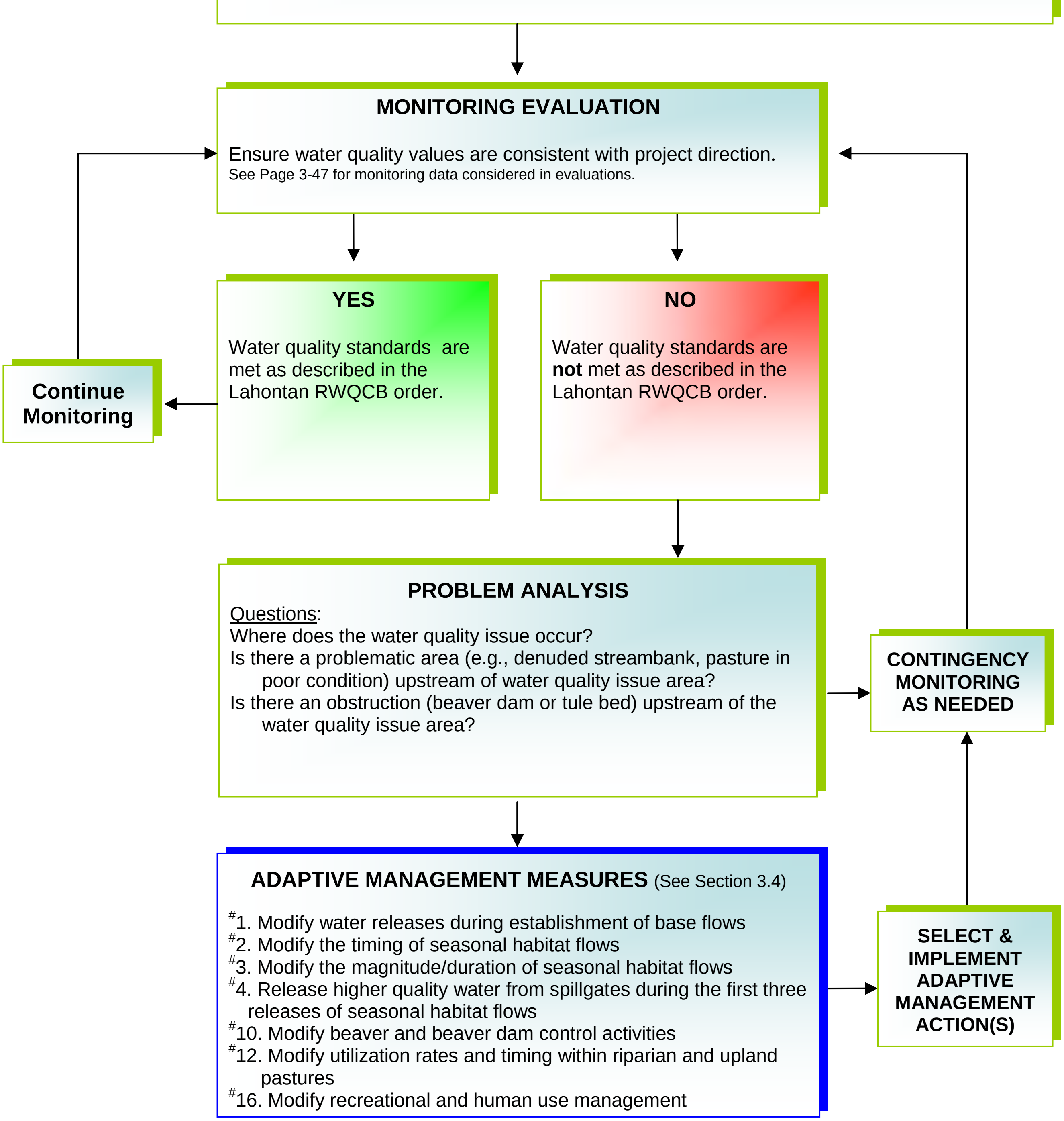
- If monitoring data indicate that seasonal habitat flows are being released outside of the peak time of seed development and/or flows adjusted to account for variable seed development between lower river reaches, then adaptive management actions may be taken. A determination that the habitat goals being achieved will be based upon monitoring data that show habitats are not achieving desired trend in habitat characteristics related to understory structure and composition and recruitment. An appropriate adaptive management action for this situation would be to adjust the timing of seasonal habitat flows to maximize seed dispersal and germination and avoid seeding period of exotic species.
- If monitoring data shows riparian plants are not being recruited (within the first 5 years) or sustained through time (within the 15-year monitoring period) in areas subject to out-of-channel flooding from seasonal habitat flows, then an appropriate adaptive management action might be to modify the ramping pattern of seasonal habitat flows by adjusting the peak flow and/or length of time during which seasonal habitat flows are released.
- If natural revegetation is not occurring to the extent expected even after adjustments of seasonal habitat flows and/or adjustments to grazing management, then it might be appropriate to plant native vegetation species to encourage the establishment of vegetation at specific sites or managers could disperse seeds of native vegetation into the river during seasonal habitat flows and/or into areas that will be inundated by seasonal habitat flows.
- If existing livestock grazing strategies are hindering achievement of habitat goals, based upon monitoring data that show recruitment or growth of desired vegetation is prevented or inhibited due to current grazing strategies, a grazing management change may be required. An appropriate action might be to alter utilization rates employed to manage livestock grazing and/or alter timing of livestock grazing.

Deviations from Mandatory Documents

There are no meaningful deviations in goals among the mandatory documents. There are some changes in habitat monitoring, as habitat development monitoring has been removed and replaced with CWHR monitoring and site-scale vegetation assessment, as detailed in Section 4.2.6.

3.14 WATER QUALITY

Compliance Monitoring



OBJECTIVE

Water Quality standards, as outlined in the Lahontan RWQCB Order, are being met within the Lower Owens River. *Lahonton RWQCB exemption to discharge prohibitions expires July 14th 2015.

MONITORING EVALUATION

Ensure water quality values are consistent with project direction.
See Page 3-47 for monitoring data considered in evaluations.

YES

Water quality standards are met as described in the Lahontan RWQCB order.

Continue Monitoring

NO

Water quality standards are **not** met as described in the Lahontan RWQCB order.

PROBLEM ANALYSIS

Questions:
Where does the water quality issue occur?
Is there a problematic area (e.g., denuded streambank, pasture in poor condition) upstream of water quality issue area?
Is there an obstruction (beaver dam or tule bed) upstream of the water quality issue area?

CONTINGENCY MONITORING AS NEEDED

ADAPTIVE MANAGEMENT MEASURES (See Section 3.4)

#1. Modify water releases during establishment of base flows
#2. Modify the timing of seasonal habitat flows
#3. Modify the magnitude/duration of seasonal habitat flows
#4. Release higher quality water from spillgates during the first three releases of seasonal habitat flows
#10. Modify beaver and beaver dam control activities
#12. Modify utilization rates and timing within riparian and upland pastures
#16. Modify recreational and human use management

SELECT & IMPLEMENT ADAPTIVE MANAGEMENT ACTION(S)

3.14 Water Quality

Water quality monitoring is integral to achieving the LORP Ecosystem Management Plan and MOU goal of establishing a functioning ecosystem and maintaining diverse riverine-riparian and wetland habitats. Before, during and after initiation of base flow and seasonal habitat flow releases, water quality is monitored to ensure compliance with water quality standards.

Water Quality Evaluation:
Data Used for Compliance Monitoring

Ensure water quality values are consistent with project direction. Evaluated by:

- Base Flow Monitoring (4.2.1.1)
- Water Quality Monitoring (4.2.2)
- Seasonal Habitat Flow Monitoring (4.2.3.1)
- Rapid Assessment Survey (4.2.5)
- Irrigated Pasture Condition Scoring (4.6.1)
- Utilization Monitoring (4.6.2)
- Range Trend Monitoring (4.6.3)

Project Expectations

As described in the Lahonton Regional Water Quality Control Board (RWQCB) Permit and Order, the reintroduction of flows to the river under the LORP is expected to result in adverse impacts to water quality, including increased turbidity, lowered dissolved oxygen, and release of hydrogen sulfide and ammonia. Possible poor water quality conditions may result in adverse effects to the existing non-native game fish populations in the wetted reach, including potential fish kills. Impacts are expected to attenuate over time as the new higher flow regime becomes established and are expected to result in the restoration of designated beneficial uses.[58] The LORP must meet basin water quality standards 7 years after flow release.

Feedback Mechanism for
Monitoring and Adaptive Management

Before, during and after initiation of base flows and seasonal habitat flows, if water quality thresholds outlined by the Lahontan Regional Water Quality Board Order have been exceeded at a monitoring station, water will be released to the river through the spillgate linked to that monitoring station to create refugia for fish in the spillgate channel and at the confluence with the river below the spillgate. Other adaptive management measures that may be used to address water quality issues include: modifying the magnitude, duration and timing of seasonal habitat flows, modifying beaver and beaver dam control activities, modifying utilization rates and timing within riparian and upland pastures, and modifying recreational and human use management.

3.14.1 Document Integration and Direction

MOU

The MOU goal for water quality includes managing water quality to meet applicable laws, standards and objectives. Water quality is an essential element in achieving the MOU goal of “establishing a healthy, functioning Lower Owens riverine-riparian ecosystem…”[59]

Technical Memorandum #7

Technical Memo #7, *Water Quality in the Lower Owens River: Existing and Future Conditions* develops a matrix of designated beneficial uses and water quality objectives. It provides water quality monitoring data used to establish water quality baseline conditions. Adaptive management will include implementing action plans for the emergency recovery of fish (includes catch

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[58] Lahonton RWQCB Order 2005, Page F-21

[59] MOU 1997, pg. 13

and transport to nearby lakes and ponds) should water quality conditions begin to deteriorate or release of water through spill channels until water quality conditions improve. During monitoring, the Lahonton Regional Board, LADWP and Inyo County will work closely together to address specific water quality issues.

Technical Memorandum #11

Technical Memo #11, *Critical Path for Flow Management during the Initial Years*, discusses the potential impacts of re-watering during the initial years as it pertains to water quality, including fish kills and a short-term influence on water quality conditions. Monitoring will be conducted during the initial flows to prevent fish kills and minimize stress on existing fish populations from rapidly deteriorating water quality conditions. The adaptive management approach to addressing water quality concerns is generally referred to as “anticipating adverse conditions and adjusting the system as needed.”

LORP Ecosystem Management Plan

Project actions include avoiding, minimizing and managing water quality degradation during the establishment of base flows and during seasonal habitat flows, within the flow requirements of the MOU. Monitoring actions include measuring water quality parameters related to RWQCB designated beneficial uses and tracking trends in water quality over time.

Water quality is measured at 9 locations. Water quality parameters measured include dissolved oxygen, pH, electrical conductivity, temperature, turbidity, ammonia, hydrogen sulfide, tannins and lignins. Ambient air quality measurements for hydrogen sulfide, methane and ammonia are also recorded.

The Ecosystem Management Plan contains monitoring schedules for the different phases of flow releases: prior to the Phase I flows, water quality monitoring was conducted to establish baseline conditions. During Phase I releases, water quality monitoring is conducted weekly or bi-weekly; during Phase II releases, water quality is monitored 1-5 days per week for up to six months, as necessary, then one day per week for another six months. Thereafter, water quality monitoring will cease (except during seasonal habitat flows, which will be monitored weekly and the data compiled and submitted to LADWP and Inyo County).

If water quality thresholds are exceeded (during the Phase I and Phase II flows and during the seasonal habitat flows), flows downstream of the River Intake will be augmented with higher quality water released from the spillgates (augmentation of seasonal habitat flows will only occur during the first three seasonal habitat flows). These water quality thresholds include: (1) Decrease in dissolved oxygen to less than 90 percent of the natural concentration based on one month of baseline data collection, and/or (2) 10 percent increase in hydrogen sulfide concentration above ambient levels as determined by one month of baseline data collection, and/or (3) 10 percent increase in ammonia concentration above ambient levels as determined by one month of baseline data collection.

Final EIR

The Final EIR describes the regulatory framework relative to water quality for the LORP. The Lahontan RWQCB Basin Plan sets forth water quality standards, which include (1) designating beneficial uses of water, and (2) narrative and quantitative water quality objectives (see description below under the Regional Water Board). The LORP must comply with these standards and the standards established under Section 303(d) of the federal Clean Water Act,[60] within 7 years after flow release.

The FEIR describes water quality thresholds for dissolved oxygen, hydrogen sulfide, ammonia and fish conditions (pg. 2-18). If these thresholds are exceeded, the FEIR recommends spillgate releases to provide fish with refuge areas of higher quality water at the confluences of spillgate channels with the river channel (pg. 4-27). Once operation

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[60] LORP FEIR, pp. 4-12 to 4-14

of a spillgate is commenced, water quality monitoring by spot measurements will be conducted in the river below the spillgate channel. Monitoring below spillgate channels will be in addition to the water quality monitoring at the four monitoring stations (pg. 2-17). Operation of the three spillgates to create refuges for fish will be discontinued when: (1) water quality at the monitoring station linked to the spillgate and at the confluence with the river below the spillgate channel rises above the water quality thresholds, or (2) fish at the monitoring stations are not exhibiting signs of stress. If releases from one or more of these spillgates are required, flows to the river will be adjusted so that approximately 40-cfs are maintained.

Lahonton Regional Water Quality Board

The 2005 permit issued to LADWP by the Regional Water Quality Control Board (RWQCB) requires that LORP flow management comply with water quality provisions pursuant to Sections 301, 302, 303, 306, 307 of the Clean Water Act and the RWQCB Water Quality Plan (Basin Plan) to protect beneficial uses within 7 years after flow release. The Monitoring and Reporting Program[61] specifies the location of monitoring stations, the water quality parameters to be measured and monitoring schedules. It includes narrative surface water limitations for ammonia, bacteria/coliform, biostimulatory substances, California Toxics Rule Constituents, chemical constituents, color, dissolved oxygen, floating materials, non-degradation of aquatic communities and populations, pH, sediment, settleable materials, suspended materials, taste and odor, temperature, toxicity and turbidity. Numerical surface water limitations for the LORP include: total dissolved solids, chloride, boron, fluoride, nitrogen (and nitrogen as nitrate), sulfate and dissolved orthophosphate.

The Order states that: "…the Discharger [LADWP] is expected to make use of indicator parameters including, but not limited to, ammonia, dissolved oxygen, and turbidity for compliance screening, and to obtain real-time feedback for evaluating maintenance of water quality objectives to guide adaptive management and maintain compliance" (p. 24). Water quality parameters are described in detail in the Order (p. 13-18) and in Section 4 of this monitoring plan. This Order has more stringent water quality monitoring requirements (to meet water quality standards contained in the Basin Plan) than the other mandatory documents.

If water quality thresholds are exceeded, the Order is consistent with the Final EIR and EMP requirement that "water will be released to the river from the Aqueduct through the spillgate linked to the monitoring station to create a refuge for fish in the spillgate channel and at the confluence with the river below the spillgate channel" (p. H-3).

Deviations from Mandatory Documents

The Lahontan Regional Water Quality Control Board Order for the LORP contains more stringent requirements for water quality monitoring than the other mandatory documents, and supersedes those documents.

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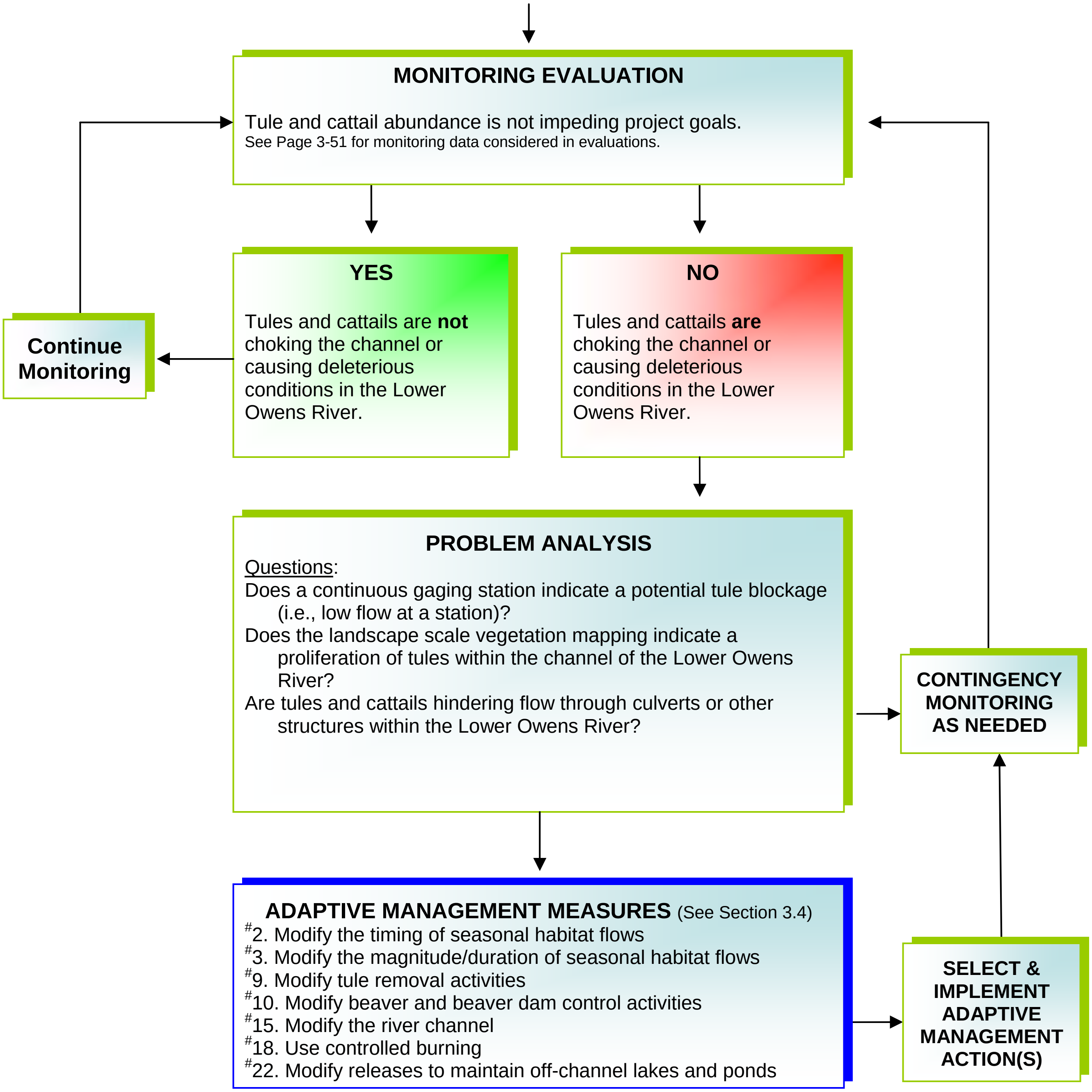
[61] Lahonton Regional Water Quality Board, Attachment E

3.15 Tule/Cattail Control

Effectiveness Monitoring



Objective

Control tules and cattails to the appropriate extent.

MONITORING EVALUATION

Tule and cattail abundance is not impeding project goals.
See Page 3-51 for monitoring data considered in evaluations.

YES

Tules and cattails are **not** choking the channel or causing deleterious conditions in the Lower Owens River.

Continue Monitoring

NO

Tules and cattails **are** choking the channel or causing deleterious conditions in the Lower Owens River.

PROBLEM ANALYSIS

Questions:

Does a continuous gaging station indicate a potential tule blockage (i.e., low flow at a station)?

Does the landscape scale vegetation mapping indicate a proliferation of tules within the channel of the Lower Owens River?

Are tules and cattails hindering flow through culverts or other structures within the Lower Owens River?

CONTINGENCY MONITORING AS NEEDED

ADAPTIVE MANAGEMENT MEASURES (See Section 3.4)

#2. Modify the timing of seasonal habitat flows
#3. Modify the magnitude/duration of seasonal habitat flows
#9. Modify tule removal activities
#10. Modify beaver and beaver dam control activities
#15. Modify the river channel
#18. Use controlled burning
#22. Modify releases to maintain off-channel lakes and ponds

SELECT & IMPLEMENT ADAPTIVE MANAGEMENT ACTION(S)

3.15 Tule/Cattail Control

The Lower Owens River supports a high biomass of tules (formerly *Scirpus acutus*, *now Schoenoplectus acutus*), and cattails (*Typha* spp.). Tules and cattails often dominate wetted reaches of the channel from just above Mazourka Canyon Road to the Delta, and are expected to increase in the dry reach following flow initiation. Excessive tule/cattail biomass can be a disadvantage in the development of a flowing and functioning river, as prolific tule growth and consequential die-off can have an ongoing and deleterious effect on dissolved oxygen, BOD and sediment transport and deposition. On the other hand, tules and cattails provide many ecological benefits.

For example, tule/cattail growth in the Lower Owens River provides bank and channel stability, reduces erosion and adds shade and nutrients. High density tule stands are essential habitat for many bird and animal species and provide winter habitat for waterfowl and shorebirds. Dense vegetation stands also provide valuable refuge and early rearing habitat for both native and introduced fish species. Stands of emergent vegetation also filter sediments from stream flow which improves water quality; tules remove nutrients, organics and suspended solids and modify low winter and high summer temperatures. Thus, the issue is not the elimination of tules but the control and management of excessive tule/cattail growth and their influence on the Lower Owens River's flow and function.[62]

Tule/Cattail Control Evaluation:
Data Used for <u>Effectiveness Monitoring</u>

Tule and cattail abundance is not impeding project goals.
Evaluated by:

- Base Flow Monitoring (4.2.1.1)
- Seasonal Habitat Flow Monitoring (4.2.3.1)
- Seasonal Habitat Flooding Extent Monitoring (4.2.3.2)
- Rapid Assessment Survey (4.2.5, 4.3.2, 4.4.2, 4.5.2)
- Habitat Monitoring (4.2.6.1, 4.3.3, 4.4.3)
- Landscape Vegetation Mapping (4.2.7.1, 4.3.4, 4.4.4)
- Site Scale Vegetation Assessment and Landform Elevation Mapping (4.2.7.2)

Project Expectations

The expectations for tules and cattails, outlined in the documents mentioned below, are all similar. It is expected that tules and cattails will encroach in certain areas of the Lower Owens River and that they will need to be controlled. In fact, the FEIR on page 4-32 (Table 4-11) expects a 15% increase in tule cover throughout the river. Yet, control does not entail elimination as the ecological benefits of tules and cattails to the Lower Owens River system are great. Technical Memorandum #9 summarizes the expectations of tule/cattails in the Lower Owens River by stating, "that tules will occupy channel landforms when the following environmental conditions occur: (1) riparian overstory (particularly tree willows and cottonwoods) do not develop; (2) water depth is less than six feet; (3) light penetration is greater than three feet; (4) and stream velocities associated with high flows are too low to prevent rhizome cloning. Over time, as the system develops, cottonwood/willow canopies will expand to shade the river reducing light penetration into the water column and becoming a significant natural tule control mechanism.[63]

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[62] Tech Memo #9

[63] Tech Memo #9 p.13

Yet, until cottonwood/willow canopies develop the mechanical removal of tule and cattails will be required to maintain the flow and function of the Lower Owens River.

Feedback Mechanism for Monitoring and Adaptive Management

The extent of tules and cattails in the Lower Owens River will be primarily monitored through vegetation mapping. Vegetation mapping will identify areas inundated with tules and cattails. Additional on-site, field monitoring will be needed to evaluate whether or not the tule and cattail infested areas are a detriment to project goals. For example, if tules and cattails are causing a culvert to not function properly then mechanical removal will be required. Overall, management decisions on when and where to implement mechanical removal will rest with the Scientific Team. As mentioned in each of the mandatory documents summarized above, flooding extent and time are the two most important components used to adaptively manage tules and cattails. For example, seasonal habitat flows are intended to increase water depth, reduce light penetration and sufficiently increase stream flows to prevent rhizome cloning, which will reduce the extent of tules and cattails. Balancing action and inaction in adaptive management decisions is always important.[64] For example, the Scientific Team must be cognizant of allowing time for cottonwood/willow canopies to expand and shade the river channel, thus allowing the natural processes to control tules and cattails.

3.15.1 Document Integration and Direction

MOU

The MOU describes the control of tules and cattails as a goal of the seasonal habitat flow. The MOU states, “the purpose of the habitat flow is the creation of a natural disturbance regime that produces a dynamic equilibrium for riparian habitat, the fishery, water storage, water quality, animal migration and biodiversity which results in resilient and productive ecological systems. To achieve and maintain riparian habitats in a healthy ecological condition, and establish a healthy warm water recreational fishery with habitat for native species, the plan will recommend habitat flows of sufficient frequency, duration and amount that will . . . *(4) control tules and cattails to the extent possible.*”[65]

Technical Memorandum #9

Technical Memorandum #9 describes the existing and projected conditions of tule/cattails in the LORP and alternative methods to manage tules and cattails. The document also includes a review of ecological values that are provided by tules/cattails in the riverine-riparian environment. Technical Memorandum #9 also presents options to prepare the channel for initial flows and includes a management approach for tules and cattails. Technical Memorandum #9 is very clear in stating the goal of tule/cattail control in the LORP is not the elimination but the control of tules and cattails in areas where they may cause deleterious conditions (e.g. culverts).

In terms of adaptive management Technical Memorandum #9 explains that, “it may be necessary to intervene and mechanically remove some tule stands to create channels and prevent excessive backwater effects. Adaptive management provides the flexibility to respond to real time conditions and revise management methods to fit actual conditions. For example, monitoring of tule beds may indicate that flow would be enhanced in the short term by removing tules in a specific problem area to create an open channel. However, the keys to successful tule and organic sediment management with stream flow are time and patience; it will take time for riparian vegetation to develop and patience to recognize that tules and cattails are critical and important components of the Lower Owens River ecosystem” (p.14). In conclusion, Technical Memorandum #9 elucidates the importance of tules and cattails to a healthy functioning

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[64] Salafsky, Margoluis and Redford 2001

[65] MOU 1997, Section II.C.ii

riverine environment, but acknowledges that control of tules and cattails is a necessary requirement to achieve the goals of the LORP.

LORP Ecosystem Management Plan

The Ecosystem Management Plan addresses tule/cattail control in Chapter 2, the River Management Plan. This section describes the disadvantages and merits of tules and cattails within the LORP. On page 14, the EMP explains the overall goal of the management of tules and cattails in the LORP by stating, "as a result of the ecological benefits provided, the LORP does not desire to eliminate tules, but to control and manage negative influences on river flow and function as a result of excessive tule growth."

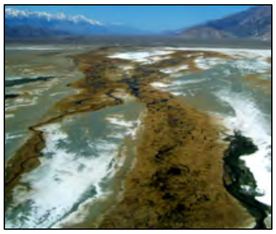
The EMP differs from the MOU and Technical Memorandum #9 by outlining where and when the active intervention of tule/cattail removal will occur during the initial years of the project. These actions call for cutting a channel through areas that are excessively choked with tules and cattails between Mazourka Canyon Road and the Delta. Similar to Technical Memorandum #9 the Ecosystem Management Plan advises project managers to be patient and "allow tules and riparian communities to achieve a natural balance in response to base and riparian flows that will create river reaches of both closed and open canopy over time." The closed canopy sections will shade the river channel, which offers a natural tule/cattail control.

Final EIR

The FEIR is consistent with the MOU, Technical Memorandum #9 and the Ecosystem Management Plan regarding the goals, ecological merits of tules and cattails, and the advantages and disadvantages of tule/cattail control. The FEIR expands on the other documents by describing where, when and by what means tules and cattails will be removed from the river. For example, the FEIR explains on page 2-26, that "active tule removal will only be conducted in rare instances, and would probably only be considered where there are significant constrictions along the river or at culverts." Additionally, the FEIR explains that, "in the rare instances of active tule removal, they would be removed by mechanical means. A tracked excavator would work from adjacent dry banks or levees to remove tules (both above and below ground parts). Excavated material would be temporarily stockpiled in upland areas to dewater, then would be removed from the site. The excavator would typically create a 15 to 25 foot wide open channel, removing whole tule plants and roots from the channel bottom" (p 2-26). The FEIR excludes fire as a management prescription for the control of tules and cattails by stating, "Tules would not be removed or managed by controlled burns" (p 2-26).

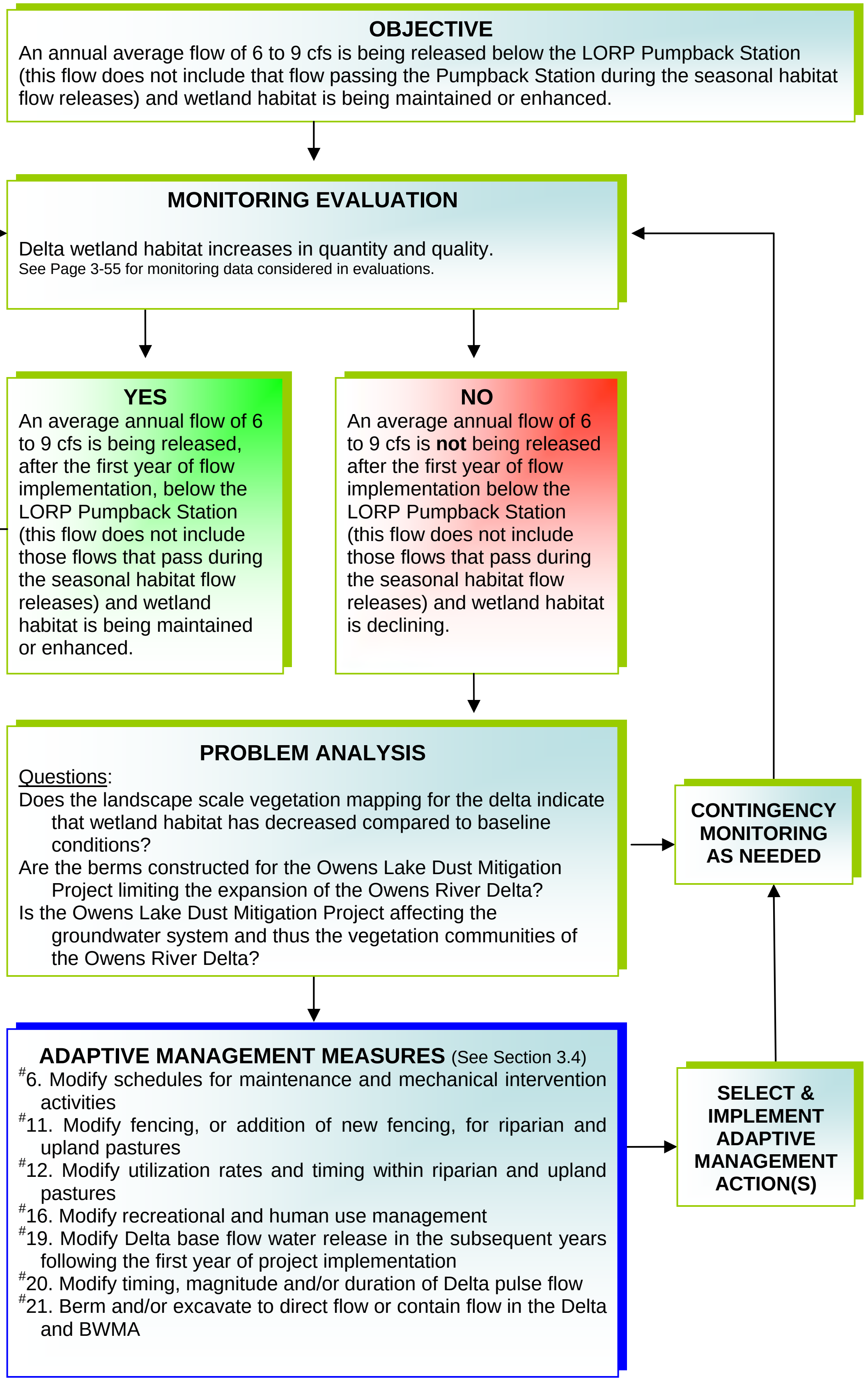
Deviations from Mandatory Documents

There are no significant deviations among the LORP mandatory documents regarding tule/cattail control. The greatest deviation from the mandatory documents is the difference between the FEIR and the present on-going tule/cattail control in the LORP. The FEIR, as described above, states that tule/cattail control will be conducted using a tracked excavator from adjacent banks. This method would cause significant impacts to the banks of the Owens River. The FEIR's description of tule/cattail removal is dated as new technology is available that minimizes impacts to the banks of the river. LADWP commenced, in early December 2007, tule/cattail control in preparation of the initial 200 cfs seasonal habitat flow. LADWP cleared tules and cattails using the "Terminator", a boat equipped with blades that cut a 15 – 20 ft wide path through tules and cattail beds, upstream and downstream of culverts at Mazourka Canyon Road, Manzanar Reward Road, Lone Pine Narrow Gauge Road, from Keeler Bridge to the pumpback station, and in portions of the Islands. The "Terminator" caused minimal disturbance to the banks of the Owens River where it was employed.



3.16 Delta Habitat Area

Compliance Monitoring



OBJECTIVE

An annual average flow of 6 to 9 cfs is being released below the LORP Pumpback Station (this flow does not include that flow passing the Pumpback Station during the seasonal habitat flow releases) and wetland habitat is being maintained or enhanced.

MONITORING EVALUATION

Delta wetland habitat increases in quantity and quality.

See Page 3-55 for monitoring data considered in evaluations.

YES

An average annual flow of 6 to 9 cfs is being released, after the first year of flow implementation, below the LORP Pumpback Station (this flow does not include those flows that pass during the seasonal habitat flow releases) and wetland habitat is being maintained or enhanced.

Continue Monitoring

NO

An average annual flow of 6 to 9 cfs is **not** being released after the first year of flow implementation below the LORP Pumpback Station (this flow does not include those flows that pass during the seasonal habitat flow releases) and wetland habitat is declining.

PROBLEM ANALYSIS

Questions:

Does the landscape scale vegetation mapping for the delta indicate that wetland habitat has decreased compared to baseline conditions?

Are the berms constructed for the Owens Lake Dust Mitigation Project limiting the expansion of the Owens River Delta?

Is the Owens Lake Dust Mitigation Project affecting the groundwater system and thus the vegetation communities of the Owens River Delta?

CONTINGENCY MONITORING AS NEEDED

ADAPTIVE MANAGEMENT MEASURES (See Section 3.4)

#6. Modify schedules for maintenance and mechanical intervention activities

#11. Modify fencing, or addition of new fencing, for riparian and upland pastures

#12. Modify utilization rates and timing within riparian and upland pastures

#16. Modify recreational and human use management

#19. Modify Delta base flow water release in the subsequent years following the first year of project implementation

#20. Modify timing, magnitude and/or duration of Delta pulse flow

#21. Berm and/or excavate to direct flow or contain flow in the Delta and BWMA

SELECT & IMPLEMENT ADAPTIVE MANAGEMENT ACTION(S)

3.16 Delta Habitat Area

To comply with MOU flow requirements for the Owens River Delta Habitat Area, base flows and pulse flows (also called habitat flows) will be implemented in the Delta to maintain vegetated wetlands and create and enhance habitat conditions consistent with the needs of habitat indicator species.

Delta Habitat Area Evaluation:
Data Used for Compliance Monitoring

Delta wetland habitat increases in quantity and quality. Evaluated by:

- Delta Flow Monitoring (4.4.1)
- Rapid Assessment Survey (4.4.2)
- Habitat Monitoring (4.4.3)
- Landscape Vegetation Mapping (4.4.4)
- Wetland Avian Census (4.4.5)
- Utilization Monitoring (4.6.2)
- Range Trend Monitoring (4.6.3)

Project Expectations

Manage Owens River Delta base flows to comply with MOU flow requirements. The proposed flow releases and other management actions are anticipated to increase the total area of riverine-riparian and wetland habitat areas, increase the size and connectivity of the individual habitat areas and increase the structural complexity, productivity and diversity of vegetation communities within individual habitat areas.[66] The pulse flows are expected to enhance the health and vigor of wetlands and enhance production, resulting in the rise of effective water level and further expansion of wetlands.[67]

Other anticipated benefits resulting from implementation of flows include: (1) conversion of unvegetated playa to vegetated wetlands; and (2) conversion of drier wetland types to wetter vegetated wetland types and open water. The flows will also enhance foraging areas in the vegetation-playa-water interface.[68]

Feedback Mechanism for Monitoring and Adaptive Management

To document compliance with MOU goals, flows released to the Delta will be managed and documented as part of pumpback station management. Flow release data from the pumpback station will be documented by a continuous recorder module. The data will be reported weekly. Data from stream gages established to continuously monitor outflow from the DHA will be reported every 14 days for one year after project implementation and monthly thereafter.[69] Monitoring of releases to the Delta from the pumpback station will occur over the life of the project. During establishment of base flows (first year following project implementation), a combined flow of at least 0.5 cfs must be passing the two gaging stations on the east and west branches of the delta.

If monitoring indicates that the MOU flow requirements are not being met, or if the 2000 conditions are not being maintained, under adaptive management, base flows released at the pumpback station can be modified (while maintaining a flow within the 6 to 9 cfs annual average MOU requirements) to the Delta Habitat Area. The magnitude and duration and/or timing of pulse flows released at the pumpback station may also be modified (within the 6 to 9 cfs annual average).[70] Also, if monitoring indicates that flows to the Delta can be reduced while still meeting the MOU goals and maintaining the 2000 Delta conditions, flows may be adjusted downward within the 6 to 9 cfs annual average range.[71] Other adaptive management measures that may be employed in the Delta are listed above in Figure 3.16.

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[66] Final EIR pg. 2-73
[67] Final EIR, pg. 6-24
[68] EMP, pg. 48
[69] EMP, pg. 107
[70] Final EIR, pg. 2-81
[71] EMP, pg. 45

3.16.1 Document Integration and Direction

MOU

The goal for the Owens River Delta Habitat Area is to "enhance and maintain approximately 325 acres of existing habitat consisting of riparian areas and ponds suitable for shorebirds, waterfowl and other animals and to establish and maintain new habitat consisting of riparian areas and ponds suitable for shorebirds, waterfowl, and other animals" (p. 14). These diverse natural habitats will be created and maintained through flow and land management, consistent with the needs of habitat indicator species for the Owens Delta Habitat Area.

The MOU states that "subject to applicable court orders concerning the discharge of water onto the bed of Owens Lake, the quantity of water that will be released below the pumpback station for these purposes will be an annual average of approximately 6 to 9 cfs (not including water that is not captured by the station during periods of seasonal habitat flows)" (pg. 15). The MOU defers to the Wetlands Management Plan element of the LORP Plan, which will "determine the amount of water needed to maintain existing habitats, to enhance existing habitats, and to create new habitats, and will determine the amount and use of seasonal habitat flows". The Wetlands Management Plan will also recommend "how existing habitats should be maintained, which existing habitats should be enhanced, what new habitats should be established, and how the water should be released and used so that these habitats are maintained in a healthy ecological condition" (pg. 15).

Technical Memorandum #8

Technical Memo #8, *Owens River Delta Habitat Area*, contains management objectives for achieving the MOU goal of "…enhancing and maintaining approximately 325 acres of existing habitat…". These objectives for flow management are consistent with the MOU, Final EIR/EIS, and EMP, and include: (1) Implement flows to enhance and maintain approximately 325 acres of existing habitat and if possible, establish and maintain new habitat (estimated water use to maintain and enhance Delta habitat is about 5,205 ac-ft/yr); (2) Implement 3 to 4 periodic habitat maintenance flows to the Delta that will increase the distribution and availability of water and nutrients at key times throughout the year and cause minor disturbance to habitat; and (3) Implement an evaluation and monitoring program that will provide feedback for adaptive management. This memo does not contain specifics regarding monitoring and adaptive management.

The Addendum to Technical Memorandum #8 changes the schedule and duration of Delta habitat flows described in the tech memo to more effectively meet MOU goals for the Owens River Delta Habitat Area.

LORP Ecosystem Management Plan

The Wetland Management Plan (Chapter 3 of the Ecosystem Management Plan) description of management actions for the Delta Habitat Area is consistent with the MOU and Final EIR/EIS, and states: "The management action for creating and enhancing habitats in the Delta is to establish base flows and pulse flows to the Delta from the Lower Owens River with an average annual flow of 6 to 9 cfs, as specified in the MOU."

Stream gages equipped with recording devices will be installed in the outlet of the lower west branch and in the outlet of the lower east branch to measure outflow, which will be analyzed every 14 days during the first year following project implementation (p. 47). If monitoring indicates that the MOU goals are not being met, or if the 2000 conditions (800 acres of water and vegetated wetland) are not being maintained, adaptive management includes adjusting flows to the Delta Habitat Area within the 6 to 9 cfs annual average range specified in the MOU. The monitoring triggers described in the EMP are consistent with those in the Final EIR/EIS (see below).

Final EIR

The Final EIR is consistent with the MOU with regard to flow management for the Owens River Delta Habitat Area. The proposed flow regime (6 to 9 cfs average annual flow) for the Delta is designed to increase water spreading for specific wetland and avian needs. If monitoring indicates that the MOU goals are not being met, or if the "Delta conditions" (as established by the mapping effort using aerial photographs taken prior to implementation of the LORP) are not being maintained, adjustments of daily base flows to the Delta Habitat Area within the 6 to 9 cfs annual average range will be made to attempt to meet the MOU goals and to maintain the "Delta conditions". Similarly, if monitoring indicates that flows to the Delta can be reduced while still meeting the MOU goals and maintaining the "Delta conditions", flows may be adjusted downward within the 6 to 9 cfs annual average range.

Flow compliance monitoring for the Delta Habitat Area includes:

- Flows released to the Delta from the pump station will be recorded hourly and collected biweekly from a continuous recorder.
- During the first year of project implementation, outflow from the Delta will be recorded hourly and collected biweekly from continuous recorders at temporary gaging stations established at the ends of the east and west branches.

Adjustments to the base flows (within the 6 to 9 cfs annual average range) are based upon the following monitoring triggers: (1) A decrease of 10 percent or more during any 3-year period (i.e., the present year and the previous two years) from the "Delta conditions" (total acreage of vegetated wetlands plus water) as estimated from aerial or satellite imagery or other appropriate methods; (2) A 20 percent or greater reduction in habitat suitability index (aerial extent and habitat quality) as measured at 5-year intervals after the commencement of releases of base flows to the Delta; and (3) A reduction in base flows to the Delta will be considered if monitoring indicates an increase of 10 percent or more in area during any 3-year period from the "Delta conditions" and an increase of 20 percent or more in habitat suitability index as measured at 5-year intervals.

The pulse flows (of 20 to 30 cfs), which will be released to the Delta for short periods of time to increase the distribution and amount of water in the Delta to benefit certain vegetation growth periods and shorebird activity, may be modified as part of adaptive management based upon the monitoring triggers described above.

In addition to modifying base flow releases, other adaptive management measures identified in the EIR/EIS for the Delta include: modifying the duration and/or timing of pulse flows, excavating the river channel upstream of the Delta, planting native vegetation species, dispersing native plant species during seasonal habitat flows, removing tules, beavers and beaver dams and modifying the magnitude of pulse flows.

Deviations from Mandatory Documents

The FEIR deviates from other documents in recognizing that the existing Delta habitat will be greater than the 325 acres specified in the MOU. By agreement among MOU parties, the Delta acreage to be maintained and enhanced will be the 2005 area of 1,160 acres.

3.17 Exotic and Invasive Plants

Effectiveness Monitoring

OBJECTIVE

Control, to the extent possible, exotic and invasive (class A and B noxious weeds) plants, that interfere with the achievement of LORP goals.

MONITORING EVALUATION

Invasive and/or exotic plant infestations are not impeding native habitat quality.

See Page 3-59 for monitoring data considered in evaluations.

YES

Class A and B noxious weed plant species **are not** hindering the achievement of LORP goals. Monitoring data indicates exotic and invasive plants are growing in concentrations that **do not** prevent or inhibit the growth of native species.

Continue Monitoring

NO

Class A and B noxious weed plant species **are** hindering the achievement of LORP goals. Monitoring data indicates exotic and invasive plants are growing in concentrations that **do** prevent or inhibit the growth of native species.

PROBLEM ANALYSIS

<u>Questions</u>:

Do the Rapid Assessment Survey data indicate an increase in tamarisk compared to baseline conditions?

Do the land use monitoring data indicate that grazing prescriptions are sufficient to control the recruitment and establishment of class A and B noxious weeds?

Do the Rapid Assessment Survey data indicate an increase in Class A and B noxious weeds compared to baseline conditions?

CONTINGENCY MONITORING AS NEEDED

ADAPTIVE MANAGEMENT MEASURES (See Section 3.4)

#2. Modify the timing of seasonal habitat flows
#3. Modify the magnitude/duration of seasonal habitat flows
#7. Plant native vegetation species
#8. Conduct exotic plant control activities
#18. Use controlled burning
#12. Modify utilization rates and timing with riparian and upland pastures
#11. Modify fences, or add new fences for riparian and upland pastures
#14. Modify livestock management following wildfire

SELECT & IMPLEMENT ADAPTIVE MANAGEMENT ACTION(S)

3.17 Exotic and Invasive Plants

Terms such as invasive weed or noxious weed are often used interchangeably to refer to unwanted, non-native plants that infest large areas or cause economic and ecological damage to an area. In the FEIR, the term noxious weed is used broadly to mean any non-native plant species that is highly competitive, difficult to control and destructive to native plants and habitats or agriculture.

Exotic and Invasive Plants Evaluation: Data Used for Effectiveness Monitoring

Invasive and/or exotic plant infestations are not impeding native habitat quality. Evaluated by:

- Seasonal Habitat Flow Monitoring (4.2.3.1)
- Seasonal Habitat Flooding Extent Monitoring (4.2.3.2)
- Habitat Monitoring (4.2.6.1, 4.3.3, 4.4.3)
- Rapid Assessment Survey (4.2.5, 4.3.2, 4.4.2, 4.5.2)
- Landscape Vegetation Mapping (4.2.7.1, 4.3.4, 4.4.4)
- Site Scale Vegetation Assessment and Landform Elevation Mapping (4.2.7.2)
- Flow and Wetland Area Monitoring (4.3.1, 4.5.1)
- Utilization Monitoring (4.6.2)
- Range Trend Monitoring (4.6.3)

Project Expectations
There are no specific expectations for exotic and invasive plants, except that project implementation may provide conditions for the spread of some exotic and invasive plants. Control of these plants will likely be required to accomplish project goals.

Feedback Mechanism for Monitoring and Adaptive Management
Monitoring data collected from Saltcedar Control Program reports, flow monitoring, vegetation mapping, habitat and land use monitoring, and the rapid assessment surveys will alert managers to new exotic and invasive plant infestations. This information, along with information from the Inyo County Agricultural Commission, will be included in the annual report. The Scientific Team will then determine which of the actions specifically described in the FEIR will best address the infestation.

3.17.1 Document Integration and Direction

MOU
The MOU identifies “Control of deleterious species whose presence within the Planning Area interferes with the achievement of the goals of the LORP” as a goal of the LORP in Section II.B.4 (pg. 9).

Technical Memorandum #8, #15 and #18
Technical Memoranda #8, #15, and #18 identify the potential risk of infecting new areas with salt cedar or increasing vigor and productivity of existing stands is considered a significant issue in all three management areas, and comport with the goals and actions detailed in the EMP and FEIR described below.

LORP Ecosystem Management Plan
The EMP identifies the potential risk of infecting new areas with salt cedar or of increasing the vigor and productivity of existing stands is considered a significant issue in the Blackrock Waterfowl Habitat Area, the Owens River Delta Habitat Area and the Owens River Riverine-Riparian Area (pages 3-5). Although the suggested procedures were designed for the Blackrock Waterfowl Habitat Area, they are also appropriate and applicable to the entire LORP. As a result, several wetland management practices, such as water drawdowns (partial drainage) will be restricted to reduce this risk. Other management practices that will help circumvent and limit the spread of salt cedar (tamarisk) include:

- minimizing construction and other disturbance of substrates;
- providing for good water circulation and drainage in wetlands to minimize accumulation of salts;

- restricting use of fire for vegetation management--when fire is used, then flushing or leaching along with careful monitoring should follow;
- timing, duration and extent of wetland water drawdowns will be managed to minimize the chance of invasion by tamarisk (i.e., winter months); and
- monitoring will be focused upon the early detection of tamarisk recruitment.

If monitoring results from habitat, vegetation, or rapid assessment efforts indicate the growth of exotic plant species is hindering achievement of habitat management objectives, adaptive management measures may be employed. A determination that exotic plant control activities is hindering the achievement of habitat management objectives will be based upon monitoring data that show exotic plants are growing in concentrations that prevents or inhibits the growth of native species. Adaptive management activities would consist of increasing any ongoing activities to control saltcedar[72] and/or other exotic plant species.[73] Contingency measures will help prevent establishment of the exotic pest plants in the event that new areas become infected. It details a combination of the following contingency measures on page 5 that may be appropriate:

- Application of a broadleaf specific herbicide is a very effective means of eradicating young plants. The most appropriate herbicide to use depends upon specific site factors, including the target plant species, whether the site is wet or dry and the size of the treatment area.
- Hand removal of young plants is an option if the problem extent is small.
- Cutting and flooding of young plants is an effective means of killing salt cedar if the plants can be completely submerged in water for 6 weeks.

Final EIR

The noxious weeds of primary concern related to implementation of the LORP identified in the FEIR are perennial pepperweed, Russian knapweed and saltcedar due to their existing presence in the Owens Valley and the potential for economic and ecological damage. A fourth invasive species, Russian olive, also occurs in the LORP area and is being managed.

The FEIR acknowledges that rewetting of the channel and construction activities may create conditions for infestation of the above mentioned species. To prevent and limit such infestations, the following actions (summarized from Table S-1) will be undertaken:

- Construction and other disturbance of substrates will be minimized.
- When possible, good water circulation will be provided in project wetlands to minimize accumulation of salts to prevent saltcedar infestation.
- The use of fire for vegetation management will be minimized.
- To the extent possible, LADWP will initiate flow releases and initiate dry phases within the Blackrock area between November 1 and March 15 (i.e., when saltcedar is not producing seed) to minimize the chance of invasion by saltcedar.
- Construction equipment will be maintained “weed free” by washing and inspecting equipment used in weed-infested areas prior to moving.
- On-site fill materials for construction will be used to the extent possible. If offsite fill materials are necessary, they will be taken from borrow pits located in areas that are free of noxious weeds.
- Provide funding to the Inyo-Mono County Agricultural Commissioner. LADWP shall provide $50,000 per year to the Agricultural Commissioner to fund the monitoring and control of new infestations of perennial pepperweed and other noxious weeds (excluding saltcedar) in the LORP project area for the first 7 years of LORP implementation. In addition, LADWP shall provide $150,000 per year for the first 7 years to the Agricultural Commissioner to fund the control of existing perennial pepperweed and other

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[72] Saltcedar and Tamarisk are synonymous.

[73] Table 2, page 104. LORP EMP, 2004.

noxious weed populations outside of the LORP area that could serve as seed sources for the LORP area.

The Agricultural Commissioner will develop protocols for monitoring and controlling infestations based upon past experience and current literature. Based on the protocols, the Agricultural Commissioner will use the funds to identify and treat new infestations of noxious weeds within the LORP area in a timely manner, with priority given to the riparian areas. Existing infestations outside of the LORP area that could serve as seed sources for the LORP area will also be monitored and treated. A Memorandum of Understanding between the Agricultural Commissioner and LADWP will be entered into, and will outline the responsibilities of each agency under the protocols. In addition to LADWP's contribution to the existing Inyo County Saltcedar Control Program, LADWP will provide funding to Inyo County in order for the County's Saltcedar Control Program to implement the following measures (the measures described below are in addition to the activities that will be conducted as part of the continuation of the existing Inyo County Saltcedar Control Program):

- LADWP will provide to the Saltcedar Control Program reports and data compiled through the LORP monitoring program concerning flows and water levels related to the river baseflow and seasonal habitat flows, releases to the Delta and water levels at the Off-River Lakes and Ponds and in the Blackrock area.
- LADWP will notify the Saltcedar Control Program of the timing and extent of annual seasonal habitat flows, increased flow releases to Blackrock units, pulse flows to the Delta and other changes in land management that could cause a new infestation of saltcedar.
- LADWP will provide to the Saltcedar Control Program work products relevant to saltcedar control that are prepared through the LORP monitoring program, such as maps, imagery, etc.

Protocols for monitoring and treating new saltcedar infestations in the project area will be developed and implemented by the Inyo County Saltcedar Control Program in cooperation with LADWP. The protocols will include, but not be limited to, the following:
1. Prioritization for monitoring and treatment of areas that are to undergo a change in hydrologic status and that do not have an established cover of native plants.
2. Provisions for treating new saltcedar infestations, including protocols for treating saltcedar near rare plant populations.

LADWP shall conduct a training program for LADWP and Inyo County personnel, lessees, and their employees working within the LORP area on identification and reporting of noxious weeds, including saltcedar. The training will be conducted at LADWP or Inyo County facilities in the Owens Valley. The Eastern Sierra Weed Management Area Noxious Weed Identification Handbook will be provided to program participants. The instruction will detail how to accurately describe their locations to aid in verification and timely response and identify the agencies to which sightings of the species should be reported. As new personnel are hired or when training is updated, a refresher course will be provided. In addition, photos of relevant deleterious species will be posted in the assembly rooms of appropriate LADWP and Inyo County facilities.
1. Provisions for annual pedestrian monitoring of project areas potentially subject to saltcedar infestations.
2. Provisions for annual follow-up treatments of previously treated saltcedar infestations.

The FEIR also states that if the ongoing Inyo County Saltcedar Control Program is not able to achieve the priorities for the control of existing saltcedar populations in the LORP area, the control of existing saltcedar populations will be completed.

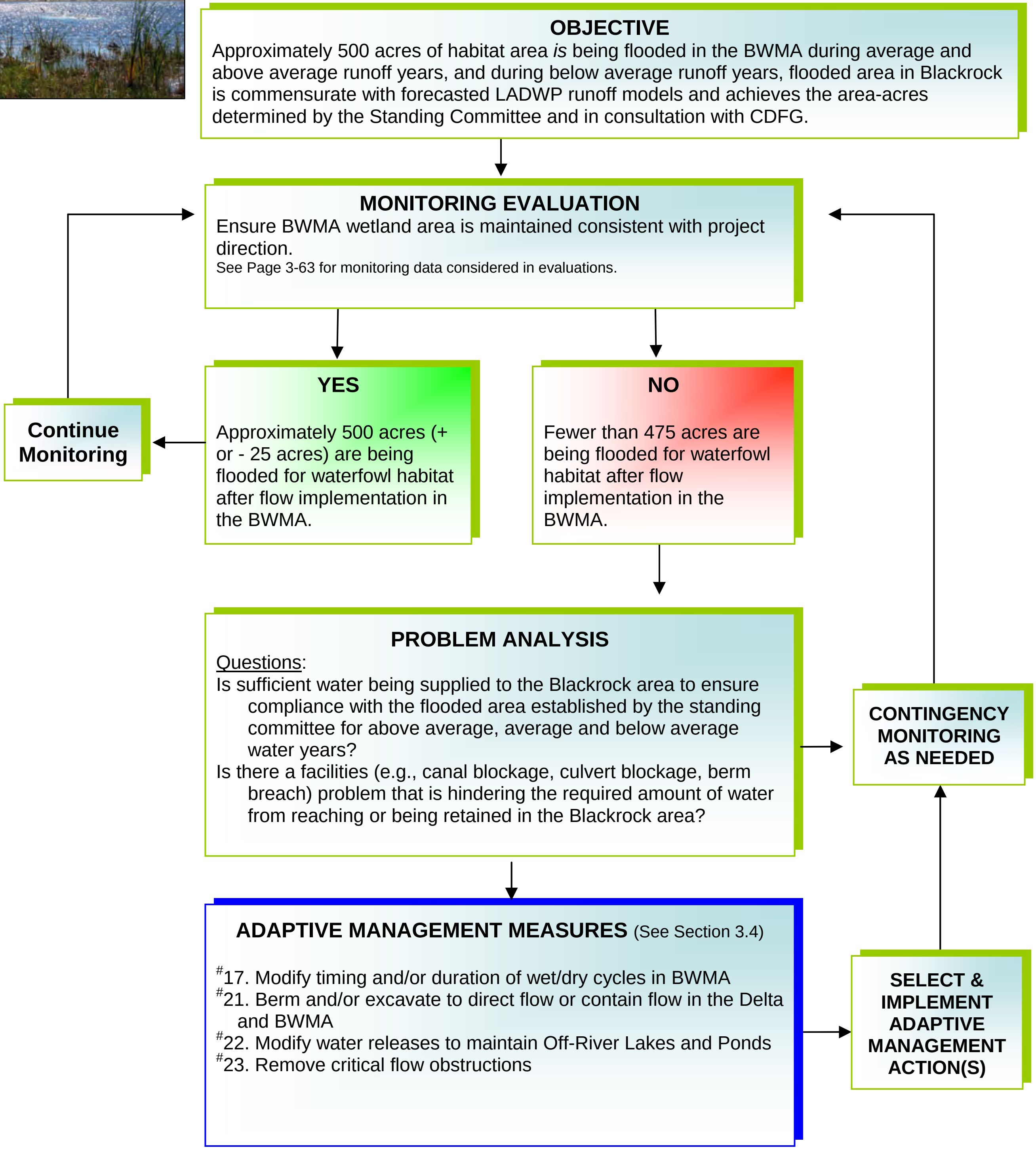
Deviations from Mandatory Documents

No major deviations were detected between the mandatory documents.

3.18 BWMA Wetlands

Compliance Monitoring

Average, Below Average and Above Average Runoff Years



OBJECTIVE

Approximately 500 acres of habitat area *is* being flooded in the BWMA during average and above average runoff years, and during below average runoff years, flooded area in Blackrock is commensurate with forecasted LADWP runoff models and achieves the area-acres determined by the Standing Committee and in consultation with CDFG.

MONITORING EVALUATION

Ensure BWMA wetland area is maintained consistent with project direction.

See Page 3-63 for monitoring data considered in evaluations.

YES

Approximately 500 acres (+ or - 25 acres) are being flooded for waterfowl habitat after flow implementation in the BWMA.

Continue Monitoring

NO

Fewer than 475 acres are being flooded for waterfowl habitat after flow implementation in the BWMA.

PROBLEM ANALYSIS

<u>Questions</u>:

Is sufficient water being supplied to the Blackrock area to ensure compliance with the flooded area established by the standing committee for above average, average and below average water years?

Is there a facilities (e.g., canal blockage, culvert blockage, berm breach) problem that is hindering the required amount of water from reaching or being retained in the Blackrock area?

CONTINGENCY MONITORING AS NEEDED

ADAPTIVE MANAGEMENT MEASURES (See Section 3.4)

[#]17. Modify timing and/or duration of wet/dry cycles in BWMA

[#]21. Berm and/or excavate to direct flow or contain flow in the Delta and BWMA

[#]22. Modify water releases to maintain Off-River Lakes and Ponds

[#]23. Remove critical flow obstructions

SELECT & IMPLEMENT ADAPTIVE MANAGEMENT ACTION(S)

3.18 BWMA Wetlands

Portions of the Blackrock Waterfowl Management Area (BWMA) will be flooded in order to create habitats consistent with the needs of indicator species.

BWMA Wetlands Evaluation:
Data Used for Compliance Monitoring

Ensure BWMA wetland area is maintained consistent with project direction. Evaluated by:

- Flow and Wetland Area Monitoring (4.3.1)
- Rapid Assessment Survey (4.3.2)

BWMA Wetlands Evaluation:
Data Used for Effectiveness Monitoring

BWMA wetland habitat increases in quantity and quality. Evaluated by:

- Flow and Wetland Area Monitoring (4.3.1)
- Rapid Assessment Survey (4.3.2)
- Habitat Monitoring (4.3.3)
- Landscape Vegetation Mapping (4.3.4)
- Avian Census (4.2.8.1)
- Utilization Monitoring (4.6.2)
- Range Trend Monitoring (4.6.3)

Project Expectations

Implementation of the LORP will result in significant changes to the extent and quality of wetlands in the BWMA. The quality of wetlands will increase as a result of improved water, wetland vegetation and livestock management practices, and from cumulative effects as a result of ecosystem management practices on a valley wide scale.[74] The areas within 300 feet of the flooded areas in the BWMA, called "adjacent zones", are expected to benefit from the flooding and to provide important nesting, resting and feeding habitat for waterfowl and many other wildlife species that use the Blackrock area.[75]

Feedback Mechanism for
Monitoring and Adaptive Management

Monitoring activities will be conducted to ensure compliance with MOU flow requirements in the BWMA (Figure 3.18, Compliance Monitoring) and to achieve wetland habitat goals (Figure 3.18, Effectiveness Monitoring). Adaptive management measures for compliance monitoring includes modifying the timing and/or duration of wet/dry cycles for the management units in the BWMA, modifying water releases to maintain Off-River Lakes and Ponds, berming and/or excavating to direct flow or contain flow in the delta and BWMA and removing critical flow obstructions. The adaptive management measures for BWMA effectiveness monitoring are listed in Figure 3.18 below.

3.18.1 Document Integration and Direction

MOU

The MOU goal for the Blackrock Waterfowl Habitat Area is "*to maintain this waterfowl habitat area to provide the opportunity for the establishment of resident and migratory waterfowl populations as described in the EIR and to provide habitat for other native species. Diverse natural habitats will be created and maintained through flow and land management, to the extent feasible, consistent with the needs of the "habitat indicator species" for the Blackrock Waterfowl Habitat Area. These habitats will be as self -sustaining as possible".*[76]

To achieve this goal, the MOU requires that:

"Approximately 500 acres of the habitat area will be flooded at any given time in a year when the runoff to the Owens River watershed is forecasted to be average or

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[74] Tech Memo #15, pg. 66

[75] EMP, pg. 28

[76] MOU 1997, Section II

above average. In years when the runoff is forecasted to be less than average, the water supply to the area will be reduced in general proportion to the forecasted runoff in the watershed. (The runoff forecast for each year will be DWP's runoff year forecast for the Owens River Basin, which is based upon the results of its annual April 1 snow survey of the watershed.) Even in the driest years, available water will be used in the most efficient manner to maintain the habitat. The Wildlife and Wetlands Management Plan element of the LORP Plan will recommend the water supply to be made available under various runoff conditions and will recommend how to best use the available water in dry years. The amount of acreage to be flooded in years when the runoff is forecasted to be less than average will be set by the Standing Committee based upon the recommendations of the Wildlife and Wetlands Management Plan and in consultation with the DFG".[77]

Blackrock Waterfowl Management Area and Vicinity Vegetation Inventory - 2000 Conditions (2004)

This vegetation inventory of the Blackrock Waterfowl Management Area and vicinity (BWMA) is a component of a more comprehensive inventory of wetland/riparian resources in the Owens Valley that serves as a baseline and planning tool for future project implementation and monitoring. It describes baseline conditions for soils, land types, water regimes and vegetation in the BWMA. It does not discuss monitoring methods or adaptive management tools for the BWMA.

Technical Memorandum #4

Technical Memorandum #4 discusses the extent and composition of existing wetlands in the BWMA. It does not include monitoring methods and adaptive management measures for the BWMA.

Technical Memorandum #15

Technical Memo #15, *Resource Management in the Blackrock Waterfowl Habitat Area*, reiterates the MOU goal (see above under MOU) for the BWMA. The management goals will be achieved by manipulating, evaluating and monitoring conditions in four separate management units (Drew, Waggoner, Winerton, Thibaut); these units will be managed in concert to derive a spectrum of fish and wildlife values over time and space. Management objectives for the BWMA include:

- Provide a reliable and dependable source of water and wetland habitat that will attract residential and migratory wildlife.
- Control and maintain the ratio and diversity of open water and emergent vegetation near optimal conditions (mean 40 to 60%).
- Provide greater richness, distribution and spatial diversity of wetland types.
- Control the time, duration and water levels (depth) of flooding.
- Achieve periodic complete drawdown to reinitiate the wet-dry cycle, reduce salinity, control vegetation and revitalize productivity.
- Achieve periodic partial drawdown to increase food availability, concentrate foods and manage emergent vegetation.
- Manage sites based on their own potential while recognizing the interactions among all management units.
- Fire will be used as a contingency to remove residual emergent vegetation and increase productivity and spatial diversity.
- Increase the availability (i.e., abundance and accessibility) of resources to a greater number and array of species.
- Increase the availability of unique and limiting resources over a large area.
- Maintain wetland productivity without sacrificing wetland richness.
- Increase connectivity among other components of the LORP ecosystem.

The technical memo also includes specific management objectives for each of the four management units on p. 72-93. Though this memorandum does not include specific monitoring methods, it provides "suggested"

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[77] MOU 1997, Section II

monitoring variables for the Blackrock Waterfowl Habitat Area, which includes:

- **Estimate and track changes:** Extent, relative composition, richness and diversity, and interspersion of wetland management types; extent and duration of flooding; and, life of the structure and/or expected cost of maintenance.
- **Long term sustainability and integrity:** Age structure of woody riparian (recruitment and tracking survivorship of cohorts); and, ratio of live to dead cover in herbaceous wetlands.
- **Mapping type condition and trend:** Ratio of open water to vegetation (emergent wetland mapping types); composition and cover estimates wetland mapping types; and vegetation density by layer.
- **Other tools:** Evaluation using photo-point monitoring; and periodic re-mapping and quantification of the habitat area.

LORP Ecosystem Management Plan

The EMP reiterates the MOU requirement that LADWP flood 500 acres (of the 1,342 acres within the four units in which flooding could potentially occur). Management objectives for the Blackrock Waterfowl Habitat Area include the following: (1) provide a reliable and dependable source of water and wetland habitat that will attract resident and migratory waterfowl and shorebirds, the MOU indicator species for this project element; and (2) maintain the ratio of open water wetlands to emergent/seasonal wetlands at about 50 percent each, with a range of about 40 to 60 percent throughout the entire area. The EMP describes specific management objectives for the four units and summarizes the management actions to achieve those objectives on pp. 33 to 43. Management objectives will be met for the Blackrock area by manipulating a carefully designed water regime, evaluating and monitoring habitat response and adaptively managing conditions in the four separate management units. The initial wet and dry cycles will be adaptively managed as the LORP evolves. Factors that will provide feedback for these decisions include the relative response of the management unit, the available water, the avian census, the development of wetland vegetation and the need to reduce the extent of robust emergent vegetation.

The overall strategy to maintain Blackrock as a wetland habitat is to allow the value of each management unit to vary in regard to a specific functional species group (e.g., open water birds) as wetlands develop and evolve.

Each management unit at Blackrock will be in a different condition or state at any given time, and therefore the entire habitat area will always provide a diverse set of conditions across a relatively broad landscape. The value of any specific site to any species group will continue to change as habitat changes, but the Blackrock Area as a whole will always provide adequate resources to sustain a wide range of wildlife species (p. 31).

Management strategies for different types of runoff years are summarized below:

Forecasted Average to Above Average Water Year (100 percent or more of the average annual runoff): The MOU requires that 500 acres of habitat be flooded at any given time under these runoff conditions. This acreage requirement would be met through flooding operations in one or more of the four management units at any one time.

Forecasted Below Average Water Year (50 to 99 percent of average annual runoff): The MOU states that water for the Blackrock Waterfowl Habitat Area will be reduced in general proportion to the reduction in the forecasted runoff. The amount of acreage to be flooded in years when the runoff is forecasted to be less than average will be set by the Standing Committee based on recommendations in the LORP Plan and in consultation with the CDFG. The LORP Plan proposes that under these conditions, the duration of the dry phase of a management unit then in a dry phase would be extended, and water supply to units then in a wet phase would be reduced. Hence, there would not be a rapid and substantial change in water conditions in these years. Instead, there would be small incremental changes in the amount of water in the area, reflecting the general reduction in runoff throughout the valley.

Forecasted Dry Years (less than 50 percent average annual runoff): The MOU states that water would be applied to the Blackrock Waterfowl Habitat Area in dry years, and that even in the driest year's available water will be used in the most efficient manner to maintain the habitat. Under these conditions, the LORP Plan recommends that the only area to receive water would be the Thibaut Unit. Final water allotments and flooded extents will be determined by the Standing Committee.

Wetland monitoring in the BWMA to determine compliance with MOU requirements includes: record spillgate discharge, flows at diversions and staff gage elevations that serve as indicators of a real extent of flooding. Adaptive management measures to ensure wetland compliance includes modification of the timing and/or duration of wet/dry cycles in the management units.

Final EIR

The Final EIR reiterates the MOU goal for the BWMA (see above under MOU) and describes the overall management strategy for the area. Specific project objectives described for the BWMA are the same as the EMP, however, the Final EIR includes an additional objective "to create and maintain diverse habitats while minimizing the use, extent, and frequency of intervention and manipulation" (pg. 2-41). The MOU states "approximately 500 acres of the habitat area will be flooded at any given time in a year when the runoff to the Owens River watershed is forecasted to be average or above average." In less than average runoff years, the water supply to the Blackrock area may be reduced in general proportion to the forecasted runoff and will be set by the Standing Committee. The Final EIR states that LADWP plans to meet the above goal for the Blackrock habitat area by maintaining an average annual flooded acreage of approximately 500 acres (+ 50 acres) during average or above average years and by maintaining on an annual average basis the acreage set by the Standing Committee for years that have less than average runoff. Within the annual average, the total area flooded at any time during a runoff year will vary seasonally. The BWMA will be implemented in two flooding cycles that will occur during the first 10 to 15 years of the project. At this time, it is intended that the two cycles would be repeated, unless it is determined through adaptive management that the goals of the MOU would be better achieved by modifying the flooding regime.

As part of project implementation, LADWP will establish a system of gaging stations in the four management units, which will serve as indicators of the area of flooding in each of the units. During the first several years of project implementation and during the initiation of active cycles in the management units, it will be necessary to closely monitor water levels and manage water releases to develop water release schedules to meet MOU's requirements. LADWP and the County will monitor water levels at gaging stations and flows at spillgates and diversions that supply the units. Monitoring information will be reported to agency managers so that releases can be adjusted to ensure compliance with the MOU. LADWP and the County will also track the extent of emergent vegetation within the active units using remote sensing imagery, or other appropriate tools.

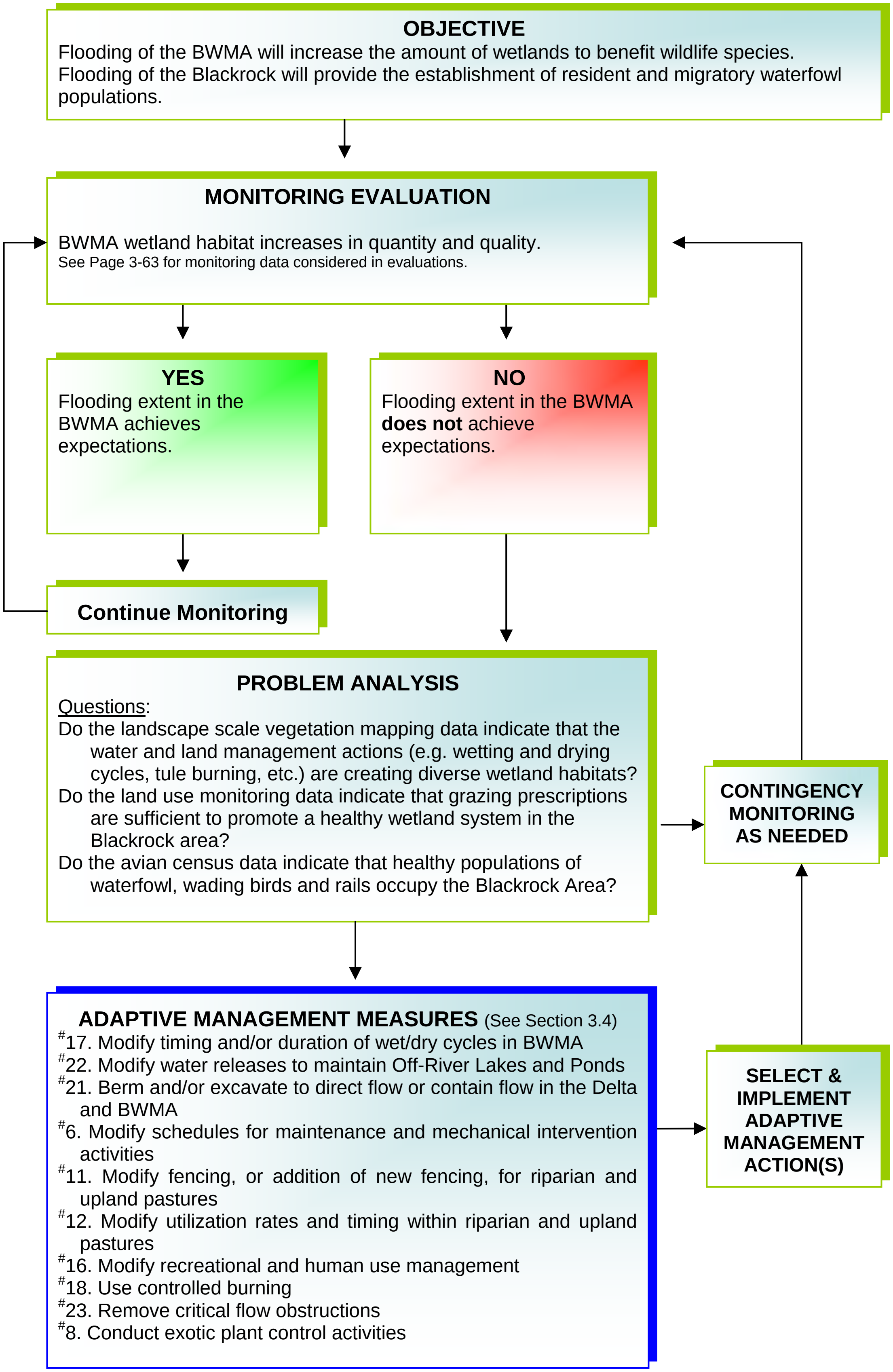
Adaptive management measures for the BWMA are the same as those described in the EMP and include modification of timing and/or duration of wet/dry cycles to alter the drying and wetting cycle for the management units in the BWMA.

Deviations from Mandatory Documents

The mandatory documents are consistent with respect to BWMA wetland management strategies and comply with MOU requirements for the BWMA.

3.18 BWMA Wetlands

Effectiveness Monitoring



OBJECTIVE

Flooding of the BWMA will increase the amount of wetlands to benefit wildlife species. Flooding of the Blackrock will provide the establishment of resident and migratory waterfowl populations.

MONITORING EVALUATION

BWMA wetland habitat increases in quantity and quality.
See Page 3-63 for monitoring data considered in evaluations.

YES
Flooding extent in the BWMA achieves expectations.

NO
Flooding extent in the BWMA **does not** achieve expectations.

Continue Monitoring

PROBLEM ANALYSIS

Questions:
Do the landscape scale vegetation mapping data indicate that the water and land management actions (e.g. wetting and drying cycles, tule burning, etc.) are creating diverse wetland habitats?
Do the land use monitoring data indicate that grazing prescriptions are sufficient to promote a healthy wetland system in the Blackrock area?
Do the avian census data indicate that healthy populations of waterfowl, wading birds and rails occupy the Blackrock Area?

CONTINGENCY MONITORING AS NEEDED

ADAPTIVE MANAGEMENT MEASURES (See Section 3.4)
#17. Modify timing and/or duration of wet/dry cycles in BWMA
#22. Modify water releases to maintain Off-River Lakes and Ponds
#21. Berm and/or excavate to direct flow or contain flow in the Delta and BWMA
#6. Modify schedules for maintenance and mechanical intervention activities
#11. Modify fencing, or addition of new fencing, for riparian and upland pastures
#12. Modify utilization rates and timing within riparian and upland pastures
#16. Modify recreational and human use management
#18. Use controlled burning
#23. Remove critical flow obstructions
#8. Conduct exotic plant control activities

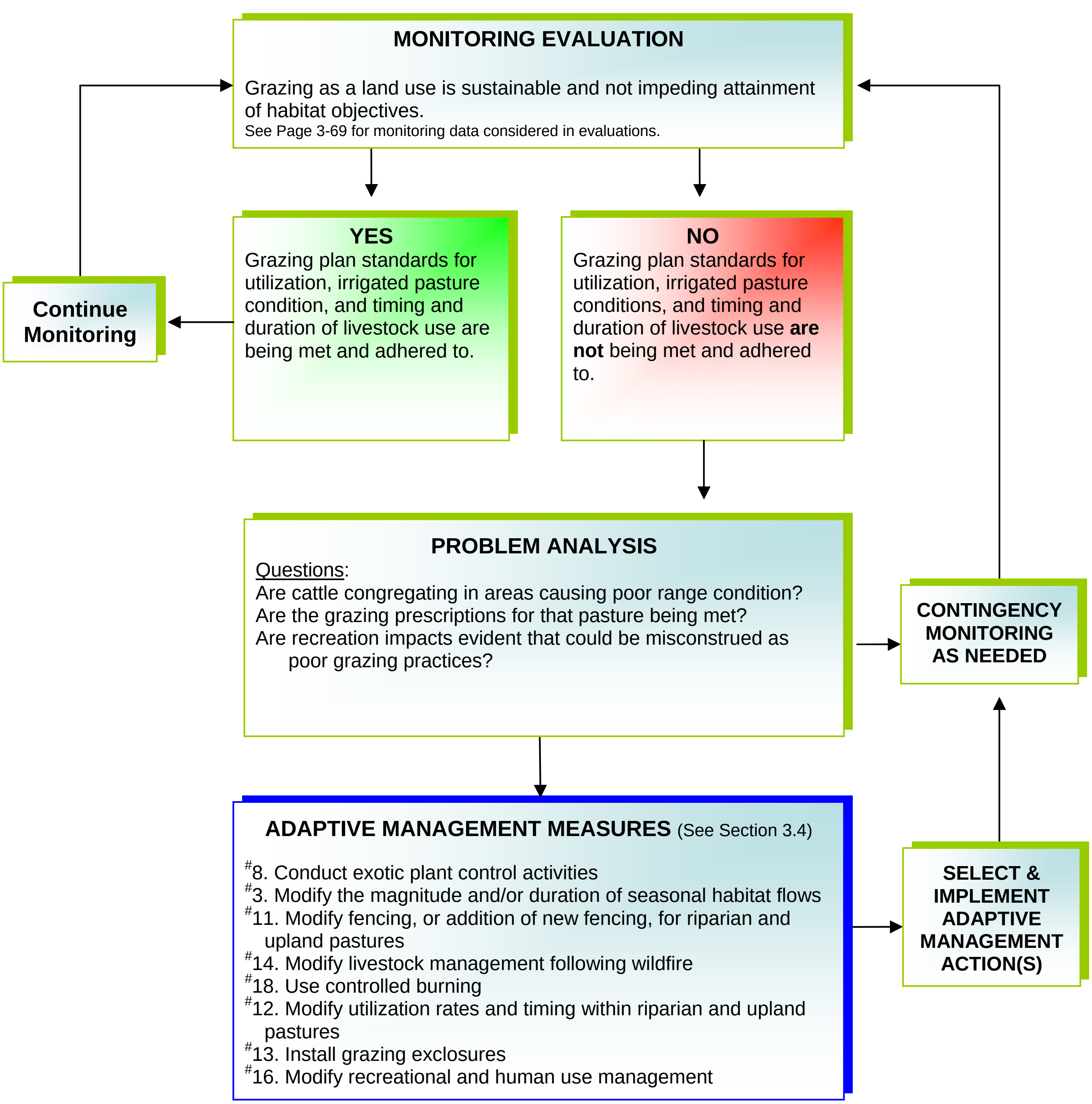
SELECT & IMPLEMENT ADAPTIVE MANAGEMENT ACTION(S)

3.19 Range Condition

Effectiveness Monitoring

OBJECTIVE

Grazing strategies lead to the establishment of healthy riparian pastures and exhibit an upward trend in range conditions.



MONITORING EVALUATION

Grazing as a land use is sustainable and not impeding attainment of habitat objectives.

See Page 3-69 for monitoring data considered in evaluations.

YES

Grazing plan standards for utilization, irrigated pasture condition, and timing and duration of livestock use are being met and adhered to.

Continue Monitoring

NO

Grazing plan standards for utilization, irrigated pasture conditions, and timing and duration of livestock use **are not** being met and adhered to.

PROBLEM ANALYSIS

Questions:

Are cattle congregating in areas causing poor range condition?
Are the grazing prescriptions for that pasture being met?
Are recreation impacts evident that could be misconstrued as poor grazing practices?

CONTINGENCY MONITORING AS NEEDED

ADAPTIVE MANAGEMENT MEASURES (See Section 3.4)

#8. Conduct exotic plant control activities
#3. Modify the magnitude and/or duration of seasonal habitat flows
#11. Modify fencing, or addition of new fencing, for riparian and upland pastures
#14. Modify livestock management following wildfire
#18. Use controlled burning
#12. Modify utilization rates and timing within riparian and upland pastures
#13. Install grazing exclosures
#16. Modify recreational and human use management

SELECT & IMPLEMENT ADAPTIVE MANAGEMENT ACTION(S)

3.19 Range Condition

The principle land use in the Lower Owens River project area is livestock grazing (cattle, horses and mules). It was recognized at the beginning of project planning that it would not be sufficient to include only riparian and irrigated pastures in the LORP, but that uplands were transitionally connected to the riparian zones. Consequently, grazing management took into account all elements (uplands, riparian, sensitive areas and irrigated meadows) on all leases in the LORP.

Range Condition Evaluation:
Data Used for Effectiveness Monitoring

Grazing as a land use is sustainable and not impeding attainment of habitat objectives. Evaluated by:

- Seasonal Habitat Flow Monitoring (4.2.3.1)
- Seasonal Habitat Flooding Extent Monitoring (4.2.3.2)
- Habitat Monitoring (4.2.6.1, 4.3.3, 4.4.3)
- Landscape Vegetation Mapping (4.2.7.1, 4.3.4, 4.4.4)
- Site Scale Vegetation Assessment and Landform Elevation Mapping (4.2.7.2)
- Avian Census (4.2.8.1)
- Irrigated Pasture Condition Scoring (4.6.1)
- Utilization Monitoring (4.6.2)
- Range Trend Monitoring (4.6.3)
- Rapid Assessment Survey (4.2.5, 4.3.2, 4.4.2, 4.5.2)

Project Expectations

Unlike the other LORP monitoring and adaptive management activities, LADWP will be solely responsible for funding and monitoring lease conditions on its leases located wholly or partially within the LORP area.[78] The FEIR[79] describes the expected benefits of grazing management to include increased plant production and cover in riparian areas, which would provide more food for small mammals and birds and cover for ground- and understory-nesting birds. The application of appropriate grazing strategies in the LORP is expected to complement the habitat enhancements anticipated along the river and in the Blackrock and Delta areas where a greater diversity and abundance of aquatic and terrestrial species are anticipated. In order to determine if grazing strategies are leading to the establishment of healthy riparian pastures (increased plant production an cover in riparian areas) and exhibiting an upward trend in range conditions (enhanced habitat), monitoring will consist of utilization and rangeland trend. Details of each monitoring effort are described in Section 4 of this plan.

Feedback Mechanism for Monitoring and Adaptive Management

Riparian, upland or irrigated areas within pastures will be monitored with the utilization, range trend and irrigated pasture protocols described in Section 4 of this plan. Grazing plans specify utilization standards, guidelines with respect to the placement of supplements, post-fire grazing management and the timing and duration of grazing for each pasture.

In the event these standards and prescriptions are not being met or the trend in range condition is not improving or the pasture is not being maintained in good condition, the diagnostic (evaluation) phase of monitoring will be performed. In addition to the data collected for range condition monitoring, the evaluation could rely upon monitoring data from riparian vegetation mapping, upland vegetating mapping, rapid assessment surveys and habitat development for additional information to inform the diagnosis.

Analysis of the monitoring data will identify the problem(s), which will allow the Scientific Team to recommend appropriate adaptive management action(s) from the list of measures shown in Figure 3.19 and described in Section 4.

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[78] FEIR page 2-58
[79] FEIR Section 9.2.2.1, page 9-4

Once adaptive management action(s) have been selected and implemented, additional short-term or contingency monitoring may be necessary to evaluate the effectiveness of the action if there is uncertainty or it is intended as trial and error to test adaptive management actions.

Adaptive management actions loop-back into monitoring on the schedule shown in the protocols until utilization standards are met, or timing and duration are improved, or range trend condition improves – whatever is necessary to correct with adaptive management.

3.19.1 Document Integration and Direction

MOU

The MOU, page 8, Section B, states that a goal of the LORP is "…the continuation of sustainable uses including recreation, livestock grazing, agriculture and other activities". Section II B 5, page 9, of the MOU goes on to mandate the "Management of livestock grazing and recreation use consistent with the other goals of LORP". In the Action Plan, Attachment A to the MOU, page 6, the land management plan is described; "This plan will address livestock grazing and other land uses within the Planning Area. In developing the plan, priority will be given to riparian areas, irrigated meadows and sensitive plant or animal habitats. The management plan will consider multiple resource values and will provide for management based on holistic management principles. The goals of the management plan will be to promote biodiversity and a healthy ecosystem, while allowing for continuation of sustainable uses of the land".

Grazing Management Plans

There are seven leases in the LORP area; Twin Lakes, Intake, Blackrock, Thibaut, Island, Lone Pine and Delta. For each lease a detailed grazing management plan was developed. The grazing plans establish livestock management guidelines which include grazing utilization standards and/or modification to the timing or length of use of various fields and irrigated pastures. These management actions accomplish the objectives of holistic resource management for multiple benefits. Grazing plans describe monitoring of riparian and upland management areas with utilization and trend. Monitoring of irrigated pastures will be done with pasture condition scoring.

LORP Ecosystem Management Plan

Chapter 4 of the 2002 LORP Ecosystem Management Plan summarizes each of the grazing management plans for the leases. The plan also describes individual management objectives and actions for each lease. Chapter 7 of the plan briefly describes monitoring and adaptive management measures to meet habitat management objectives in riparian pastures and uplands. The management objectives for all leases are to (1) establish healthy riparian pastures while protecting riparian habitat and (2) establish an upward trend in upland pastures. Monitoring of utilization and range trend is specified in the plan.

Final EIR

The FEIR[80] states that monitoring will consist of grazing utilization and trend measurements. In Section 9.1.2, page 9-1, the FEIR states the land management plan will modify grazing practices in riparian and upland areas on seven leases in order to complement the habitat enhancements anticipated with the re-watering efforts. The intensity, location and duration of grazing will be managed by establishing new riparian pastures, forage utilization rates and prescribed grazing periods. These actions, according to the FEIR, are expected to improve plant vigor, seedling recruitment of forage species and exhibit an overall improving trend in range condition.

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[80] FEIR Section 2.8.1.4, page 2-57

Deviations from Mandatory Documents

Monitoring and adaptive management of range conditions deviates from grazing plans, the Ecosystem Management Plan, and the FEIR in two respects; utilization monitoring and incorporation of irrigated pasture rating.[81] Instead of utilization cages or utilization gages described in the grazing plans, EMP and FEIR, respectively, plant species specific height-weight algorithms will be used to calculate the percent of biomass removed as a function of the percent of height that has been removed. This technique provides a more reliable and accurate measurement of grazing. Irrigated pasture rating is a measure of pasture condition and the effectiveness of management in terms of optimizing plant and livestock productivity while minimizing detrimental effects to soil or water resources.

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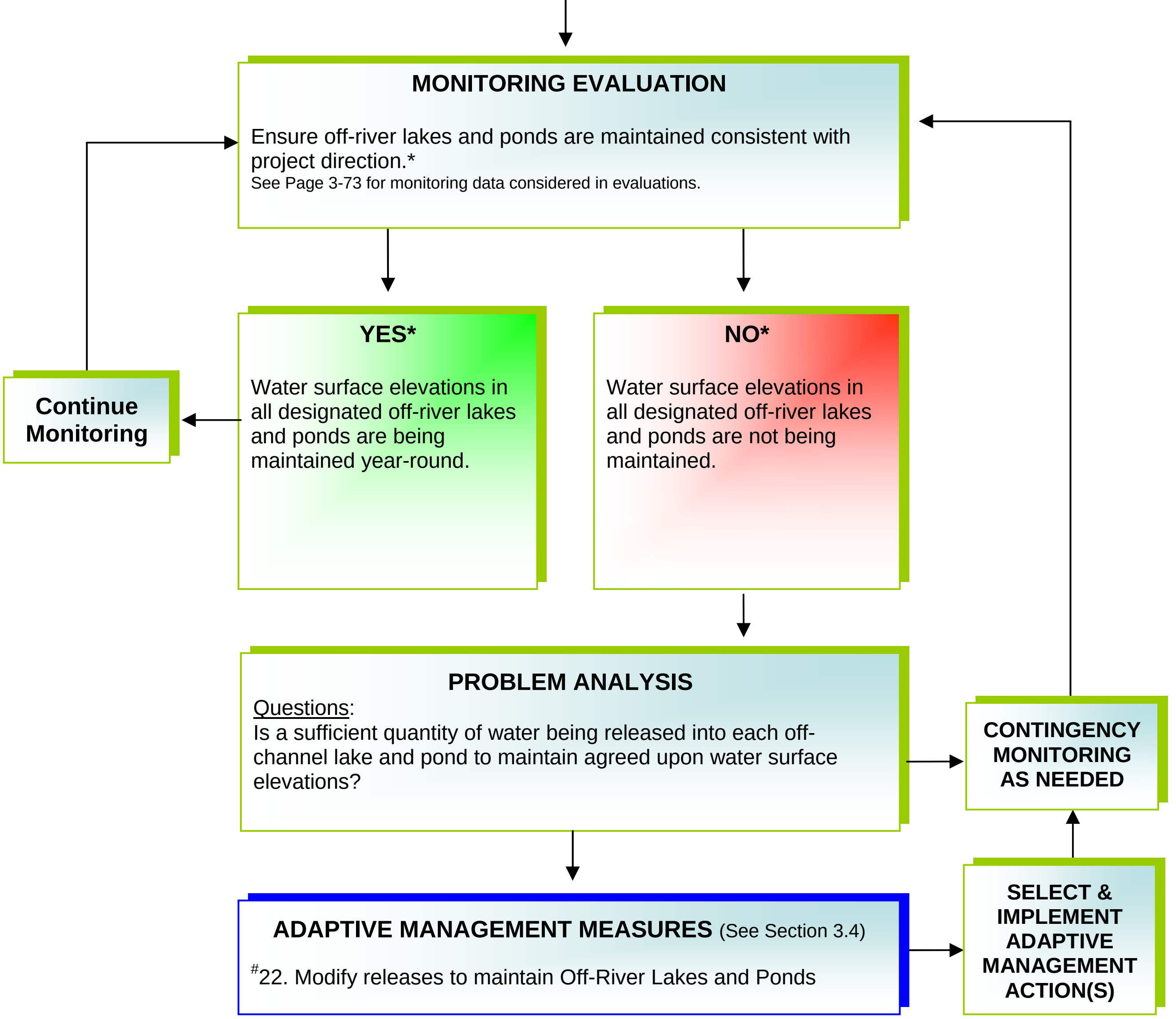
[81] The initial plans called for “ocular estimates of forage removal” and ocular evaluation of range conditions. LADWP, which is responsible for monitoring, reporting and management of lease use, amended the monitoring and evaluation to standardized and quantitative protocols.

3.20 Lakes and Ponds Compliance

Compliance Monitoring

OBJECTIVE

Maintain existing water surface elevations for each off-river lake and pond.



MONITORING EVALUATION

Ensure off-river lakes and ponds are maintained consistent with project direction.*
See Page 3-73 for monitoring data considered in evaluations.

YES*

Water surface elevations in all designated off-river lakes and ponds being maintained year-round.

Continue Monitoring

NO*

Water surface elevations in all designated off-river lakes and ponds are not being maintained.

PROBLEM ANALYSIS

Questions:
Is a sufficient quantity of water being released into each off-channel lake and pond to maintain agreed upon water surface elevations?

CONTINGENCY MONITORING AS NEEDED

ADAPTIVE MANAGEMENT MEASURES (See Section 3.4)

#22. Modify releases to maintain Off-River Lakes and Ponds

SELECT & IMPLEMENT ADAPTIVE MANAGEMENT ACTION(S)

***Lakes and Ponds Compliance Measures from the LORP EIR:**

- Upper and Lower Twin Lakes: Existing staff gages will be maintained between 1.5 and 3.0, which represent maintenance of existing conditions.
- Goose Lake: Goose Lake must be kept full in order to spill over and provide a continuous flow to the river. Therefore, Goose Lake will always be full. Typical staff gage readings reflecting Goose Lake at full capacity are between 1.5 and 3.0.
- Billy Lake: Billy Lake will remain full in order to maintain a continuous spill to the river. A staff gage was never placed in Billy Lake because it has always been operated at a spillover level.
- Thibaut Ponds: One or more gaging stations will be installed to monitor pond levels. The Thibaut Ponds area will be kept full.

3.20 Lakes and Ponds Compliance

Lakes and ponds compliance ensures that a water supply will continue to be delivered to Twin Lakes (Upper and Lower), Goose Lake, Billy Lake and Thibaut Ponds to sustain diverse habitat for wildlife.

Lakes and Ponds Evaluation:
Data Used for <u>Compliance Monitoring</u>
Ensure off-river lakes and ponds are maintained consistent with project direction. Evaluated by:

- Flow and Wetland Area Monitoring (4.5.1)
- Rapid Assessment Survey (4.5.2)
- Creel Census (4.5.3)

Project Expectations

Flow compliance for the off-river lakes and ponds will sustain existing water levels.

Feedback Mechanism for
Monitoring and Adaptive Management

Monitor flows using data collected weekly (frequency may decrease after the first year of the project) from staff gages at Upper and Lower Twin Lakes, Goose Lake, Billy Lake and Thibaut Ponds. The average weekly water surface elevation will be calculated, along with the monthly and annual mean, median, maximum and minimum. If WSE requirements for off-river lakes and ponds are not met, the adaptive management measure includes modifying releases to maintain the water levels.

3.20.1 Document Integration and Direction

MOU

The goal for off-river lakes and ponds is to *"maintain and/or establish off-river lakes and ponds to sustain diverse habitat for fisheries, waterfowl, shorebirds and other animals as described in the EIR. Diverse natural habitats will be created and maintained through flow and land management, to the extent feasible, consistent with the needs of the "habitat indicator species" for the Off-River Lakes and Ponds. These habitats will be as self-sustaining as possible".*[82]

LORP Ecosystem Management Plan

Lakes and ponds compliance in the EMP is consistent with the MOU and is defined as "maintaining the existing lakes and ponds". Monitoring entails recording staff gage elevations at the lakes and monitoring vegetation trends through habitat mapping.

Final EIR

To achieve the MOU goal of maintaining the existing lakes and ponds, the Final EIR/EIS describes the following management objectives for the off-river lakes and ponds:

- Upper and Lower Twin Lakes: Existing staff gages will be maintained between 1.5 and 3.0.
- Goose Lake: Goose Lake must be kept full in order to spill over and provide a continuous flow to the river. Therefore, Goose Lake will always be full. Typical staff gage readings reflecting Goose Lake at full capacity are between 1.5 and 3.0.
- Billy Lake: Billy Lake will remain full in order to maintain a continuous spill to the river. A staff gage was never placed in Billy Lake because it has always been operated at a spillover level.
- Thibaut Ponds: One or more gaging stations will be installed to monitor pond levels and will be kept full.

Water from the Aqueduct would be provided through the existing network of spillgates and ditches. Lake levels will be maintained by either maintaining existing flows, or by controlling lake levels at the outlet weirs. Flows to all but Upper Twin Lake and Thibaut Ponds will be part of the riverine-riparian enhancement program in which corridors will be established for non-native game fish.[83]

Deviations from Mandatory Documents

No deviations from the mandatory document.

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[82] MOU 1997, Section II

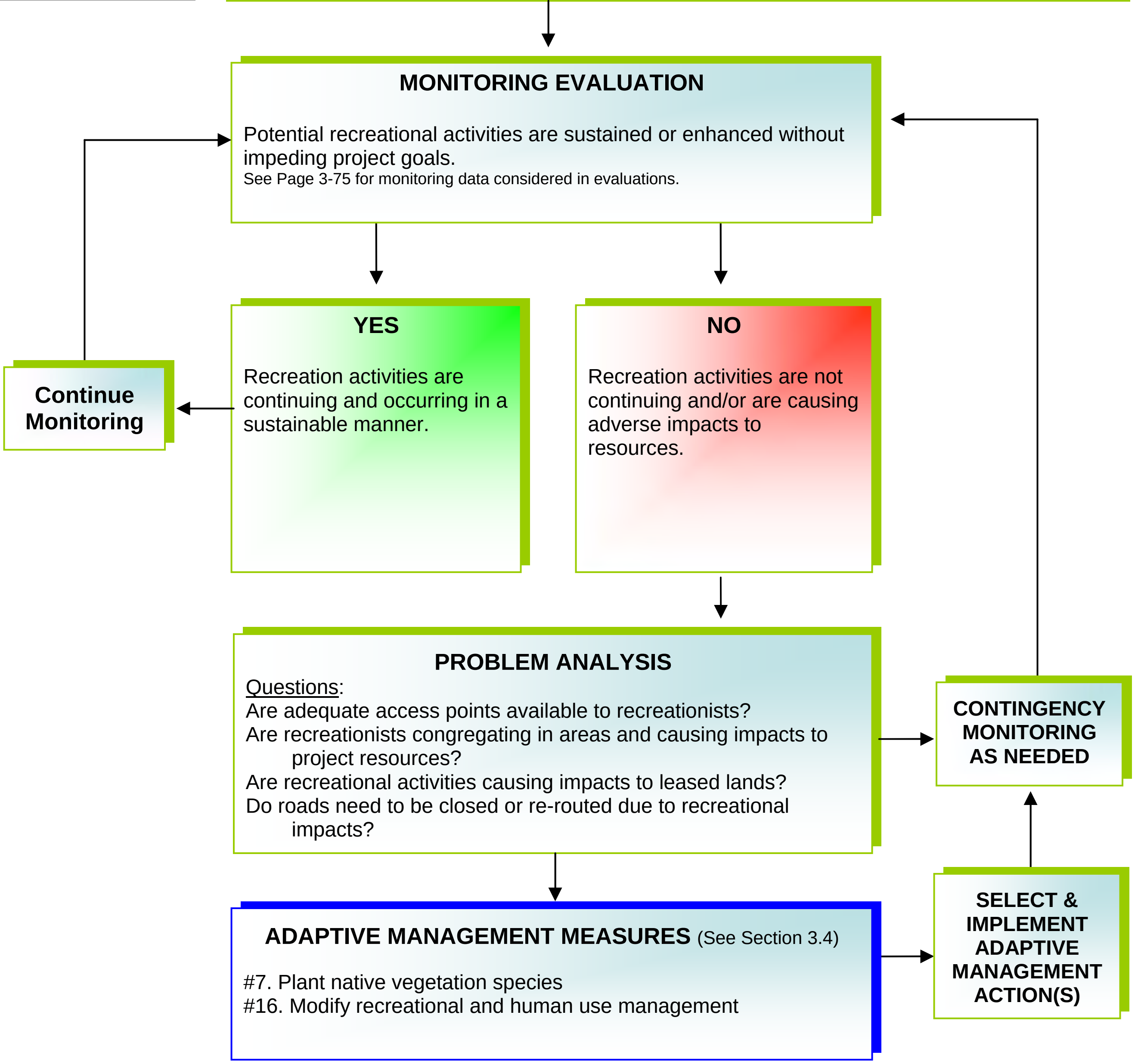
[83] Final EIR, pg. 8-1

3.21 Recreation

Effectiveness Monitoring

OBJECTIVE

Provide for continued and sustainable recreational uses, consistent with LORP goals.



MONITORING EVALUATION

Potential recreational activities are sustained or enhanced without impeding project goals.
See Page 3-75 for monitoring data considered in evaluations.

YES

Recreation activities are continuing and occurring in a sustainable manner.

Continue Monitoring

NO

Recreation activities are not continuing and/or are causing adverse impacts to resources.

PROBLEM ANALYSIS

Questions:
Are adequate access points available to recreationists?
Are recreationists congregating in areas and causing impacts to project resources?
Are recreational activities causing impacts to leased lands?
Do roads need to be closed or re-routed due to recreational impacts?

CONTINGENCY MONITORING AS NEEDED

ADAPTIVE MANAGEMENT MEASURES (See Section 3.4)

#7. Plant native vegetation species
#16. Modify recreational and human use management

SELECT & IMPLEMENT ADAPTIVE MANAGEMENT ACTION(S)

3.21 Recreation

The LORP planning area is located entirely on city of Los Angeles-owned lands where, with the exception of irrigated pastures, the public has mostly unrestricted recreational access (during daylight hours). The primary recreational use is fishing in the riverine-riparian and off-channel lakes and ponds areas. Overnight camping is restricted to designated campgrounds that are outside the LORP project area. Hunting is allowed except in areas that are posted. CDFG administers all fishing and hunting permits and manages the stocking of game fish species.

Recreation Evaluation:
Data Used for Effectiveness Monitoring

Potential recreational activities are sustained or enhanced without impeding project goals. Evaluated by:

- Rapid Assessment Survey (4.2.5, 4.3.2, 4.4.2, 4.5.2)
- Landscape Vegetation Mapping (4.2.7.1, 4.3.4, 4.4.4)
- Site Scale Vegetation Assessment and Landform Elevation Mapping (4.2.7.2)
- Irrigated Pasture Condition Scoring (4.6.1)
- Utilization Monitoring (4.6.2)
- Range Trend Monitoring (4.6.3)

Project Expectations

It is anticipated that the LORP area will be a high-use recreation area that will appeal to recreationists who enjoy bird watching, wildlife viewing, hunting and fishing or many other outdoor activities in a natural and unique ecosystem (LORP EMP, p.87). Increases in visitor use are expected each year for the first 10-15 years of the project. It is expected that impacts from visitations will increase, as well. Impacts include road deterioration, waste and litter accumulation, facility and ecological vandalism, fire, unauthorized road use, artifact gathering, vegetation trampling and soil disturbance.

Feedback Mechanism for Monitoring and Adaptive Management

Recreational impacts are assessed as part of the annual Rapid Assessment Survey (RAS), which will be conducted for the first ten years after LORP implementation. The RASs provide qualitative feedback regarding changes to a variety of project area resources, including recreation-oriented impacts. Observations of impacts related to river access, vehicles, roads, fences, off-highway vehicle travel, trash, vandalism and unauthorized camping will be reported. See Sections 4.2.5, 4.3.2, 4.4.2 and 4.5.2 for specific details about the RASs. Vegetation assessments and Land Use Monitoring are also capable of detecting impacts potentially caused by increased recreation. Landscape Vegetation Mapping (see Sections 4.2.7.1, 4.3.4 and 4.4.4), which is a remote method, will detect significant impacts to vegetation including unauthorized road/vehicle use and fire. Although not comprehensive and restricted to the riverine-riparian area, Site Scale Vegetation Assessment and Landform Elevation Mapping (see Section 4.2.7.2) will also detect impacts to the vegetation and river channel. Lastly, the three Land Use Monitoring components, Irrigated Pasture Condition Scoring (4.6.1), Utilization Monitoring (4.6.2) and Range Trend Monitoring (4.6.3) will help to provide information about recreation impacts.

If monitoring results indicate an increase in recreation-related impacts, or if recreational access is being impacted in any way, then adaptive management decisions should modify recreation management prescriptions and guidelines to address specific issues and general resource concerns.

3.21.1 Document Integration and Direction

MOU

The 1997 MOU addresses recreation by including it as a portion of the overall goal of the LORP. Specifically the MOU states, "The goal of the LORP is the establishment of a healthy, functioning Lower Owens River riverine-riparian ecosystem, and the establishment of healthy, functioning ecosystems in the other physical features of the LORP, for the benefit of biodiversity and Threatened and Endangered Species, while providing for the continuation of sustainable uses including *recreation*, livestock grazing, agriculture and other activities."[84]

Additionally, the MOU dictates that the management of recreation must be consistent with the other goals of the LORP.[85]

And finally the MOU references the importance of the creating a *recreational* fishery by stating, "The goal for the Lower Owens River Riverine-Riparian System is to create and sustain healthy and diverse riparian and aquatic habitats, and a healthy warm water *recreational* fishery."[86]

1991 Agreement

The 1991 agreement between LADWP and Inyo County describes recreation enhancement projects that both entities agreed to implement. For the Type E vegetation classification requirements (city of Los Angeles-owned lands that are supplied with water) the agreement stipulates that recreational uses be considered by the Department during the conversion of cultivated land to other irrigated uses. The agreement also provides that LADWP fund projects for park rehabilitation (existing County parks and campgrounds, development of new County campgrounds, parks, and recreational facilities and programs, and annual operation and maintenance of existing and new facilities and programs). These facilities are located, or will be located on city of Los Angeles-owned lands.

LORP Ecosystem Management Plan

The Ecosystem Management Plan addresses recreation in the LORP in Chapter 6 – The Recreation Plan. The Recreation Plan describes the recreational opportunities within the LORP and elucidates LADWP's existing recreation management. Specifically, the Recreation Plan addresses the existing recreation management for the following topics: camping, fires, off-road vehicles, leased-land, fishing, hunting, woodcutting, boating and water sports, hiking and biking and artifact gathering.

The Ecosystem Management Plan addresses future management of recreation in the LORP by stating, "The primary concern of recreation management in and around the LORP area is the natural ecosystem itself. Recreational activity that disturbs natural processes, the abundance or total mass of vegetation, soils, water quality, fish and wildlife habitat and diversity or any activity that conflicts with other established recreational activities may need to be prohibited and/or regulated to certain areas and/or times of year. A sustainable recreation resource requires a healthy productive ecosystem and therefore demands recreation management as well as land and water management in order to continue to exist and provide opportunities for recreational users."

In short, the Ecosystem Management Plan focuses on preserving the natural environment and minimizing recreational impacts to the LORP area. Specifically, the EMP states that the overall objective for recreation management is an on-going process with the primary goal of protecting the ecosystem and minimizing user conflicts. LADWP will adaptively manage recreational uses of the LORP in line with the land and water use management objectives and actions that result from resource management decisions.

Over time it is expected that LADWP will draft a recreation strategy specifically for the

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[84] MOU 1997, Section II B, p. 7
[85] MOU 1997, Section II B, 5, p. 7
[86] MOU 1997, Section II C, a, p. 7

LORP. The recreation plan will focus on defining recreational management protocols with broad, loose and indirect guidelines that include multiple-use recreation in the LORP. Indirect guidelines provide motivation for recreationists to feel welcome to use the area, to take pride and partial ownership in maintaining the quality of the area and to do no harm to the resources. As long as guidelines and protocols are effective to limit and alter high-impact activity and behavior, they are effective and sufficient.

Final EIR

The FEIR expands on the LORP EMP with regard to recreation. The FEIR explains that no new recreation regulations will be enacted for the LORP. Although new fencing will be constructed public access will be granted to the river channel via walkthroughs. Additionally, LADWP will be required to install signs at key access points to the LORP area (such as Mazourka Canyon Road, Manzanar Reward Road, the pump station and the Delta) describing LADWP policies on recreational uses of city-owned lands, contact information for reporting violations and the location of fences across the river.[87]

Deviations from Mandatory Documents

No deviations from the mandatory document were identified for recreation management within the LORP.

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[87] FEIR, p.2-64

Section 4

Monitoring Methods

Uplands in the Lower Owens River

Lower Owens River Project

Monitoring, Adaptive Management and Reporting Plan

April 28, 2008

4.1 Monitoring Description

Monitoring is performed by staffs of LADWP, ICWD and the MOU Consultant, collectively referred to as "Staffs." Staffs take direction from the Scientific Team and LADWP and ICWD management. The MOU Consultant is responsible for evaluating scientific data and making recommendations to LADWP and ICWD management for all LORP actions, including adaptive management. The Scientific Team is comprised of scientists from each entity: LADWP, ICWD and the MOU Consultant (see Section 3.3). The Scientific Team may designate a Task Leader (TL) to supervise Staffs; the TL is responsible for each monitoring task. Should monitoring protocols need to be amended, Staffs must obtain approval and direction from the Scientific Team.

Input will be solicited from the Advisory Committee by the MOU Consultant regarding the annual monitoring data and results. The MOU Consultant will then provide the summary and make recommendations regarding adaptive management to LADWP and ICWD management by 01 November of each year. It is the responsibility of LADWP and ICWD management to publish the LORP Annual Report and make it publicly available each year beginning in 2009; there are detailed directions concerning the release and drafting of the LORP Annual Report in the Stipulation and Order (see Appendix A.7).

Section 4 describes the specific monitoring methods integral to evaluating LORP management actions. Each protocol description identifies the project action that is the focus of each monitoring effort and then identifies the prescribed monitoring tasks in detail. Many monitoring protocols are seasonally and geographically specific, as indicated in each protocol that follows. The monitoring objective and a description of the baseline data are presented, followed by direction regarding specific methods and associated temporal and geographical details. These protocols provide data that can be analyzed to inform the adaptive management processes described in Section 3. Monitoring protocols are presented according to LORP physical and geographic features, as described in Section 2.1 and displayed in Figures 2.1 – 2.8.

4.1.1 Data Management / QA-QC

Following is a description of data management and compilation procedures that are common to all the monitoring methods described in Section 4. Any modifications of these procedures are made only with approval of the Scientific Team.

- Staffs use datasheet forms in the field to collect data. The datasheet forms provide check boxes for each step that must be taken to complete the data compilation process. Check boxes should be checked, initialed and dated after each step is completed.
- Datasheets are reviewed by one of the field crew members and the project manager for completeness prior to data entry.
- The TL is responsible for collecting all completed field forms from the field crew and delivering them in person to the LADWP offices in Bishop. All field forms receive a document control number and are filed and retained for a minimum

Lower Owens River near Lone Pine Narrow Gage Road

of 15 years at LADWP offices in Bishop. In addition to retaining hard copies, field forms are scanned and stored in electronic format on the project server for the life of the project.
- Staffs enter data into a spreadsheet or database. Record the name of the staff entering the data on the original field form.
- Download and identify the location of photos taken during monitoring. Name photos according to a standard naming format and record on the datasheet. Develop a spreadsheet to track the photos.
- Check data entry errors according to the quality assurance protocols described below.

Data quality control activities common to all monitoring tasks are described below. More specific direction is described, where necessary, under each monitoring method.

- For quality assurance purposes, individuals with adequate knowledge and appropriate training of field and sampling tasks (e.g., plant identification, use of nested frequency frames, estimation of vegetation cover, use of Robel poles, age classification of shrubs) are included in each field crew. Training is conducted in the field by the TL before the first sampling activity and as needed (e.g., when a new crew member is added).
- Scientific Team designates the TL for some or all monitoring activities. The TL is responsible for managing and overseeing Staffs' actions and deliverables.
- Before leaving each sample site, field forms are reviewed by someone other than the data collector to ensure data are complete, legible, accurate and in standard format. Correct errors with a line drawn through them and the correct term or value written above. Staffs flag suspect data and describe in the comments section on the field form. Staffs enter data into spreadsheets or databases.
- The TL (or designee) performs weekly and randomized reviews of field forms to verify accurate transcription and to identify suspect data. TL corrects all transcription errors (e.g., incorrect numerals, misspelled codes or species names, etc.).
- Designated TL is responsible for weekly and randomized review of all calculation results to verify accuracy. All calculation errors are corrected and reported to the Scientific Team.
- The TL is responsible for overseeing routine maintenance and metering of monitoring equipment (e.g., calibration of flow meters). TL reports maintenance and metering schedules to Scientific Team coincident with data submissions.
- Scientific Team reviews all flagged suspect data and makes the decision to exclude any data from use in further analyses.

4.1.2 Decision Making

Staffs carry out the protocols described here and as dictated by the Scientific Team. The Scientific Team compiles and evaluates all monitoring data as monitoring tasks are completed and then provides these data and associated analyses to the MOU Consultant. The MOU Consultant considers the compiled data and consults with the Advisory Committee about monitoring direction and resource prescriptions. The MOU Consultant uses this information, assess the monitoring data and uses it to inform adaptive management recommendations, which are provided to ICWD and LADWP management. At the latest, the MOU Consultant needs to receive all pertinent data and analyses from Staffs by the end of September, each year, in order to provide its summary and recommendations to ICWD and LADWP management before the first of November each year. ICWD and LADWP management make all monitoring and adaptive management decisions and deliver resource management prescriptions to the Technical Group and Standing Committee in the LORP Annual Report. Presentation protocols of LORP Annual Reports are described in the Stipulation and Order (see Appendix A.7).

4.1.3 Future Wetland Values Monitoring

Compliance with the Lahontan Water Quality Control Board Order (E-8) includes long-term monitoring of wetland functions and values in the LORP area. Protocols for this monitoring effort are not included in this Section, but require LADWP to comply with the following:

1. *By April of 2014, the Discharger shall provide an updated hydrogeomorphic analysis of wetland functions and values suitable for comparison with the pre-project hydrogeomorphic analysis of the LORP, and a determination on whether "no net loss" requirements of the section 401 certification have been achieved with regard to wetland functions and values. An updated analysis shall be provided by April 1, 2019, and April 1, 2024, unless the Regional Water Board Executive Officer determines that "no net loss" requirements have been fulfilled based on information provided by the Discharger.*

2. *A jurisdictional wetland delineation of 500-acre portions of the Blackrock Waterfowl Area shall be completed (using the U.S. Army Corps of Engineers 1987 wetland delineation manual) two years following action to restrict the water supply to any area currently being artificially supplied with water, until delineations have been completed for the entire Blackrock Waterfowl Area.*

Table 4.01 Annual monitoring schedule

Short-term and long-term metrics for the LORP based on frequency of monitoring over the 15-year monitoring period (an X in the column indicates the year that metric will be monitored). Not all monitoring tasks will be conducted each year, as is shown in the table. Monitoring tasks are intended to provide data to inform adaptive management decision making.

MONITORING METRIC	Term	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
RIVERINE-RIPARIAN SYSTEM																
Base Flow	Shortterm	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Base Flow Water Quality[*]	Shortterm	X														
Base Flow Fish Condition[*]	Shortterm	X														
Seasonal Habitat Flow Compliance	Shortterm	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Seasonal Habitat Flooding Extent	Shortterm	X	X	X	X	X			X			X			X	
Seasonal Habitat Flow Water Quality	Shortterm	X	X	X												
Seasonal Habitat Flow Fish Condition	Shortterm	X	X	X												
River Channel Rapid Assessment Survey	Shortterm	X	X	X	X	X	X	X	X	X	X					
Indicator Species' Habitat	Longterm		X			X		X			X					X
Fish Habitat	Longterm			X			X			X						
Landscape Vegetation Mapping	Longterm		X			X		X			X					X
Site Scale Vegetation Assessment & Landform Elevation Modeling	Longterm		X			X		X			X					X
Avian Census	Longterm		X			X		X			X					X
Creel Census	Longterm		X			X		X			X					X
Contingency Monitoring	Shortterm	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Data Analysis and Reporting	Longterm	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

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[*] Water quality monitoring will continue until the Lahontan Water Quality Control Board determines discharges no longer pose a threat to water quality.

Table 4.01 Annual monitoring schedule (Continued)

Short-term and long-term metrics for the LORP based on frequency of monitoring over the 15-year monitoring period (an X in the column indicates the year that metric will be monitored). Not all monitoring tasks will be conducted each year, as is shown in the table. Monitoring tasks are intended to provide data to inform adaptive management decision making.

MONITORING METRIC	Term	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
BLACKROCK MANAGEMENT																
Blackrock Flow and Wetland Area Compliance	Shortterm	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Blackrock Rapid Assessment Survey	Shortterm	X	X	X	X	X	X	X	X	X	X					
Indicator Species' Habitat Monitoring	Longterm		X			X		X			X					X
Landscape Vegetation Mapping	Longterm		X			X		X			X					X
Wetland Avian Census	Longterm		X			X		X			X					X
Contingency Monitoring	Shortterm	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Data Analysis, Report Preparation, Recommendations	Longterm	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
DELTA HABITAT AREA																
Delta Flow Monitoring	Shortterm	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Delta Rapid Assessment Survey	Shortterm	X	X	X	X	X	X	X	X	X	X					
Indicator Species' Habitat	Longterm		X			X		X			X					X
Landscape Vegetation Mapping	Longterm			X	X		X		X	X		X	X	X	X	
Wetland Avian Census	Longterm		X			X		X			X					X
Contingency Monitoring	Shortterm	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Data Analysis, Report Preparation, Recommendations	Longterm	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
OFF-RIVER LAKES AND PONDS																
Flow and Wetland Area Monitoring	Shortterm	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Rapid Assessment Survey	Shortterm	X	X	X	X	X	X	X	X	X	X					
Creel Census	Longterm		X			X		X			X					X
Contingency Monitoring	Shortterm	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Data Analysis, Report Preparation, Recommendations	Longterm	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
RANGE TREND																
Utilization	Shortterm	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Irrigated Pasture Condition Scoring	Shortterm	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Range Trend	Longterm	X	X	X		X					X					X
Contingency Monitoring	Shortterm	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Data Analysis, Report Preparation, Recommendations	Longterm	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

4.2 Riverine-Riparian Area Monitoring

The Riverine-Riparian Area is identified and described in Section 2.1.1 and displayed in Figures 2.2–2.4. Monitoring in the Riverine Riparian Area includes monitoring flows, water quality, habitats, vegetation and populations. The monitoring activities are designed to track the development of a healthy and functional riparian system. As well, the Rapid Assessment Survey monitors a suite of parameters and is designed to alert managers to resource impacts potentially occurring from a variety of sources. Although grazing occurs in the Riverine-Riparian Area, grazing monitoring is addressed separately, in Section 4.6.

As described in Section 1, the overall objective of the LORP is to establish and maintain healthy, functioning ecosystems in the four management areas of the LORP. The proposed flow releases and land management actions are designed to establish, enhance and maintain habitats that are consistent with the needs of the habitat indicator species, which have been defined for each of the four geographic areas of the LORP.

The proposed flow releases and land management actions are designed to result in changes over time (trends) in the extent and quality of riparian, wetland and aquatic habitats, which will benefit the indicator species. The overall objective of the habitat monitoring task is to assess whether environmental changes in the LORP area over time are consistent with the expected trends. The habitat monitoring task will be conducted for the full term of the monitoring effort, which is 15 years after project implementation.

Riverine-Riparian habitat monitoring consists of methods designed to detect changes at different temporal and spatial scales for various habitat characteristics. These include rapid assessments, baseflow compliance, seasonal habitat flow compliance, site and landscape scale vegetation assessments, habitat development and fish habitat. If the changes observed through the habitat monitoring task are not consistent with the expected trends, the potential causes will be investigated and appropriate modifications to water and land management actions will be identified and implemented. The Riverine-Riparian habitat monitoring tasks are summarized in Table A.1 of Appendix A.2.

4.2.1 Base Flow

Base flows were reintroduced to the Lower Owens River beginning on December 2006. These flows are maintained at approximately 40 cfs (as per the MOU and Stipulation and Order) in order to enhance native and game fisheries and riparian habitats along 53 miles of the river (the remaining nine miles of channel are part of Delta Habitat Area and subject to other flow parameters; see Section 4.4.1). Flows are measured continuously using automated stream gages to ensure maintenance of the 40 cfs flow from the LAA Intake to the pumpback station. Mean daily flows, 15-day average flows and daily averages are calculated to determine flow compliance.

Flow releases are anticipated to increase the total area of riverine-riparian and wetland habitat areas, increase the size and connectivity of the individual habitat areas and increase the structural complexity, productivity and diversity of vegetation communities within individual habitat areas.

The July 11, 2007 Stipulation and Order from the Superior Court of the State of California, County of Inyo (see Appendix A.7) serves to establish certain data reporting requirements, provides criteria as to what constitutes a permanent base flow of approximately 40 cfs in the LORP and provides a mechanism for enforcement of the provisions stated in the Stipulation and Order.

Monitoring associated with base flows includes flow monitoring and water quality monitoring. Flow monitoring is described in this section, but baseflow water quality monitoring is combined with seasonal habitat flow water quality monitoring and described in Section 4.2.2.2.

4.2.1.1 Base Flow Monitoring

Base Flow Monitoring Purpose

Base flow monitoring in the Lower Owens River is designed to document compliance with LORP requirements, the MOU and the Stipulation and Order and to achieve management objectives as described in Section 3.8. Base flow monitoring helps to inform the following adaptive management decisions (see Section 3.7.1): Baseflow, Fishery, Riverine-Riparian Habitat, Water Quality and Tule/Cattail Control.

To achieve baseflow compliance, the following conditions must exist in the Lower Owens River:

- A minimum flow of 40 cfs released from the LAA Intake at all times;
- None of the 10 in-river flow measuring stations described in Table 4.2 has a 15 day running average of less than 35 cfs;
- The mean daily flow at each of the 10 in-river flow measuring stations must be equal or exceed 40 cfs on at least 3 individual days per any continuous 15 day period, except that this requirement shall not apply to the following measuring stations at Reinhackle Springs and Lone Pine Narrow Gage Road between November 1 and April 30 of each runoff year;
- The 15-day running average of the 10 in-river flow measuring stations is no less than 40 cfs.

To achieve these parameters, LADWP has the discretion and responsibility to augment flows as needed. Except as provided in Section I.4 of the Stipulation and Order (“Planned Events Resulting in an Inability to Comply”), at all times, LADWP will release a sufficient amount of water to the Lower Owens River to maintain the required base flows.

Baseline Data Collected

Baseline data collected for flow monitoring consists of photographs of newly installed gaging stations, associated equipment and general site conditions. Upon initial installation records were made of Universal Transverse Mercator (UTM) coordinates for metering and staff gage locations in the field using a Global Positioning System (GPS) unit.

Methods

Base flow monitoring is described in Technical Memorandum #1 and #11, the EMP, FEIR and the Stipulation and Order. The Stipulation and Order has prominent legal authority. Since ICWD staff does not have appropriate equipment to do so, it is the responsibility of LADWP staff to perform all tasks related to Base Flow Monitoring.

Protocol

Collect flow data at ten locations (see Figure 4.1) in the Owens River using automated gaging equipment. Collect flow data from automated gaging equipment at six locations (see Figure 4.1) in ditches and tributaries that may convey water to the Owens River channel. If the automatic gaging equipment is nonfunctional, then Staff is responsible for manually measuring flow on a daily basis. The Stipulation and Order provides more extensive provisions should the automated gaging equipment not function properly. The metering equipment (Langemann Gate or Argonaut-SW) continuously record flow velocity (fps) and water surface elevation (feet) data. The equipment also computes the discharge (cfs) on a real-time basis based on channel cross-section geometry (surveyed during initial and subsequent calibration). Store electronic data in the data recorder at each station; transmit by telemetry to a computer located at the LADWP Bishop office on an hourly basis.

Electronic measuring devices are used at all temporary flow measuring stations and will be used at permanent flow measuring stations. If the electronic measuring or radio equipment does not function properly for 24 hours or should the integrity of a flow measuring station be compromised, the Stipulation and Order directs LADWP to commence either current meter measurements or daily manual data collection at the affected station(s) as soon as practical, but not later than the second workday after discovery. The site(s) will be current metered daily until the problem is resolved.

The frequency of current metering can be reduced if the flows at the flow measuring stations above and below the affected measuring station are considered stable by LADWP. Document with photographs and descriptions any substantial change in site conditions observed during field inspection or equipment calibrations. Record Universal Transverse Mercator (UTM) coordinates of staff gage locations in the field using a Global Positioning System (GPS) unit at each sampling event. ICWD and LADWP management will make the ultimate adaptive management decisions in the LORP Annual Report or otherwise. The Standing Committee and Staffs will implement those prescriptions.

Sites

Seventeen flow measuring stations are identified in the FEIR. There are sixteen flow measuring stations constructed. An addendum to the EIR was made and incorporated into the Stipulation and Oder that Locations of ten of the constructed flow measuring stations include: the LAA Intake (a permanent station), Owens River above Blackrock Ditch Return, Owens River East of Goose Lake, Owens River at 2 Culverts (formerly 5 Culverts), Owens River at Mazourka Canyon Road, Owens River at Manzanar Reward Road, Owens River at Reinhackle Springs, Owens River at Lone Pine Narrow Gage Road, Owens River at Keeler Bridge and the pumpback station. (For the purposes of flow criteria compliance, flow measurement at the pumpback station is considered an in-river station and is the sum of the outflow from the pumps' outlet pipes and releases to the Delta Habitat Area from the Langemann Gate and overflow weir, along with the sum of those three flow measurements.) Five flow measuring stations for augmentation ditches are located at the Owens River (Blackrock Ditch Return, Goose Lake Return, Billy Lake Return, Locust Ditch Return and George's Ditch Return) and one is located at the Alabama Gates Return. Figure 4.1 displays the approximate locations of the flow monitoring stations. Six of the in-river gaging stations are temporary and only required to be maintained and operated until July 2009 and when the Standing Committee designates the permanent stations, as described in the Stipulation and Order. These stations will be sited so that base flows and seasonal habitat flows can be managed in each of the hydrologically varying sections of the river channel in order to meet the goals and objectives of the LORP. Prior to designating the permanent flow measuring sites, the Standing Committee will notify all the Parties of the intended designations so the Parties have an opportunity to comment. The Standing Committee may also designate one or more temporary flow measuring stations, which will continue to be monitored after the permanent stations have been designated. The MOU requires at least 4 permanent flow monitoring stations, which will be designated by the Standing Committee; six of the 10 in-river flow measuring stations are temporary. Except as provided in the Stipulation and Order, the temporary flow monitoring stations will be maintained and operated until at July 2009, when the permanent flow measuring stations are designated.

Frequency

Continuously collect flow data in the Owens River using automated gaging equipment and transmit to the LADWP Bishop Office.

Data Management

In addition to the general quality control activities listed in Section 4.1.1, quality control activities specific to the flow monitoring task are identified here. Designated (by Scientific Team) TL is responsible for ensuring functional equipment and accurate measurements by calibrating flow meters and rechecking calculations. As described in Section 4.1.1, TL reports maintenance and calibration schedules and results to Scientific Team. Perform routine current metering at all the in-river flow measuring sites (except the pumpback station) on at least a monthly basis to insure the measuring devices are properly calibrated. The Task Leader is responsible for making sure Staff posts LORP flow reports daily on the LADWP website showing mean daily flows and summary statistics (in-river station average and running average at each station) at all in-river flow measuring stations and all augmentation stations. The Task Leader will ensure that before July 2009, Staff will add and post real time flows to the current LADWP real-time website for LAA Intake, Owens River at 2 Culverts, Owens River at Reinhackle Springs, Keeler Bridge and pumpback station flow measuring stations. Compile continuous flow data in a spreadsheet program in tabular form. Include the entire ramping cycle from baseflow through the habitat flow cycle and back to baseflow for all river stations.

Data Analysis and Reporting

Statistical Applications

Base flow calculations include: the mean daily flow, which is the 24-hour mean of the flow data from midnight at each measuring station or a current meter measurement if the automated gage is not functioning; the 15-day running average is the mean of the mean daily flow for 15 consecutive days up to the date of calculation. Running averages are calculated daily, beginning on July 26, 2007. The mean daily flow is the 24-hour mean of the flow data from midnight to midnight at each measuring station or a current meter measurement if the automated gage is not functioning. The 15-day running average is the mean of the mean daily flow for 15 consecutive days up to the date of calculation. Running averages are calculated daily, beginning on July 26, 2007. As temporary flow monitoring stations are taken out of service, the number of stations in the base flow and monitoring/reporting criteria will be reduced accordingly. When the Standing Committee designates four or more permanent flow measuring stations (pursuant to Section F.2 of the Stipulation and Order), compliance with the base flow criteria will be based only on designated permanent flow measuring stations.

GIS Applications

No GIS applications are recommended.

Reporting

Daily Data: The TL will post daily LORP flow reports on the LADWP website showing mean daily flows and summary statistics (in-river station average and running average at each station) for all in-river flow measuring stations and all augmentation stations. The daily LORP flow report covers a midnight to midnight period and is posted on the website before midnight of the following work day.

LORP real-time data: By July 2009, add and post real time flow data to the current LADWP real-time website for the LAA Intake, Owens River at 2 Culverts, Owens River at Reinhackle Springs, Keeler Bridge and pumpback station flow measuring stations. Real-time data will be posted on workdays, weekends and holidays. Once four or more permanent flow measuring stations have been designated by the Standing Committee, real-time data will be posted only from the designated in-river permanent flow measuring stations and from any of the temporary flow measuring stations designated by the Standing Committee for continued monitoring. The MOU Consultant is to provide recommendations to the Sanding Committee, which makes decisions official.

Monthly reports: the TL generates monthly data reports and provides them to all the Parties by the last workday of each month unless all the Parties agree to another schedule. Include final archived data for the flow measuring stations (both in-river and augmentation ditch stations), current meter measurements, stage data, mean daily flow values and other routinely collected data and provide a synopsis of events for the month. Identify data indicating possible noncompliance with the base flow criteria; this monthly report is the official record for determining compliance with the Stipulation and Order flow compliance criteria. The monthly data reports report data from the month ending approximately 60 days prior to the data report. Post the data to the LADWP website.

Annual Report: The MOU Consultant will provide a adaptive management recommendations to ICWD and LADWP management by the first of November, each year. The ICWD and LADWP management will prepare the LORP Annual Report that includes data collected during the habitat and flow monitoring, results of analyses and directions for adaptive management actions. The LORP Annual Report will be submitted to the Standing Committee and will also be made available to the public.

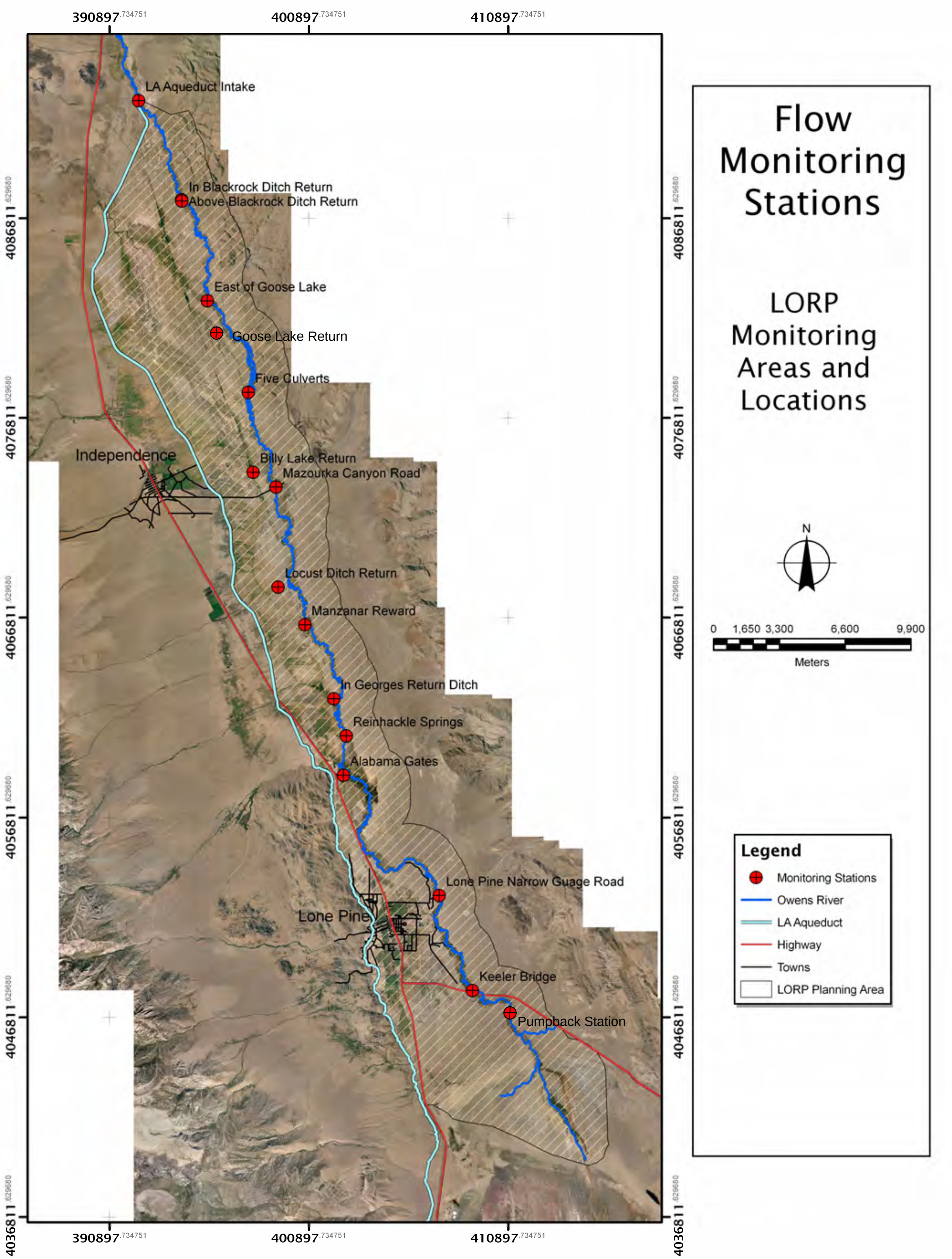

Figure 4.1 LORP Flow Gaging Stations

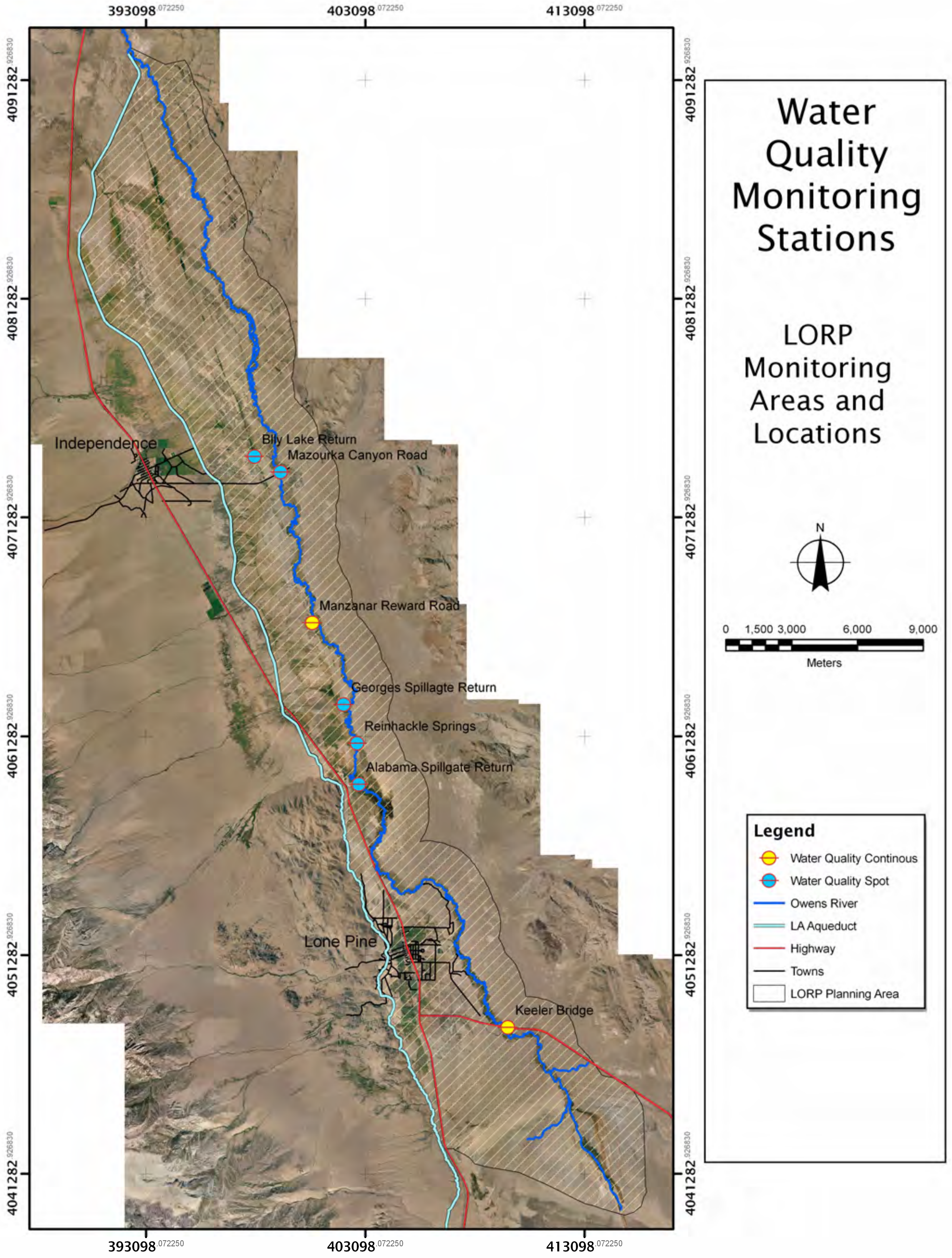

Figure 4.2 LORP Water Quality Sampling Stations.

4.2.2 Water Quality Monitoring

Base Flow and Seasonal Habitat Flows

LORP water quality monitoring provides an early warning of declines in water quality during and after initiation of flow releases and during seasonal habitat flows; this allows LADWP to modify flow releases to improve water quality in limited areas around spillgate returns designated as fish refuges. Water quality monitoring also allows LADWP and others the ability to track the gradual, expected improvement of water quality conditions over time. This monitoring program began before the initiation of base flow releases to the river and continues until the Lahontan RWQCB determines that there is no longer a threat to water quality. Water quality monitoring is managed to maintain LORP Ecosystem Management Plan water quality standards and objectives and comply with the 2005 Order issued by the Lahontan RWQCB.

Monitoring Purpose

Base flow and seasonal habitat flow water quality is monitored in limited areas around spillgates so that flow releases can be modified, if necessary, to improve the water quality in these fish refugia. Water quality monitoring helps to inform the following adaptive management areas (see Section 3.7.1): Fishery, Water Quality and Seasonal Habitat Flows. Water quality parameters (dissolved oxygen [DO], turbidity, pH and possibly ammonia, temperature and electrical conductivity [EC]) are monitored to meet the Lahontan RWQCB water quality objectives and protect the designated beneficial uses of the Lower Owens River.

Baseline Data Collected

Prior to Phase 1 of base flow implementation, water quality data (dissolved oxygen, hydrogen sulfide, ammonia, turbidity, pH, temperature, EC, tannins and lignins) were collected at the monitoring stations identified in Table 4.2 for one month. Data were also collected to determine fish conditions (thresholds for dissolved oxygen, hydrogen sulfide and ammonia- see Table 4.1). Sampling locations were originally selected based on river access and observed past water quality degradation events as well as potential fish refugia. The frequency and timing of the water quality monitoring for base flows is described in Table 4.3. Base flow monitoring began one month prior to initiation of Phase I, during Phases I and II and after Phase II. These data serve as baseline water quality data along the currently wetted reach of the Lower Owens River.[1] No baseline water quality data have been collected for seasonal habitat flow water quality monitoring.

Methods

Water quality monitoring for base flows and seasonal habitat flows is described in Technical Memorandum #07 *Water Quality Existing and Future Conditions*, the Ecosystem Management Plan, FEIR and the 2005 Lahontan Regional Water Quality Control Board Order.

Constituent or Observation	Threshold	Source
Dissolved Oxygen	1.5 mg/L and downward trend in data	USFWS, 1982 (1.0 mg/L)
Hydrogen Sulfide	0.030 mg/L	96 hour LC_{50} for adult bluegill 0.045 mg/l (Smith et al, 1976)
Ammonia	Acute Criterion (one-hour average concentration) for Non-Salmonids (pH dependent)	U.S. EPA, 1999
Fish Conditions	The condition of fish visible at each station will be observed for evidence of stress such as excessive jumping, lying motionless near the surface, rapid gill movement and poor coloring or body appearance. The threshold will be observance of one or more of these behaviors in several fish.	

Table 4.1. Water Quality Fish Condition Thresholds

Protocol

Prior to initiating Phase I and during Phases I and II, measure DO, turbidity, pH, ammonia, temperature and EC at Manzanar Reward Road and Keeler Bridge with stand-alone, fixed and multi-parameter water quality field instrumentation. Measure DO, turbidity, pH, temperature and EC with a man-portable,

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[1] LADWP 2004, Final EIR and EIS, LORP

multi-parameter water quality field instrument at the remaining locations identified under “Base Flows Prior to Phase I and during Phases I and II” in Table 4.2. Use field test kits at all locations to measure hydrogen sulfide, ammonia, tannins and lignins.

Record and spot measure water quality using fixed and man-portable, multi-parameter water quality probes and individual constituent test kits. Install probes in fixed casings and locate in mid-stream or as close as practically possible. Take grab samples for constituent test kits in mid-stream facing upstream with a 500 ml beaker.

Station Location	Linked Spillgate	Equipment	River Miles from Intake*
Base Flows Prior to Phase I and during Phases I and II			
Mazourka Canyon Road	Independence	Spot Measurement	24.1
Billy Lake return	Independence	Spot Measurement	23.6
Manzanar Reward Road	Georges	Continuous Recorder	32.9
Georges Spillgate return	Georges	Spot Measurement	36.9
Reinhackle Springs	Alabama	Spot Measurement	39.2
Alabama Spillgate return	Alabama	Spot Measurement	44.2
Keeler Bridge	None	Continuous Recorder	56.4
Base Flows Post Phase II			
Mazourka Canyon Road	Independence	Spot Measurement	24.1
Lone Pine Narrow Gage Road	None	Spot Measurement	50.7
Keeler Bridge	None	Spot Measurement	56.4
Pump Station Forebay	None	Spot Measurement	61.7
Seasonal Habitat Flow Monitoring Stations			
Mazourka Canyon Road	Independence	Spot Measurement	24.1
Lower Owens River	None	Spot Measurement	100 ft upstream of River Intake
Pump Station Forebay	None	Spot Measurement	61.7

Table 4.2. Base Flow and Seasonal Habitat Flow Water Quality Monitoring Stations.

* River miles from pg. 2-16, FEIR.

Take spot measurements with the surveying multi-parameter water quality probe in mid-stream, approximately six inches from the surface, with the probe facing upstream. Staffs will analyze samples in the field.

Field conditions may vary and it may become necessary to implement modifications to sampling. When appropriate, Staffs will notify the Scientific Team and obtain a verbal approval before implementing any changes. Note modifications to sampling in the field logs or notebooks.

Field equipment consists of the following:

- Two continuously recording, fixed and multi-parameter water quality instruments with components for DO, pH, turbidity, temperature, EC and possibly ammonia measurements.
- One man-portable, multi-parameter water quality instrument for spot measurements at locations along the river reach where continuous recorders are not installed.
- Maintenance and calibration materials for the above field instrumentation for operation of up to three years at the sampling frequency provided in Table 4.3. This includes a laptop computer.
- Field Test kits for measurement of hydrogen sulfide, ammonia and tannins and lignins. Sampling materials for up to three years at the frequency provided in Table 4.3.
- Digital camera.

If a single fixed, multi-parameter water quality instrument fails, reduce monitoring to one fixed station and one surveying unit until the broken unit is repaired or replaced. Maintenance materials are available for up to three years of operation, according to the frequency of measurements in Table 4.3. If the surveying man-portable, multi-parameter water quality instrument unit fails, temporarily replace with borrowed meters from LADWP or the California Department of Fish and Game until repairs are made.

Prepare, maintain and calibrate field equipment as per manufacturer specifications and schedules. Use manufacturer’s calibration standards and maintenance supplies. Keep maintenance and calibration records in instrument-dedicated bound surveyors’ notebooks.

At a minimum, record the following information while collecting samples, downloading or calibrating:

- Sample location and description
- Site or sampling area sketch showing sample location and measured distances
- Sampler's name(s)
- Date and time of sample collection
- Designation of sample as spot measurement, grab or download from instrumentation and the data file name
- Type of sample
- Type of sampling equipment used
- Field instrument reading and calibration
- Field observations and details related to analysis or integrity of samples (e.g., weather conditions, noticeable odors, colors, etc.)
- Preliminary sample descriptions (e.g., clear water with strong ammonia-like odor)
- Team members and their responsibilities
- Time of arrival and time of site departure
- Other personnel on site
- Summary of any meetings
- Calibration readings for any equipment used and equipment model and serial number

Transport test kit reagents and samples to LADWP or Inyo County facilities for disposal. Do not dump samples with reagents in the field.

Take photographs at sampling locations and other areas of interest on the site to verify information entered in the field logbook. Note the time, date, location, weather conditions, description of the subject and the name of the person taking the photograph in the logbook or in a separate field photography log.

If water quality thresholds (see Table 4.1) are exceeded at a monitoring station, then staffs are to inform LADWP management so it can release water to the river through the spillgate linked to that monitoring station. If monitoring indicates a downward trend in water quality toward any of the thresholds, water may be released to the river through the linked spillgate in anticipation of reaching the water quality threshold. Once operation of a spillgate is commenced, conduct water quality monitoring by spot measurements in the river channel below the spillgate channel. Discontinue operation of the spillgates when water quality at the monitoring station linked to the spillgate and at the confluence with the river below the spillgate channel returns to acceptable levels as defined in Table 4.1.

Time Period	Monitoring Frequency
1 month prior to Phase I	Once
Phase I	Weekly or biweekly
Phase II	Weekly or Biweekly for 6 months; then weekly
Post-Phase II	Monthly

Table 4.3. Base flow Water Quality Monitoring Frequency

Sites
Table 4.2 identifies the locations of water quality monitoring stations for base flows (prior and during Phases I and II and post-Phase II) and for seasonal habitat flows.

Frequency
The frequency of base flow water quality monitoring is described in Table 4.3. The Lahontan RWQCB requires that water quality monitoring be conducted monthly during the post-Phase II time period and continue until “discharges no longer pose a threat to water quality” (pg. E-11 of the Order). The frequency of water quality monitoring during seasonal habitat flows is described in Table 4.4. Monitoring begins the first day of initiating seasonal habitat flows, including the Alabama Release and continues daily until up to two weeks after the seasonal habitat flows or Alabama Release are concluded.

Time Period	Monitoring Frequency
During Seasonal Habitat Flows	5 days per week
After Seasonal Habitat Flows	1-5 days per week (as needed) for up to 2 weeks

Table 4.4. Seasonal Habitat Flow Water Quality Monitoring Frequency; occurs only for first three years that habitat flows occur.

Data Management
The Task Leader is responsible for ensuring functional equipment and accurate water quality measurements. As described in Section 4.1.1, follow all instrumentation standard operating procedures and calibration protocols and test kit instructions, as supplied by the manufacturers, to provide the quality of data necessary for management purposes.

Maintain field logbooks for each of the multi-parameter water quality instruments to document downloads and samples. Use a field notebook for independent constituent test kits. Store data in a dedicated instrument-compatible database program and/or spreadsheets. Maintain two disk backups at all times along with the working data directory in a desktop computer at the Inyo County Water Department main office in Bishop, California. Keep the other disks at an alternate location.

Data Analysis and Reporting

Statistical Applications
Only basic statistics are necessary for LORP water quality data analysis. Calculate averages using arithmetic means and plot data on graphs.

GIS Applications
No GIS applications are recommended.

Reporting
Prior to the commencement of Phase I flows, monitoring data were reported once. During Phase I releases, monitoring results were reported weekly or biweekly. During Phase II releases, monitoring results were reported weekly or biweekly for six months and then weekly thereafter. The Lahontan RWQCB Order requires the LADWP to provide annual Self-Monitoring Reports on February 1 following each calendar year. In addition, provide monthly reports the first day of the second calendar month following the month of sampling. Report data in tabular form and summarize to describe water quality conditions and impacts to beneficial uses (if observed or identified) and to clearly illustrate compliance with water quality objectives (Attachment E of the Order, Monitoring and Reporting Program).

4.2.3 Seasonal Habitat Flows

As described in Section 3.9, seasonal habitat flows are prescribed to encourage a transition to riparian vegetation on the floodplains as well as manage channel sediments. The initial seasonal habitat flow was released to the river in the winter of 2008 following the initiation of Phase II flow releases. Subsequent habitat flows will be released in late-spring/early-summer to roughly coincide with the spring run-off and to facilitate dispersal and germination of riparian plant species. Seasonal habitat flows will be released from the LAA Intake. The quantity, duration and timing of water releases for seasonal habitat flows are determined by the Scientific Team. The monitoring associated with seasonal habitat flows in the Riverine-Riparian Area includes measuring flooding extent, flow, water quality and fish condition.

As planned, a full 200 cfs habitat flow was released in 2008. Flows followed the ramping rates described in the 1997 EIR and the LORP Ecosystem Management Plan.

The purpose of the habitat flow is to create a dynamic equilibrium for riparian habitat, fishery, water storage, water quality, animal migration and biodiversity, which result in resilient productive ecological systems. Management actions are designed to achieve and maintain riparian habitats in a healthy ecological condition and establish a healthy warm water recreational fishery with habitat for native species.

Three general parameters are the focus of seasonal habitat flow monitoring: flow, flooding extent and water quality.

4.2.3.1 Seasonal Habitat Flow Monitoring

Seasonal Habitat Flow Monitoring Purpose

Monitoring of seasonal habitat flows is designed to document compliance with project requirements as well as aid the Scientific Team to achieve management objectives, as described in Section 3.9 Seasonal habitat flow monitoring helps to inform the following adaptive management areas (see Section 3.7.1): Seasonal Habitat Flows, Riverine-Riparian Habitat, Water Quality and Tule/Cattail Control. The Scientific Team may direct Staff to modify the protocols described below if deemed insufficient toward meeting project needs.

Baseline Data Collected

Baseline data collected for seasonal habitat flows consists of photographs of newly installed gaging stations, associated equipment and general site conditions. Records were made of Universal Transverse Mercator (UTM) coordinates for metering and staff gage locations in the field using a Global Positioning System (GPS) unit upon initial installation.

Methods

Monitoring of seasonal habitat flows is described in the Ecosystem Management Plan, FEIR and the Stipulation and Order. Since the latter is the most recent document and has prominent legal authority, the direction provided here is primarily based on that document. Since ICWD staff does not have appropriate equipment to do so, it is the responsibility of LADWP staff to perform all tasks related to Seasonal Habitat Flow Monitoring.

Protocol

Collect flow data at ten locations (see Figure 4.1) in the Owens River using automated gaging equipment. Collect flow data from automated gaging equipment at six locations (see Figure 4.1) in ditches and tributaries that may convey water to the Owens River channel. If the automatic gaging equipment is nonfunctional, then Staff is responsible for manually measuring flow on a daily basis. The Stipulation and Order provides more extensive provisions should the automated gaging equipment not function properly at the time of the seasonal habitat flow. The metering equipment (Langemann Gate or Argonaut-SW) continuously records flow velocity (fps) and water surface elevation (feet) data. The equipment also computes the discharge (cfs) on a real-time basis based on channel cross-section geometry (surveyed during initial and subsequent calibration). Store electronic data in the data recorder at each station; transmit by telemetry to a computer located at the LADWP Bishop office on an hourly basis.

Document with photographs and descriptions any substantial change in site conditions observed during field inspection or equipment calibrations. Record Universal Transverse Mercator (UTM) coordinates of staff gage locations in the field using a Global Positioning System (GPS) unit at each sampling event.

Sites

Figure 4.1 shows locations of the flow gaging stations. Six of the in-river gaging stations are temporary and only required to be maintained and operated until July 2009 and when the Standing Committee designates the permanent stations, as described in the Stipulation and Order. The Standing Committee is to receive recommendations from the MOU Consultant via LADWP/ICWD management concerning the designation of permanent and temporary gaging stations and only act on that direction. The Standing Committee, based upon recommendations provided by the MOU Consultant, may also designate one or more temporary gaging station, which will continue to be a monitoring station, after the permanent stations have been identified.

It is intended that all 10 in-river measuring stations will have the capability of accurately measuring the full amount of seasonal habitat flows required by the MOU and by applicable permits. However, if a flow measuring station is not capable of accurately measuring the first full seasonal habitat flow prior to the first seasonal habitat flow and if, because of permitting requirements or other reasons, a flow measuring station cannot be modified before the first seasonal habitat flow, LADWP, in cooperation with the County will modify the station to accurately measure the full seasonal habitat flow prior to the next seasonal habitat flow.

Frequency

During the first release of seasonal habitat flows, collect continuous data from the 10 in-river permanent and temporary measuring stations and from the six in-ditch or tributary measuring stations. During subsequent releases of habitat flows, flow data are to be collected at the permanent monitoring stations in the same manner.

Data Management
Designated (by Scientific Team) TL is responsible for ensuring functional equipment and accurate measurements by calibrating flow meters and rechecking calculations. As described in Section 4.1.1, TL reports maintenance and calibration schedules and results to MOU Consultant. Perform routine current metering at all the in-river flow measuring sites (except the pumpback station) on at least a monthly basis to insure the measuring devices are properly calibrated.

Compile continuous flow data in a Microsoft Excel spreadsheet (or other spreadsheet program) in tabular form. Include the entire ramping cycle from baseflow through the habitat flow cycle and back to baseflow for all river stations.

Data Analysis and Reporting

Statistical Applications
Calculate mean daily flows and summary statistics (in-river station average and running average at each station) and plot graphs of all pertinent data for all in-river flow measuring stations and all in-ditch or augmentation stations. Scientific Team is to direct Staffs to perform any additional statistical or analytical tasks.

GIS Applications
No GIS applications are recommended.

Reporting
Produce daily LORP flow reports showing mean daily flows and summary statistics at all in-river flow measuring stations and all in-ditch or augmentation stations. Report should cover a midnight to midnight period. Before midnight of the following day, post report on the LADWP website at:
http://www.ladwp.com/ladwp.cms/ladwp009121.jsp.

4.2.3.2 Seasonal Habitat Flooding Extent Monitoring

Flooding Extent Monitoring Purpose

Monitoring of flooding extent, which is how much land area is inundated during seasonal habitat flows, is prescribed to inform managers about the effectiveness of seasonal habitat flows. Seasonal habitat flooding extent monitoring is more qualitative than quantitative and its aim is to document that flooding is occurring and reveal which habitat communities are being affected by the flooding. Determining the extent and duration of the flooded area enables managers to identify which vegetation communities are inundated and are being affected by the seasonal habitat flow. This assists in determining if the seasonal habitat flows are meeting the 7 goals of the habitat flows listed in Section 3.9. Flooding extent monitoring helps to inform the following adaptive management areas (see Section 3.7.1): Seasonal Habitat Flows, Riverine-Riparian Habitat and Tule/Cattail Control. Monitoring flooding extent during the initial years of seasonal habitat flows will supplement baseline knowledge of the relationship between flow and area of land inundated by that flow. Digital aerial video surveys will inform managers about where flooding is and is not occurring and why.

Baseline Data Collected

HEC2 Stations (see Section 2.2.4 and 2.2.5) and landform elevation modeling plots (see Section 4.2.7.2) have been established at numerous locations on the river channel. Perform flooding extent monitoring at these known locations so that inundated landforms can be compared to baseline conditions. No other seasonal habitat flooding extent baseline data have been collected. The first habitat flow in February 2008 provided the initial data.

Methods

Monitoring of flooding extent is described in the Ecosystem Management Plan and the FEIR. The protocols described here are based upon these documents and more specific direction is provided. Methods consist of ground-based and aerial surveys.

Protocol
Perform aerial surveys from helicopter or airplane using mounted, georeferenced digital video camera or some comparable equipment, as approved by the Scientific Team. One technician may be required to manipulate the digital video camera in the aircraft and other technicians may be required to locate and mark the extent of flooding extent on the ground so that the video captures the markings. Video should capture the full lateral extent of flooding away from the main channel of the Owens River. At the very least, perform flooding extent video surveys once, three days after the peak of the seasonal habitat flow, to ensure that flow has had sufficient time to travel downstream. Ideally, multiple monitoring efforts will be performed throughout the seasonal habitat flow releases and afterward, as the water recedes from higher landforms. The Scientific Team will provide specific scheduling and logistical direction.

Perform ground-based surveys by locating the extent of flooding at specified locations adjacent to the river channel. Use field markers, survey and GPS equipment to identify and measure the extent of flooding away from the river channel. Take digital photographs of sampling locations when appropriate.

Sites
Select sites from each reach of the river. To the extent possible, select sites that correspond to established LORP video and photo monitoring points, HEC2 Stations (see Section 2.2.4 and 2.2.5) and landform elevation modeling plots (see Section 4.2.7.2). The Scientific Team ultimately indicates exact monitoring locations.

Frequency
Perform flood extent monitoring (aerial and ground-based) annually, during the seasonal habitat flow, for the first five years of the project. Once a baseline of seasonal habitat flooding extent is created, based on the results of the first five years, Scientific Team may wish to reduce monitoring frequency to once every three years.

Data Management
Staffs are to upload the video data produced by the monitoring effort and manipulate the data so that it is accessible for viewing and analysis for the MOU Consultant. Field measurements should be used to identify, on aerial photographs and maps, the landforms inundated by flooding. Flood extent digital video recordings and GIS shapefiles are to be stored at the LADWP office in Bishop on the LORP server. Data from the flood extent surveys will be saved for the life of the project to allow for comparative studies of the effects of flooding on the LORP ecosystem.

Data Analysis and Reporting

Statistical Applications
No statistical operations will be performed on the flood extent data.

GIS Applications
Single frames (aerial photographs) from the digital video camera will be imported into a Geographic Information System (GIS) and used as a base map. A GIS technician will digitize the flood extent and compare the results to an existing vegetation map, thus allowing managers to identify vegetation communities that are inundated by the seasonal habitat flow.

Reporting
Staffs are to report the results and associated analyses of flooding extent monitoring by August 1 of each year. MOU Consultant will include pertinent data, conclusions and monitoring and management prescriptions in the adaptive management recommendations.

4.2.4 Fish Condition Monitoring

Base Flow and Seasonal Habitat Flows

Monitoring Purpose

Water quality thresholds and fish conditions are monitored to avoid and minimize water quality degradation, ensure fish populations are sustained during modifications to flow and comply with applicable water quality laws, standards and objectives. In addition, monitor fish conditions to alert managers to impacts to native and recreational fisheries. Fish condition monitoring helps to inform the Fishery adaptive management area (see Section 3.7.1).

Baseline Data Collected

Prior to Phase 1 of base flow implementation, data were collected to determine water quality fish condition thresholds (Table 4.5). These data were collected at the monitoring stations identified in Table 4.2 for one month. Sampling locations were originally selected based on river access and observed past water quality degradation events as well as potential fish refugia. Data collected prior to Phase I, during Phases I and II and after Phase II serve as baseline water quality fish condition data along the currently wetted reach of the Lower Owens River.[2]

Constituent or Observation	Threshold	Source
Dissolved Oxygen	1.5 mg/L and downward trend in data	USFWS, 1982 (1.0 mg/L)
Hydrogen Sulfide	0.030 mg/L	96 hour LC_{50} for adult bluegill 0.045 mg/l (Smith et al, 1976)
Ammonia	Acute Criterion (one-hour average concentration) for Non-Salmonids (pH dependent)	U.S. EPA, 1999
Fish Conditions	The condition of fish visible at each station will be observed for evidence of stress such as excessive jumping, lying motionless near the surface, rapid gill movement and poor coloring or body appearance. The threshold will be observance of one or more of these behaviors in several fish.	

Table 4.5. Water Quality Fish Condition Thresholds

Methods

Monitoring of water quality thresholds and fish conditions for base flows and seasonal habitat flows is described in the Ecosystem Management Plan, FEIR and the Lahontan Water Board Order. Since the latter has prominent legal authority, the direction provided here is primarily based on that document.

Protocol

Base flows: During Phases I and II, monitor levels of dissolved oxygen (DO), hydrogen sulfide and ammonia and assess fish conditions using the instrumentation discussed in the base flow water quality monitoring section above. Visually assess fish conditions (evidence of stress such as excessive jumping, lying motionless near the surface, rapid gill movement and poor coloring or body appearance) and observe the river to detect fish kills. Take digital photographs of sampling locations when appropriate. If water quality thresholds or fish conditions (see Table 4.5) are exceeded at a monitoring station identified in Table 4.2, release water to the river through the spillgate linked to that monitoring station to create a refugium for fish in the spillgate channel and at the confluence with the river below the spillgate channel. If monitoring indicates a downward trend in water quality toward any of the thresholds, water may be released to the river through the linked spillgate in anticipation of reaching the water quality threshold. Once operation of a spillgate is commenced, conduct water quality monitoring by spot measurements in the river channel below the spillgate channel.

Discontinue operation of the three spillgates to create refugia for fish when: (1) water quality at the monitoring station linked to the spillgate and at the confluence with the river below the spillgate channel returns to acceptable levels as defined in Table 4.5 or (2) fish at the monitoring stations are not exhibiting signs of stress. If release from one or more of these spillgates is required, flows to the river will be adjusted to maintain approximately 40 cfs.

Seasonal habitat flows: The water quality thresholds and fish condition monitoring methods are the same as those described above for base flows.

Sites

Base flows: Monitor water quality fish condition thresholds at Mazourka Canyon Road, Lone Pine Road, Keeler Bridge and the

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[2] LADWP 2004, Final EIR and EIS, LORP

pumpback station forebay. Visually observe fish conditions at these same measuring stations.

Seasonal habitat flows: Monitor water quality fish condition thresholds at the pumpback station forebay, Lower Owens River (100 feet upstream of the River Intake) and Mazourka Canyon Road. Visually observe fish conditions at these same measuring stations.

Frequency
Base flows: Monitor water quality fish condition thresholds monthly.

Seasonal habitat flows: Monitor water quality fish condition thresholds daily during the first winter habitat flow, Alabama Release and initial two spring season habitat flows. Begin monitoring on the day of initiating the high flow releases (>40 cfs) and continue five days per calendar week for two weeks thereafter and at least twice during the first week following cessation of high-flow releases, at a minimum of two-day intervals (Lahontan Water Board Order pg. E-8 to E-9).

Continue to monitor water quality conditions until the RWQCB determines the discharges associated with the LORP pose no threat to water quality.

Data Management
In addition to the data management requirements described for base flow water quality monitoring, maintain field logbooks that document visual observations of fish.

Data Analysis and Reporting

Statistical Applications
Only basic statistics are necessary for LORP water quality data analysis. Calculate arithmetic averages and plot data on graphs.

GIS Applications
No GIS applications are recommended.

Reporting
In addition to the reporting requirements described for base flow water quality monitoring, Staffs report evidence of fish stress (excessive jumping, lying motionless near the surface, rapid gill movement and poor coloring or body appearance) or mortality immediately to the Scientific Team.

4.2.5 Rapid Assessment Survey

Monitoring Purpose

Rapid Assessment Surveys (RAS) are conducted to document problems or potential management issues in LORP riverine-riparian area and provide qualitative project-level feedback regarding changes within the project area. Annual RAS are designed to discover and track impacts that may result from increased or altered recreational use, exotic plant invasions, beaver activity and other potentialities. The intent of the RAS is to identify management issues during intervals between monitoring years and between monitoring sites before they manifest themselves into larger, more expensive management problems. Rapid Assessment Surveys help to inform the following adaptive management areas (see Section 3.7.1): Baseflow, Seasonal Habitat Flows, Fishery, Terrestrial Habitat, Riverine-Riparian Habitat, Water Quality, Tule/Cattail Control, Exotic/Invasive Plants, Range Condition and Recreation. The results of the RAS are primarily used to alert project managers to areas of special concern or land use impacts that may not be compatible with goals of the LORP.

Baseline Data Collected

Baseline RAS data were collected for the riverine-riparian area from August 14 to September 6, 2007. Data compilation, data analysis and report writing took place in September and October for the same year. Baseline data were collected following the protocols described below.

Methods

Protocol
Train personnel on data collection protocol, sensitive plant species identification, impact record decision making, map and GPS use. Personnel should have the following items available for use in the field:

1. Four wheel drive vehicles
2. Handheld GPS units (extra batteries)
3. Digital cameras (extra batteries)
4. The following data sheets: Rapid Assessment Datasheet, Tamarisk Documentation Form and Noxious Weed Reporting Form.
5. Clipboard and writing utensils
6. Field maps including aerial imagery of the day's survey route, with pertinent features including fencelines, river and river mile shapefiles, as well as a colored pen for making notes on maps.
7. Noxious weed habitat and morphology descriptions and photographs (see the noxious weed ratings table in Appendix A.6).
8. Waypoints of areas of management interest that need to be revisited as well as river and river mile shapefiles loaded on to GPS units.
9. Plastic bags for plant samples.
10. Cell phone or two-way radio for communication.

Technical staff should turn the tracking function on their GPS units on with the tracking function set at 0.01 km or "normal or more frequent than normal" sensitivity settings. As workers walk along their assigned route, they should scan the floodplain for the including but to limited to the following impacts: Recreation impacts (including new or those located near sensitive habitats), damage to livestock fences, beaver activity, the presence of noxious weeds (see the noxious weed ratings table in Appendix A.6) and areas of new woody recruitment. Survey both sides of the river from the intake to the pumpback station generally following the water edge, while examining as much of the floodplain as possible. For example, if a tamarisk stand is spotted in the floodplain, but away from the river's edge, workers should walk to the stand and document the stand on the appropriate data sheet.

Take a GPS point at each area of management concern. Record each point on the appropriate data sheet (described below) and assign the appropriate impact code. To save time in the field, use the GPS point name automatically assigned by the GPS unit. Record detailed notes on each point as appropriate. Areas of interest not accessible by foot or those that are large and contiguous may be recorded with one point and the extent of the area drawn on field maps. Take photographs of areas of interest or management concern as needed. Set the camera to the high resolution setting. Examples of situations in which a photograph is appropriate include the documentation of visible impact from roads, proximity of roads to sensitive habitats, obstructions in the running channel, proximity of tamarisk slash piles to riverine-riparian habitats, woody recruitment or conditions supporting weed infestations. Record the reason the photograph was taken, its digital file name assigned by the camera, the GPS point associated with the photograph and the information the photograph is meant to relay.

Three data sheets are required for the RAS. Record the following general information on each data sheet include the date observer(s), the field map associated with the data, the area or river mile surveyed and the beginning and ending time of the survey. The information recorded on these data sheets is described below.

Rapid Assessment Data Sheet

The Rapid Assessment Data Sheet is used to document all impacts or area of interest except for tamarisk plants. Note the impact code associated with each impact. Use the following impact codes: Noxious weeds (EXW), Recreation (REC), Beaver Activity (BEA), Fencing (FEN), Livestock Management Issues (GRZ), Woody Recruitment (WDY) or other (OTH). These impacts are described below.

Woody Recruitment

Record any native woody recruitment sites encountered. Take general notes on recruitment patches including number of individuals, approximate height, site conditions and the presence of non- native species such as tamarisk. Woody species of particular interest include all willow species [e.g., Goodding's Black Willow (*Salix gooddingii*), Red Willow (*S. laevigata*), Coyote Willow (*S. exigua*)] and Fremont cottonwood (*Populus fremontii*).

Recreation
Record adverse impacts associated with recreation observed outside of established "recreation areas" such as parking areas and fence walk-throughs. Examples of these impacts include off-road motorized vehicle travel, trash, vandalism of signs and evidence of overnight camping. In addition, record all roads within the riverine-riparian area that allow access to the floodplain.

Beaver Activity
Beaver activity can include dams, tree cutting, huts or other evidence of beaver activity such as excessive pooling of water. Note observations of these activities on the data sheet and take a GPS point. Evidence may include but not be limited to fresh chew marks on trees, fresh material on dams or fresh material on huts. In some situations, beaver dams may not be visible, but the sound of falling water over the top of a dam may be heard or the pooling of water behind the dam may be observed. Beaver often respond to the presence of humans by slapping their tails against the water. Record indirect evidence of beaver activity such as these.

Fencing
Record any vandalism or damage to fences. Identify if the fence has been cut, impacted by wildlife or livestock or is old and in disrepair due to age. Assess whether the repair is high priority based on the presence of livestock in the area, visible impacts or proximity to riverine-riparian habitats. If recreators, anglers or livestock appear to be repeatedly accessing the floodplain at a given point, note the need for an additional access point (walk-through or wildlife crossing point). If true fence lines differ from those on field maps, note the true location for database improvement or fence construction.

Livestock Management Issues
Document livestock management issues such as presence of livestock or supplement sites in the floodplain, excessive trampling of vegetation, excessive high lining of vegetation or water gaps where livestock are trampling streambanks to access water.

Other
Record and describe other impacts as necessary. Other impacts may include presence of tamarisk slash piles on the river banks or in the channel, burned areas or evidence of wildlife utilization of the floodplain. Workers should use their judgment to discern if an impact should be recorded.

Tamarisk Documentation Form
Tamarisk is the most widespread and common noxious weed found within the LORP area. For this reason, record all tamarisk in all life stages and forms on the tamarisk Documentation Form. Record the distance form the river to the plant, the number of plants associated with the GPS point, whether the plant is a resprout, a seedling or a fully grown plant and the approximate height. Record any other pertinent information in the notes column.

Noxious Weed Reporting Form
Record any noxious weed encountered that is listed by the California Department of Food and Agriculture as "A" or "B" (see the noxious weed ratings table in Appendix A.6). Review the noxious weed's morphology and habitat preferences before going into the field and bring this information into the field to aid with identification (see the noxious weed ratings table in Appendix A.6). Take a photograph of every noxious weed occurrence. Take samples and store them in plastic bags if necessary.

Sites
Perform the RAS for riverine-riparian area on both sides of the river from the Intake to the pumpback station.

Frequency
Perform the RAS once per year in July or August for the first 10 years following implementation. After the first 10 years, assess whether the RAS should continue into the future.

Data Management
Check field data sheets for completeness by field personnel as well as the TL. Each field person is responsible for downloading the GPS and digital camera data and on a daily basis. This information should be sent electronically to the TL for compilation. The TL should

assign each data sheet with a control number in a consistent manner with the prefix “RA.” Tamarisk documentation forms should have the suffix “TARA.” Photocopy and scan every data sheet for storage at the LADWP office in Bishop. Transmit GPS track and waypoint files electronically to ICWD.

Data Analysis and Reporting

Statistical Applications
There are no applicable statistical applications for the RAS.

GIS Applications
Transfer all spatial data to ArcGIS platform and save as ArcGIS shapefiles. Create ArcMap documents for each management area. Hand-digitize notations and drawings made on field maps.

Reporting
The TL is responsible for utilizing staffs to compile and produce a draft report at the conclusion of the survey. The report will include maps showing all pertinent data, a summary of findings and suggested management actions. The MOU Consultant will review this information and consultant with the advisory committee.

In addition, ICWD will fill out noxious weed location forms and send them to Inyo/Mono County Agricultural Commissioner’s Office. The TL will send tamarisk locations and information to the ICWD tamarisk control project manager and fill out and send LADWP Fence Repair Request Forms LORP Project Manager.

4.2.6 Habitat Monitoring

Habitat monitoring in the Riverine-Riparian Area consists of two efforts: indicator species’ habitat monitoring and fish habitat monitoring.

4.2.6.1 Habitat Monitoring

Indicator Species

Monitoring Purpose

Indicator species’ habitat monitoring is designed to document changes in habitat conditions in the Riverine-Riparian Area of the LORP. Indicator Species’ habitat monitoring helps to inform the following adaptive management areas (see Section 3.7.1): Seasonal Habitat Flows, Terrestrial Habitat, Riverine-Riparian Habitat, Tule/Cattail Control, Exotic/Invasive Plants and Range Condition. Indicator species represent a subset of the entire array of species that could possibly reside within the LORP. Changes in the quantity and quality (suitability) of habitat for a particular species or guild indicates that the system is changing compared to baseline conditions. Changes in habitat for indicator species will be analyzed using the California Wildlife Habitat Relationship (CWHR) system. The CWHR System is the most extensive compilation of wildlife habitat information in California today. The CWHR is a community level matrix model that predicts wildlife habitat relationships for 692 regularly occurring terrestrial vertebrates in California. Habitat suitability predictions are based on geographic range, relationships to 59 habitat types (27 tree, 12 shrub, 6 herbaceous, 4 aquatic, 8 agricultural, 1 developed and 1 non-vegetated.) averaging 12 stages each and use of 124 special habitat elements (CWHR 2007). CWHR wildlife experts have assigned wildlife suitability values for each habitat type species occupy. Within the Lower Owens, suitability values will be derived for indicator species and guilds (species similar in their habitat needs and response to habitat changes) (Table 4.6).

Each species CWHR model has expert-applied suitability ratings for three life-requisites - breeding, cover and feeding. For each species, every habitat stage is rated as high, medium, low or unsuitable for each of the three life requirements. Each special habitat element is also assessed as essential, secondarily essential, preferred or not rated for the species (CDFG 2000).

The CWHR System rests on a set of general assumptions. In addition, there are a number of specific assumptions which model raters must adhere to when assigning suitability values to habitats and importance levels to elements for any given species. General and specific system assumptions are listed below (CDFG 2000):
1. Wildlife species occurrence and abundance are strongly influenced by habitat conditions.
2. Wildlife habitat can be described by a set of environmental characteristics.
3. Relative suitability values (i.e., high, moderate, low, unsuitable) of habitats and the relative importance of special habitat elements may be determined for each species.
4. Habitat suitability value is uniform for a species throughout its range in California for the specified habitat.

The CWHR with the software application BioView enables managers to build habitat suitability (HSI) models for each indicator species and guild, thus evaluating the quality of the LORP habitats for each species or guild. Additionally, the CWHR with BioView application HSI value output can be added to a GIS layer allowing managers to quantify the acreage of suitable habitat for each species or guild. Further information on this monitoring component can be found in section 3.12.

Baseline Data Collected

Baseline conditions of indicator species' habitat quantity and quality (suitability) will be analyzed prior to monitoring in 2010; all available data sources will be used to assign height and canopy cover stages to the vegetation GIS polygons (Vegetation Mapping section 4.2.7.1). The available data sources are:

1. Riparian Habitat Development (GANDA 2003b)
2. Range Trend – section 4.6
3. Site Scale Vegetation Assessment – section 4.2.7.2
4. PRBO vegetation assessment – separate report
5. HCP HSI model data collection – separate report

Additionally, baseline avian point count data (PRBO) is available and will inform managers of the presence/absence of indicator species within the project area.

Great blue heron *(Ardea herodias)*
Western least bittern *(Ixobrychus exlilis hesperis)*
Swainson's hawk *(Buteo swainsoni)*
Northern harrier *(Circus cyaneus)*
Red-shouldered hawk *(Buteo lineatus)*
Virginia rail *(Rallus limicola)*
Sora *(Porzana carolina)*
Marsh wren *(Cistothorus palustris)*
Wood duck *(Aix sponsa)*
Western yellow-billed cuckoo *(Coccyzus americanus occidentalis)*
Long-eared owl (*Asio otus*)
Willow flycatcher *(Empidonax traillii)*
Yellow warbler *(Dendroica petechia brewsteri)*
Yellow-breasted chat *(Icteria virens)*
Blue grosbeak *(Guiraca caerulea)*
Warbling vireo *(Vireo gilvus)*
Belted kingfisher *(Ceryle alcyon)*
Nutall's woodpecker *(Picoides nuttallii)*
Tree swallow *(Tachycineta bicolor)*
Owens Valley vole *(Microtus californicus vallicola)*

Table 4.6. Wildlife habitat indicator species for riverine/riparian habitat Lower Owens River Project (MOU 1997).

Methods

As mentioned above, habitat quantity and quality (suitability) in the LORP for each indicator species and guild will be evaluated using the CWHR system with the BioView application. LORP specific CWHR habitats (Desert Riparian, Alkali Desert Scrub, Fresh Water Emergent Wetland and Perennial Grassland) will be evaluated to derive habitat suitability values (e.g., high, moderate, low) for each indicator species and guild. LORP habitats will be described using field data that describes specific habitat elements (vegetation type, structural elements, cover classes and special elements) outlined by the CWHR. Most important to the CWHR with BioView application is the CWHR habitat type and that habitat type's size (height and age) and cover stages. Stages are defined for virtually all habitats and are a combination of size and cover class for tree-dominated habitats, age and cover class for shrub habitats, height and cover class for herb habitats and depth and substrate for aquatic habitats (Tables 4.8–4.10).

Protocol

The 4 step process described below outlines the protocol required to prepare data for use in CWHR's BioView and how to run BioView to produce suitability values for indicator species and guilds.

Step 1. Crosswalk WHA's LORP mapping to the CWHR (Table 4.7).

Whitehorse Associates (WHA) mapped the Lower Owens River Riparian Vegetation based on 2000 aerial photos. WHA's vegetation types are described in Whitehorse Associates 2004c. WHA's map units (polygons) denote areas of distinctive landtype, soil, hydrologic and vegetative character, that enable technicians to easily crosswalk WHA's vegetation types to CWHR habitat types. Thus, each WHA vegetation type will be cross walked to one of eight CWHR habitat types. The CWHR system uses the following five classification schemes to inform the development of their habitat types: Sawyer & Keeler-Wolf (1995), the USDA Forest Service CalVeg (2001), Holland (1986), Cheatham and Haller (1975) and UNESCO (1996). These five classification systems were also used to crosswalk the WHA vegetation types into CWHR habitat types. Of all the classification schemes, the Holland classification was the most useful because both WHA and CWHR use Holland's classification scheme to describe their respective vegetation types. Therefore, the Holland classification system was used as an intermediary between WHA vegetation and CWHR habitat types (Table 4.7) (Oxbow Environmental 2006). The result of this step is a new GIS shapefile that describes the spatial location and acreage of CWHR habitat types within the Lower Owens River Project area. Future vegetation mapping may not be performed by WHA. Therefore, future vegetation mapping must be able to be cross walked to CWHR habitat types.

Step 2. Assign appropriate size and cover stage classes to WHA's polygons.

Each CWHR habitat type is divided into sub-categories based on vegetation layers which are representative of unique attributes to which wildlife are thought to respond (CWHR 2005). They include tree dominated, shrub dominated, herbaceous dominated, aquatic and developed habitat categories. Each sub-category has corresponding structural components, such as height and canopy cover that are grouped into standardized size and stage classes (Tables 4.8 – 4.10). Size and stage classes refer to vegetation age and vigor conditions. By standardizing size and stage classes, comparisons in suitability values may be made between different habitat types (Oxbow Environmental 2006).

The CWHR habitat types Barren, Pasture and Urban do not have defined size and stage classes (Tables 4.11). CWHR defines size and stage classes as structural components based on native vegetation composition and non-managed habitat (Oxbow Environmental 2006). Barren is classified as having a minimal amount of vegetation (≤ 2%) and is therefore not applicable to this classification scheme. Pasture and Urban habitat types are considered to be devoid of native vegetation (Urban) or non-managed habitat (Pasture) (Oxbow Environmental 2006) and are therefore not structurally defined by their vegetation.

Size and cover stage classes will be added to WHA polygons by adding fields to the WHA attribute table and populating those fields with the appropriate CWHR classes. The CWHR program requires data to be in classes (Tables 4.8 – 4.10); therefore quantitative field data must be converted to CWHR classes before being applied to the WHA polygons. Converting raw field data to classes is beneficial as it will reduce the problems caused by using multiple data sources collected by many individuals. Most likely monitoring data will not cover every single polygon in WHA's LORP mapping. To alleviate this problem, technicians must make estimates based on aerial/satellite imagery and comparing to existing data to add stage classes to the GIS CWHR habitat layer created in step 1.

Several monitoring data can be used to add CWHR size and stage class data to the CWHR habitat GIS layer (e.g., Irrigated Pasture Scoring, Utilization Monitoring and Range Trend). The result of step 2 is a GIS layer containing polygons depicting CWHR habitat types with stage class data. Technicians will need to export the database file (*.dbf) of the GIS layer from ArcView and import it into BioView to perform the suitability modeling.

Step 3. Run CWHR Version 8.1 with BioView using database file exported from Step 2.

CWHR Version 8.1 with BioView derives suitability values for indicator species based on habitat type and stage class data. The database file exported from step 2 must contain four fields; ID which is a unique identifier, CWHR habitat type and size and stage class. The database file exported from ArcView in Step 2 must be imported into BioView. After importing the database file suitability values can be defined for each indicator species selected by the technician. Suitability values can be derived in two formats: Standard Habitat Suitability Values and Habitat Suitability Values Using Fuzzy Logic. The major difference between Standard Habitat Suitability Values and Fuzzy Logic is Fuzzy Logic uses quantitative measurements while Standard Habitat Suitability Values relies on stage class data.

CWHR rates suitability of habitat within three potential use categories: breeding, feeding and cover. Unlike previous versions of the CWHR program, CWHR Version 8.1 with BioView assigns a value to a given habitat type when one or two of the use types are suitable. Those habitat types with no suitability value for any of the three use categories are assigned a 0. When one or two of the use categories are suitable, a value of 1 is assigned. This distinguishes habitats that have no suitability from those that may have provided some value, although minimal. Habitat types with undefined size and stage classes (i.e. Barren, Pasture and Urban) are assigned a value of "1" for size class and "0" for stage class. This is necessary for BioView to be able to process these habitat types and calculate suitability values for each habitat type and indicator species.

It is recommended that technicians adhere to the standards and guidelines outlined in CDFG 2000 and the methods for the CWHR system described in CDFG 2005. These two documents are essential reading for LORP habitat suitability modelers.

The result of step 3 is one database file (*.dbf) per indicator species. The database file is compatible with ArcView and will be joined to the CWHR Habitat GIS layer created in step 2.

CWHR Habitat Type	Holland Vegetation Type	WHA Vegetation Type
Alkali Desert Scrub	Rabbitbrush scrub meadow	Rabbitbrush-NV saltbrush scrub/meadow
Desert Riparian	Modoc-GB cottonwood/willow riparian forests	Riparian Forest (cottonwood)
	Modoc-GB cottonwood/willow riparian forests	Riparian forest (willow)
	Riparian scrub	Riparian forest shrub (rose)
	Riparian scrub	Riparian shrub (willow)
Perennial Grassland	Alkali meadow	Alkali meadow
Freshwater Emergent Marsh	Transmontane alkali marsh	Marsh
	N/A	Reedgrass
	Rush/sedge meadow	Wet alkaline meadow
Riverine	Permanent lakes and reservoir	Water

Table 4.7. Sample Crosswalk CWHR to Holland to WHA

Step 4. Join indicator species database file, created in step 3, to the CWHR Habitat GIS layer created in step 2. BioView is compatible with ArcView by joining the exported database file from step 3 to the CWHR Habitat GIS layer created in step 2.

Standards for Height Classes			Standards for Canopy Closure		
CWHR Code	**Size Class**	**Plant Height**	**CWHR Code**	**Closure Class**	**Ground Cover (Canopy Closure)**
1	Seedling Tree / Shrub	<2’	S	Sparse Cover	2-9%
2	Small Tree / Shrub	2-10’	P	Open Cover	10-39%
3	Medium Tree / Shrub	10-20'	M	Moderate Cover	40-59%
4	Large Tree	>20'	D	Dense Cover	60-100%

Table 4.8. Size (height) and stage (canopy closure) classes for the CWHR tree dominated habitat subdivision. Standards listed are relevant to the Desert Riparian habitat type

Standards for Height Classes			Standards for Canopy Closure		
CWHR Code	**Size Class**	**Crown Decadence**	**CWHR Code**	**Closure Class**	**Ground Cover (Canopy Closure)**
1	Seedling Shrub	Seedlings or Sprouts <3 Years	S	Sparse Cover	2-9%
2	Young Shrub	None	P	Open Cover	10-39%
3	Mature Shrub	1-25%	M	Moderate Cover	40-59%
4	Decadent Shrub	>25%	D	Dense Cover	60-100%

Table 4.9 Size (age) and stage (canopy closure) classes for the CWHR shrub dominated habitat subdivision. Standards are relevant to Alkali Desert Scrub habitat.

Standards for Height Classes			Standards for Canopy Closure		
CWHR Code	**Size Class**	**Plant Height at Maturity**	**CWHR Code**	**Closure Class**	**Ground Cover (Canopy Closure)**
1	Short Herb	<12”	S	Sparse Cover	2-9%
2	Tall Herb	>12”	P	Open Cover	10-39%
			M	Moderate Cover	40-59%
			D	Dense Cover	60-100%

Table 4.10 Size (height) and stage (canopy closure) classes for the CWHR herbaceous dominated habitat subdivision. Standards are relevant to Fresh Emergent Wetland and Perennial Grassland herbaceous

CWHR Habitat Type	Size Class	Stage Class
Barren	None Defined	None Defined
Pasture	None Defined	None Defined
Urban	None Defined	None Defined

4.11 CWHR habitat types with no defined size and stage classes

One GIS layer per indicator species will be created, thus it is possible that 109 (number of indicator species) individual shapefiles will be created. Each indicator species database file exported from BioView will be imported into ArcView and joined to the CWHR Habitat GIS layer created in step 2. Once joined, the shapefile will need to be saved and named per indicator species. Each polygon’s area (acres) will need to be added to each individual shapefile to determine the quantity of suitable habitat per species in the LORP.

It is recommended that technicians use the XTOOLS program to calculate the area of each polygon in each indicator species shapefile. The output from this step enables managers to examine year to year changes in the quantity and quality of habitat for indicator species in the LORP. Significant changes in an indicator species’ habitat quality or quantity may warrant adaptive management action.

Sites

Indicator Species CWHR habitat suitability results will cover three of the physical environmental features of the LORP (Riverine-Riparian, Blackrock and Delta). Thus, there are no actual individual sites for the indicator species’ habitat monitoring.

Frequency

Indicator species’ habitat monitoring will occur in years 2, 5, 7, 10 and 15.

Data Management

Designated (by Scientific Team) TL is responsible for ensuring that each of the steps described above are carried out correctly. Resultant data from BioView and ArcView applications should be saved per physical environmental feature of the LORP and per monitoring year.

Data Analysis and Reporting

Statistical Applications

Statistical applications performed for this monitoring task occur in BioView and ArcView and are outlined in the protocols section above.

Future Field Work

It should be noted that HSI models, like the CWHR, are a useful way to reduce large complex data sets to one understandable metric, but they can be flawed. The models are developed from correlations between habitat attributes and species abundance. In many cases the model assumptions are inappropriate for site-specific reasons.[3] For this reason, subsequent habitat suitability data collection efforts in the LORP should be CWHR specific and focus on standardizing the methods to best fit the CWHR model.

Future field work should be focused on collecting data pertinent to the CWHR. Previous data collection efforts, specifically the Riparian Habitat Development methodology performed by GANDA, is not cost effective for such a large monitoring effort. The methodology is intensive and time consuming and not commensurate with the needs of LORP monitoring and adaptive management process. In lieu of repeating the Riparian Habitat Development methodology, quality data that specifically supports the CWHR could be collected at a fraction of the cost. Additionally, much of the data collected using the GANDA methods is duplicate data, as similar data are collected under the Range Trend, Irrigated Pasture Scoring, Utilization Monitoring and Site Scale Vegetation Assessment methods. Thus, these data can be used to describe the stage classes outlined above. If these monitoring data are insufficient to inform the CWHR with BioView application then supplemental data can be collected. A subset of the GANDA transects would be most applicable for future sample sites. Supplementary data should be area and CWHR specific. Any supplemental field data collection must be defined by the CWHR, as CDFG provides a field sampling protocol, which is well-established for determining stages in all vegetated habitats (CDFG 2007). Future monitoring should include taking digital photographs of sampling locations when appropriate. Special habitat elements are also defined and include live and decadent vegetation elements such as snags, physical elements such as banks and burrows, aquatic elements, vegetative and animal diet elements and human-made elements (CDFG 2007).

Reporting

Reporting will occur in each monitoring year following data collection and analysis. Staffs will prepare a report documenting the quality and quantity of habitat for each indicator species and guild by the end of September of monitoring years. The MOU consultant will use the report to make adaptive management recommendations to LADWP and ICWD management by November 1 of each monitoring year.

4.2.6.2 Fish Habitat Monitoring

Monitoring Purpose

The purpose of fish habitat monitoring is to track the development of habitat conditions associated with a healthy, warm-water fishery in good condition and high quality environment for native fish species. The Scientific Team will be able to use the data to evaluate fish population concerns and make adaptive management recommendations about Fishery and Water Quality.

Baseline Data Collected

Fish habitat surveys were conducted in 2002, 2003 and 2004 using the sampling sites and methods described below. Since data from the previous surveys were collected using the same methods at the same locations, data quality will be sufficient for comparison with data collected after project implementation and for use in analysis.

Data collected included:

- Channel width
- Wetted perimeter width
- Average depth
- Thalweg depth
- Substrate
- Canopy cover
- Organic debris
- Bank undercut

Methods

Fish habitat monitoring includes the collection of data concerning the physical characteristics of aquatic habitat important to indicator fish

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[3] United States Fisheries and Wildlife Service 1982

species. The sampling design for the fish habitat survey was developed based on Platts et al. (1983). Fish habitat variables to be measured include channel morphology (channel width, wetted perimeter width, average and thalweg depths and bank undercut) substrate, organic debris and canopy cover.

Protocol

Along each transect, measure and record the following fish habitat variables onto standardized field forms (see Appendix A.8):

- **Channel width** – Distance (to the nearest meter) along the transect line beginning at the top of bank or high water mark on one bank and ending at the high water mark on the opposite bank, which ever is greater
- **Wetted perimeter width** – Distance (to the nearest meter) from the edge of the water on one bank to the edge on the opposite bank or shoreline
- **Average depth** – Depth of stream (to the nearest centimeter) taken at three locations: one-quarter, one-half and three-quarters of the stream width. The total of the three measurements are divided by four to calculate the average depth (to account for zero depths at the stream margin where the water surface and the bank meet).
- **Thalweg depth** – Depth of the stream (to the nearest centimeter) at the deepest point along the transect
- **Substrate –** Substrate class (i.e., boulder, rubble, gravel and fines) of the channel substrate at 1-meter increments along the transect.
- **Canopy cover** – Percentage of a transect line covered overhead by trees and shrubs overhanging the stream at a distance of greater than 30 cm above the stream surface.
- **Organic debris** – Amount (to the nearest meter) of woody debris (submerged logs, root wads and brush) present along the transect. The total amount of woody debris will be divided by the channel width to calculate the percent covered by organic debris.
- **Bank undercut** – Distance (to the nearest centimeter) from the farthest point of protrusion of the bank to the farthest undercut of the bank on each side.

Take digital photographs of sampling locations when appropriate.

The fish habitat survey requires the following equipment:

- Blank field forms and clip board
- GPS Unit (Garmin V® or equivalent) loaded with coordinates of the sites to be sampled (with spare batteries)
- Metric steel tape measure (with graduation to 0.01 meters)
- Meter stick (with graduation to 0.01 meters)
- Digital Camera

Sites

Use the five sampling plots located along the river for the fish habitat survey (Table 4.13, Figure 4. 3). The survey plots were selected to represent various reaches of the river and to encompass the range of vegetative, geomorphic, grazing and other environmental conditions that exist along the river.

Each fish habitat sampling plot is 2 kilometers in length, with transects established every 100 meters along the length of each plot (up to 21 transects per plot depending on site accessibility). Therefore, a total of approximately 105 transects will be surveyed. The transects cross the channel perpendicular to the flow of water. Record the UTM coordinates at the beginning and end points of the transects using GIS and by overlaying a grid representing the sampling plot over aerial photographs. Store the UTM coordinates in a handheld GPS unit, which is used to locate the beginning and end points of each transect in the field. With a fencepost, mark the beginning and end points with labels to ensure repeatability and comparability. Some locations are not accessible and therefore transects are not marked. Where multiple channels exist in a plot, transects are established at each channel and labeled “E” or “W” according to east or west channel location. The transect length varies by location and are as long as necessary to encompass the width of the channel and immediately adjacent riparian areas.

Frequency
Conduct fish habitat surveys in years 3, 6 and 9, when the Habitat Development Surveys are not conducted. This is to distribute the workload associated with data collection and analysis and reduce demands on staffing. If the Scientific Team determines that it is more efficient to sample on the same years as other efforts, then this modification in the schedule may be made, as long as the frequency of sampling is preserved.

Data Management
At the sample site, field forms are reviewed by someone other than the data collector to ensure the data are complete, legible, accurate and in standard format. Errors are noted and replaced with the corrected term or value. Staffs enter the staff gage data and other pertinent information into spreadsheets in tabular form and record their name on the original field form. The Task Leader performs weekly and randomized reviews of spreadsheets to verify accurate transcription of data and to identify suspect data. Follow all data quality control activities described in Section 4.1.1.

Data Analysis and Reporting
Statistical Applications
Tabulate fish habitat data by reach and develop descriptive statistics. Data that lack normal distribution require non-parametric tests for more detailed statistical analysis. For monitoring after water is introduced to the channel, determine statistically significant overall changes in fish habitat throughout the Lower Owens River with the Kruskal-Wallis Test.[4] The Kruskal-Wallis Test is a non-parametric analog of the parametric one-way analysis of variance F-test and, thus, does not require multivariate normality.[5] It is used to test differences among two or more group means. Establish alpha = 0.05 for all tests[6] to reduce Type I error rate. Because of significant changes in habitat between monitoring years, analyze each fish habitat variable independently to find which variables contribute to the overall significance of the multivariate test. Staffs are to perform statistical applications or take alternate direction from the Scientific Team.

GIS Applications
Store transect beginning and end points in the LORP GIS database to maintain spatial consistency between monitoring efforts. There are no other specified GIS applications for fish habitat monitoring, except those already mentioned above.

Reporting
Reporting will occur in each monitoring year following data collection and analysis. Staffs will prepare a report documenting fish habitat monitoring results by the end of September of monitoring years. The MOU consultant will use the report to make adaptive management recommendations to LADWP and ICWD management by November 1 of each monitoring year.

4.2.7 Vegetation Assessments

Vegetation Assessment in the Riverine-Riparian Area includes landscape vegetation mapping and site scale vegetation monitoring.

4.2.7.1 Landscape Vegetation Mapping

Monitoring Purpose
The purpose of the Landscape Scale Vegetation Mapping is to provide managers with a landscape scale measurement of the riverine-riparian vegetation. This assessment will be able to accurately (though not necessarily precisely) monitor the entire project area. Landscape Vegetation Mapping helps to inform decision making for the following adaptive management areas (see Section 3.7.1): Seasonal Habitat Flows, Terrestrial Habitat, Riverine-Riparian Habitat, Tule/Cattail Control, Exotic/Invasive Plants, Range Condition and Recreation.

Baseline Data Collected
Baseline vegetation monitoring data consist of mapping, field review and description, accuracy assessment and the correlation of map legends. Because of the nature of vegetation assessment technology, baseline

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[4] Miller 1986
[5] Miller 1986
[6] Miller 1986

data are described below along with the methods used. Protocols for each step are based upon those defined by Whitehorse Associates in the Lower Owens River Riparian Vegetation Inventory, 2000 Conditions[7] and are described below.

Methods

In recent years mapping methods have changed dramatically with the advent of mapping software like ESRI's ArcGIS and the widespread use of remote sensing technology (satellite imagery and digital orthophotography). These two advances in mapping technology have not only reduced the amount of time it takes to map an area, but have also increased the accuracy of maps. The advances in mapping techniques will continue in the future and thus all mapping techniques must be considered for future monitoring in the LORP. Prior to each monitoring program that contains a mapping component, the Scientific Team will perform a survey of mapping techniques and the most cost effective and accurate technique should be identified. The Scientific Team will instruct staff or outside consultants, if necessary, to perform the mapping procedure.

The mapping methods used to collect baseline data are presented in this document. Since mapping techniques and methods are subject to change in the future based on emerging technology, future monitoring will likely involve using different methods.

Protocol

Baseline mapping was conducted using high-resolution (2 foot pixels) digital orthophotos. These orthophotos were plotted at 1:6,000 (1 inch=500 feet) scale on glossy photo-paper at 600 dpi using a HP Designjet 3500 Color Plotter. Areas with distinctive landform/soil, hydrologic and vegetative character were delineated based on the author's previous experience mapping riparian/wetland features in the Owens Valley[8] and other areas of the western United States. Distinctive areas were delineated using an ultra-fine point Sharpie marker on the 1:6,000 scale plots backlit on a light table. Delineations were digitized on a large-format digitizer with a magnifier puck set to record continuous points (0.5 mm point spacing). Mapping was compiled and plotted on the same 1:6,000 scale images, which are reviewed in the field. Subsequent map editing was done using "heads-up" digitizing of scales up to 1:1,000.

Map units denote areas of distinctive landtype/soil, hydrologic and vegetative character. Landtypes were distinguished by form and position relative to hydrologic gradients. Hydrologic character was distinguished by color indicative of dominant understory vegetation, viewed in the context of landforms and specified in terms of water regimes. Water regimes were defined based on the frequency and duration of flooding and/or depth to seasonal water table. Vegetation character was defined in terms of physiognomic class and plant species composition. Stream reaches with distinctive valley-form, stream channel morphology and hydrologic character were also identified. Concepts for map units and stream reaches were refined through subsequent field reconnaissance and descriptions.

Table 4.12. Wetland Status Rank

Wetland Status	Rank
Obligate (OBL)	4
Facultative wetland (FACW)	3
Facultative (FAC)	2
Facultative upland (FACU)	1
Not indicator (NI)	0

With preliminary mapping completed, baseline field reviews were conducted in April, May and June 2002. Map boundaries and labels were verified and/or refined. The reviews in April and May served to refine mapping throughout the LORP riparian area. The review in June focused on 12 study areas, each including one mile of the Owens River. Maps of study areas plotted at 1:2,000 scale served as a basis for further refining mapping and for selecting sites where vegetation, soil and hydrologic attributes were described. Map concepts developed in study areas were extrapolated to reaches (or parts of reaches).

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[7] WHA 2004c

[8] WHA 1997

Vegetation, soil and hydrologic attributes were described for the dominant map units in each of the 12 study areas. A total of 50 sites were described. These descriptions, coupled with other field observations, are the basis for qualitative descriptions of landtypes, water regimes and vegetation types.

Representative map delineations were traversed to compile a list of plant species. A canopy cover class (T=<1%; P=<5%; 1=5-15%; 2=15-25%; 3=25-35%; etc.) was assigned to each plant species based on ocular estimates. Wetland status for each species was determined from a list prepared for California by the Fish and Wildlife Service. Hydrophytic vegetation was deemed present if the status of more than half of the dominant species was facultative (FAC), facultative wetland (FACW) or obligate (OBL) hydrophytes.

Soil was described at each site that was not flooded. The layer designation, moist Munsell color, texture, degree of wetness (dry, most, wet, saturated) and the abundance, contrast and color of mottles were recorded for each soil horizon to a depth of 3 feet or to the alluvial ground water level if less than 3 feet. Hydric soil indicators (e.g., aquic moisture regime, reducing conditions and glayed color) were also noted. Hydrologic parameters (e.g. depth of flooding, depth to free water, depth to saturation) and wetland hydrology indicators were also recorded. Vegetative, soil and hydrologic criteria listed in the Wetland Delineation Manual were used to determine the wetland status of each site.

An average wetland status score was computed for each WHA description site, ICWD polygon and Resource Concepts, Inc. (RCI) polygon (RCI 1999). A numeric rank (Table 4.12) was assigned to each plant species based on the wetland status for California listed in the wetland plant list. The average wetland status score was calculated based on the rank of all species in the site or polygon, weighted by percent composition. An average wetland status class was assigned to each site and polygon based on the average wetland status score.

A cross-section schematic was developed for each of the 12 study areas. Horizontal measures of the distance of map parcels were compiled from the GIS mapping. Relative elevations were interpreted from survey transects conducted by Ecosystem Sciences (1993), 1:24,000 scale digital elevation models, aerial photo interpretation and field observations. Cross-section schematics were compiled using Adobe Illustrator.

For the accuracy assessment, it is important to note the three common types of mapping error:

1) Delineation error – putting the boundary of a parcel here when it should be there.
2) Label error – labeling a feature #1 when it should be #2.
3) Inclusions – areas of contrasting types that are too subtle, small or complex to delineate.

The scale of mapping and the specificity of the map unit largely determine the magnitude of delineation error. For broadly defined categories (e.g., vegetation complexes) mapped at small spatial scales (i.e., 1:40,000), the magnitude of potential error is relatively large (100s to 1000s of feet). For more specific categories (e.g., landforms and vegetation types) mapped at large scales (e.g., 1:6,000), the magnitude of potential error is small (< 20 feet). At 1:6,000 scale the narrowest parcels that can be delineated is about 50 feet; at 1:3,000 scale 25 feet; at 1:1,000 scale less than 10 feet. The 2000 digital orthophotos can be viewed at scales up to about 1:1,000 with good resolution. The goal was an average delineation error, relative to the 2000 digital orthophotos, less than 5 meters.

Label error (e.g., labeling a parcel “marsh,” when it is actually “wet meadow”) is influenced by the specificity at which map units are defined and the medium from which they are drawn. Distinguishing very specific classes of vegetation that appear similar on aerial photos (e.g., communities dominated by *Salix gooddingii* versus *Salix laevigata*) would result in a high degree of label error. Label error can be controlled by appropriate design of distinguishable map units. The frequency of label errors is also influenced by the resolution of the map base (e.g., aerial photos) and the experience of the interpreter. The goal was less than 5 percent overall label error.

Inclusions of contrasting types are typically common in all map units. Inclusions may include gradual transitions between similar vegetation types and/or small areas of contrasting vegetation scattered in the parcel. The goal was less than 15 percent inclusion of any contrasting type and less than 30 percent inclusion of similar types.

A product of the study was a map with consecutively numbered parcels, each labeled with vegetation type, landtype and water regime. Parcels were randomly selected for a field accuracy assessment using the following sequence:

1. Parcels were sorted by size (area) and those less than 1 acre were eliminated from further consideration.
2. Parcels were sorted by vegetation type and sequenced by parcel number (#).
3. A random number generator was used to select 20 parcels of each vegetation type based on the sequence for that type.
4. The 20 selected parcels of each vegetation type were evaluated for accessibility. Parcels that were difficult to access were eliminated from further consideration.
5. A random number generator was again used to select 10 of the accessible parcels of each major vegetation type and 3 parcels of each minor vegetation type for the field accuracy assessment.
6. The outlines of selected parcels were plotted on an aerial photo background and labeled with the parcel number (#) for use in the field. The UTM coordinates were also listed to facilitate use of a GPS to confirm the location of the parcels in the field.

The dominant landform, water regime and vegetation type was determined for each parcel. The accuracy of map boundaries and inclusions of contrasting types were also noted during field assessments.

In the office, field determinations of landform, water regime and vegetation type were compared with map attributes. The percent label error was tabulated for each vegetation type. The overall label error was estimated as the average error for all vegetation types, weighted by the total number of parcels of each type. An overall error rate for wetland versus upland was also estimated. The target overall error rate was less than 5 percent.

Descriptions of vegetation types were pooled for the DHA, LORP, MORP, BWMA, Baker and Hogback project areas. Plant species cover and frequency for combinations of vegetation type, landtype and water regime served as a basis for correlating map legends and served as a basis for testing classifications of vegetation associations and/or more general vegetation series.

WHA and selected ICWD (1998-2000), Garcia and Associates (GANDA) and RCI vegetation data were assembled into a common format. Selected transects were those that occurred entirely within a single WHA parcel. Where multiple ICWD and RCI transects were present within a single WHA parcel, cover values were averaged for the parcel prior to pooling. The pooled vegetation data for 307 parcels served as a basis for discriminate analysis to test the vegetation classifications.

Discriminate analysis was conducted using a reduced data set of selected plant species. Selection entailed the following sequential steps:

1. Similar species that are diagnostic of the same type (i.e. occur in similar habitats) were combined into a broader species class
    a. SALIX = SALGOO + SALLAE + SALIX [TREE]);
    b. SCIRPUS-TYPHA = SCIACU + SCIAME + SCIMAR + TYPLAT + TYPDOM + TYPHA;
    c. JUNCUS = JUNBAL + JUNCUS + JUNMEX;
    d. ELOCH = ELEMAC + ELEOCH + ELEPAL+ ELPAR + ELEROS;
2. The percent <u>composition</u> of plant species was calculated for understory (grass-like + forb) and overstory (shrub + tree) layers for each of the 307 parcels.

3. Species that comprised < 10 percent composition in all 307 parcels were not considered.
4. Species with ≤ 5 percent cover in all 307 parcels were not considered.

The selection reduced the number of species used for ordination analysis from 189 to 58.

Sites
Encompass the entire Riverine-Riparian Area in the landscape scale vegetation mapping.

Frequency
Conduct landscape scale vegetation mapping in years 2, 5, 7, 10 and 15.

Data Management
Store the digital imagery obtained in its original media format (CD-ROM or DVD) (which will not be modified) and on the project server located at LADWP's Bishop office (for use in analysis). Store the landform classification maps derived from the imagery as ESRI shapefiles on the project server.

Data Analysis and Reporting

Statistical Applications
In addition to the analyses described in the methods section above, generate summary statistics for each monitoring year. Present descriptive statistics like acres of vegetation type, landtype and water regime for the reach, lease and management area scales. Calculate the difference in acres of each vegetation type and water regime. Measure patch diversity per reach using the Shannon-Weiner diversity index (H') (Shannon index) to monitor biodiversity in the LORP area. The Shannon index is calculated as:

$$H' = - \sum^{s}_{i=1}(p_i)(\ln p_i)$$

Where S = # of acres per reach, p_i = the proportion of S consisting of the i^{th} community.

GIS Applications
See above.

Reporting
Staff will submit a report to the MOU Consultant following data collection and analysis in each monitoring year. The MOU Consultant will review and compile this information and present it to ICWD and LADWP management by first of November of each monitoring year; recommendations for adaptive management will also be included in this reporting.

4.2.7.2 Site Scale Vegetation Assessment and Landform Elevation Mapping

Monitoring Purpose
Site scale (scale of site ~ 1:10000, sites mapped at 1:2000 scale, refined at 1:500 scale) vegetation assessment methods and protocols are composed of vegetation transects, sub-plots, landform and vegetation community type mapping. Site Scale Vegetation Assessment and Landform Elevation Modeling are designed to inform decision making for the following adaptive management areas (see Section 3.7.1): Seasonal Habitat Flows, Terrestrial Habitat, Riverine-Riparian Habitat, Tule/Cattail Control, Range Condition and Recreation. The methods and protocols were designed to inform LORP managers about riparian conditions at a larger scale (finer resolution) than the existing Greenbook and White Horse Associates (2004c) community type mapping efforts, which were performed at the landscape scale. The landscape scale vegetation monitoring effort operates on a coarse scale, informing managers about broad changes in the entire riverine-riparian landscape. The site-scale vegetation methods will be able to detect more subtle changes in vegetation in response to restoration actions. This data will enable managers to analyze changes in community composition and structure, patch dynamics, wetland indicator status, both reach and community type diversity and several other measures. The objective of landform and elevation modeling is to establish the baseline geomorphic landforms and height above water surface elevation as they relate to riparian vegetation to determine future changes in riparian vegetation and geomorphology. The vegetation transect data, subplot data, landform and

elevation data and community type mapping all occur at five 2 km study plots established along the Lower Owens riverine-riparian corridor (Figure 4.3).

Reach	# of Reference Plots	Miles	km
1. The intake to Mazourka Canyon Road (dry reach)	2	20.7	33.3
2. Mazourka Canyon Road to Islands	1	12.8	20.6
3. Islands (wetland reach)	0	5.1	8.2
4. Islands to South of Lone Pine	1	7.6	12.2
5. Lone Pine Station Road to The pump back station	1	7.1	11.4
Lower Owens River	5	53.3	85.7

Table 4.13. Reaches, number of reference plots, river miles and river kilometers of the LORP Riverine-Riparian Area.

Baseline Data Collected

Vegetation Transect Data

- Vegetation patch species composition and structure - dominant species ranked within 6 structural levels,
- Length of vegetation patch
- Collected at 21 transects in each of the 5 Riverine-Riparian study plots.

Subplot Data

- Canopy cover for each species in 2 m x 2 m plots
- Ground cover in 2 m x 2 m plots

Landform and Elevation Data

- Elevations (above water surface) and lateral distances of landforms, as well as water surface elevations at the river channel
- Riparian vegetation type along transects

Vegetation Mapping Data

- Aerial extent of vegetation communities
- Map units are $\geq 4 \text{ m}^2$ (2 m x 2 m) mapped at five 2 km study plots
- Number, age/size class, condition and landform for native riparian hardwood species

Methods

Study Design and Site Selection

Site scale vegetation monitoring consists of vegetation transect and sub-plot sampling, landform and elevation modeling and vegetation community mapping efforts. These fine scale sampling techniques occur at five 2 km plots in 4 of the 5 reaches of the Riverine-Riparian Area (Table 4.13, Figure 4.3). The study plots were selected to be representative of each reach, encompassing the range of vegetative, geomorphic and environmental conditions, as well as grazing management approaches in the Lower Owens River.

For example, two reference plots are 50% inside a grazing lease and 50% outside the lease to enable managers to examine grazing effects on the restoration project. It was determined that because the Islands reach is a short (8.2 km) section of river composed of a vast, complex wetland with numerous channels creating access problems, more useful data would be produced by placing a second study plot in the dry reach (reach 1). The dry reach is four times larger than the islands and will likely respond more dynamically to management actions than the Islands reach. The data were designed to detect change within areas that managers have the ability to effectively manage through flow and land management.

Protocol

Transect Sampling

The purpose of the vegetation transect data is to work in conjunction with mapping and other sampling efforts to describe the riparian vegetation communities of the Lower Owens Riverine-Riparian Area. Therefore, transects were sampled at the same site locations as the site scale mapping and sub plots. Study sites are aligned with the river channel. Because of the meandering nature of the Lower Owens River, it was logistically practical and more scientifically meaningful to have all transects within each plot parallel to one another. Sites are 2 km in length and transects occur every 100 m within each Site (21 transects over 2,000 m). Each transect extends away from both sides of the wetted area of the channel through the riparian zone toward the upland zone. Transects extend laterally (perpendicular) from the center axis of the site to the edge of the riparian vegetation and encompassing the entire historic floodplain (as judged by examination of aerial photography). Fence posts were installed at what appeared to be the edge of the riparian vegetation (or the top of the terrace), to mark the outer end of each transect. Each fencepost was labeled according to site and transect. GPS locations of each fence post were recorded. Figure 4.4 shows the transect layout of Plot 1.

Along each transect, determine via a modified line-intercept method[9] the area covered by unique plant communities. Rank dominant species by estimated percent cover within each community patch (sample unit) in each of the 6 vegetation layers (upper canopy, lower canopy, high shrub, low shrub, high grass/herb, low grass/herb). Record the three species with the highest estimated canopy cover in each layer as dominant, 1st sub-dominant and 2nd sub-dominant. A minimum of 5% canopy cover (within the community patch) is required in order for a species to be eligible for inclusion. Record species by their 4-letter acronyms. Record dominant and sub-dominant species within the same layer in order of dominance and separated within each layer by dashes (-); separate structural layers by slashes (/). Measure the length of the transect segment that travels through each patch using a sonar range finder or measuring tape. Utilize fencepost locations, maps, compass and GPS units to facilitate navigation. Take digital photographs of sampling locations when appropriate. A graphical depiction of a portion of transect 17 in plot 5 is shown in Figure 4.5 to illustrate the method.

Subplot Sampling

Establish a series of 2m x 2m sub-plots to provide more detailed information about vegetation communities. After transect data have been collected, randomly select five communities from the sampled patches using accepted methods (e.g., random number generation). Establish a sub-plot at each of these randomly selected communities. Locate sub-plots adjacent to the transect line (sharing one 2m side) in the center of a community (Figure 4.5). Sub-plots will share their downstream edge with the transect on which they are located.

Within each sub-plot, record canopy cover for each species. Canopy cover is a percentage of the 2m x 2m area covered by each species when viewed from above. To understand this estimate, it is best to imagine a 2m x 2m column extending from the quadrat upwards through the canopy. Because several structural layers may exist, the cover percentages may collectively total more than 100%. For example, a willow may have 90% canopy cover in a plot, with a rush having 70% canopy cover in that same plot. To be considered for inclusion in canopy cover estimates herbaceous plants must be rooted within the sub-plot, while trees and shrubs need not be rooted within the plot. Record species using their 4-letter acronyms and a percent cover estimate (to the nearest whole percentage). Determine ground cover for each sub-plot. Unlike canopy cover estimates, ground cover estimates always total 100%. Divide ground cover into litter, rock, bare ground, downed wood, vegetation, cow manure and other (specify). Take digital photographs of sampling locations when appropriate.

Landform and Elevation Methods

Assess the physical condition of the river channel and adjacent landforms using transects that dissect the river corridor at predetermined locations (locations and site selection are described above). Measure landforms, which include the Owens River channel, streambank, cutbank, floodplain, bench and terraces at 21 cross channel transects within each of the five plots (see Figure 4.3 for plot locations and Table 4.14 for a description of landforms). Measure landform elevations (above the channel bed or water surface) and distances along each transect. Each cross channel transect illustrates the height of the landform above the water surface elevation (WSE), except for those plots located in the dry reaches of the river below the intake. Attain the height above WSE and length along the transect of each riparian landform (see Figures 4.6 and 4.7) using a laser transit that records horizontal distance, vertical height and bearing in degrees.

Site Scale Mapping

Site Scale Mapping methods roughly follow those developed for Rush Creek in the Mono basin by Kauffman et al.[10] In the field, identify all vegetation plant communities (patches)

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[9] Winward 2000

[10] Kauffman et al. 2000.

≥ 4 m^2 and map their boundaries on a Mylar sheet placed over a digital aerial photograph (scale:1:2000). Use multiple aerial photographs to map each site. Perform vegetation community type mapping at all five of the LORP 2 km riverine-riparian plots. For each mapped patch (≥4 m^2) determine and label on the map the dominant species in the tallest layer (overstory) and the understory (if possible). In order to quantify the native riparian tree demography, record age/size class data for all native riparian trees within each riparian hardwood patch. Estimate the diameter at breast height (dbh) and record as one of the eight size classes and four plant status categories listed in Table 4.15. Select the geomorphic surface that the riparian hardwood patch is rooted in from the list in Table 4.16 and recorded. In the lab, scan and fit together into a mosaic the field maps drawn on Mylar sheets using Adobe Photoshop and import them into ESRI's ArcView. Overly the scanned field maps over the digital aerial photographs and properly align them. Use this layer in Arcview as a guide from which to digitize shape files for all communities mapped. Generate associated attribute tables for each shape.

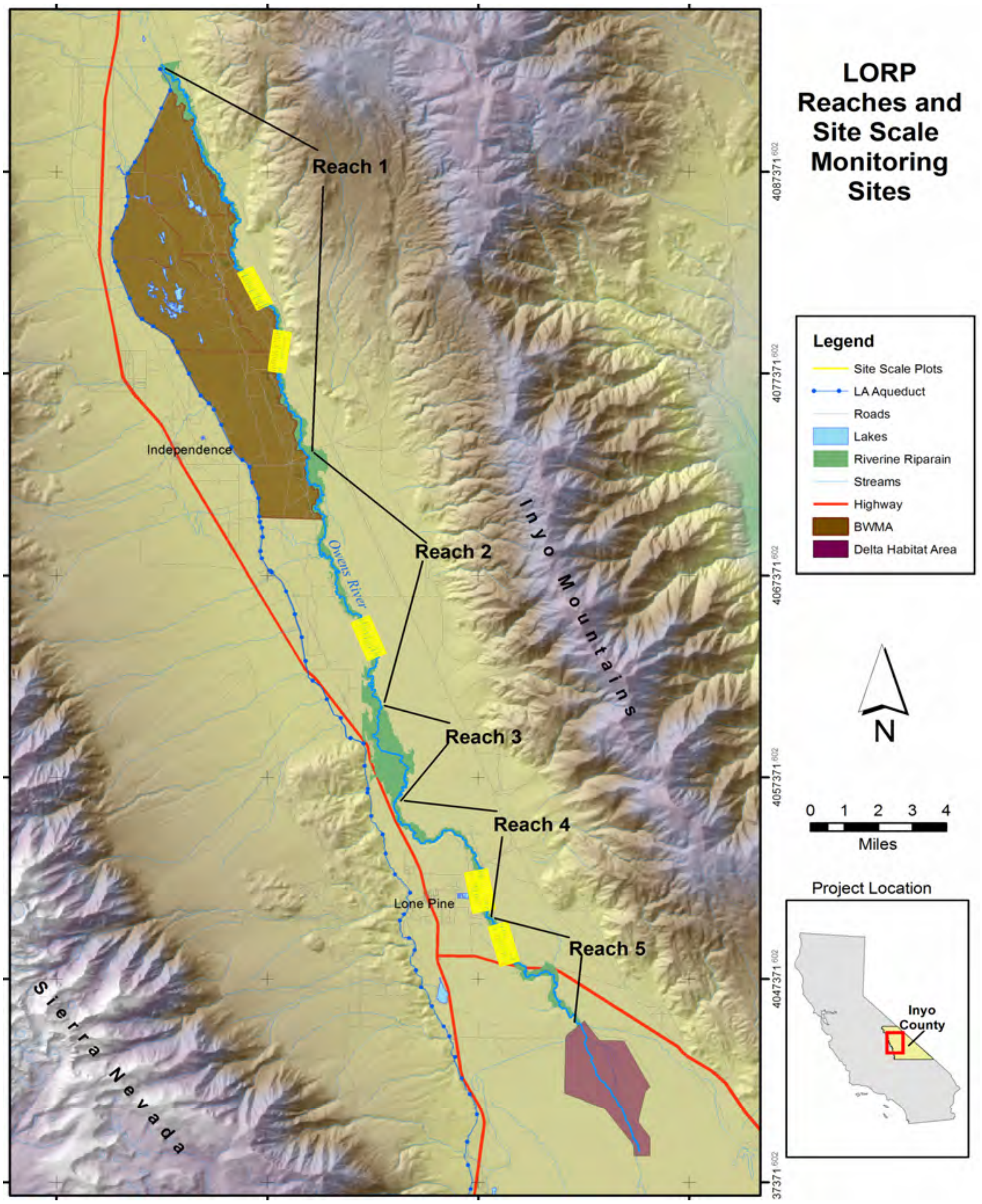


Figure 4.3. Map with plot locations and reaches

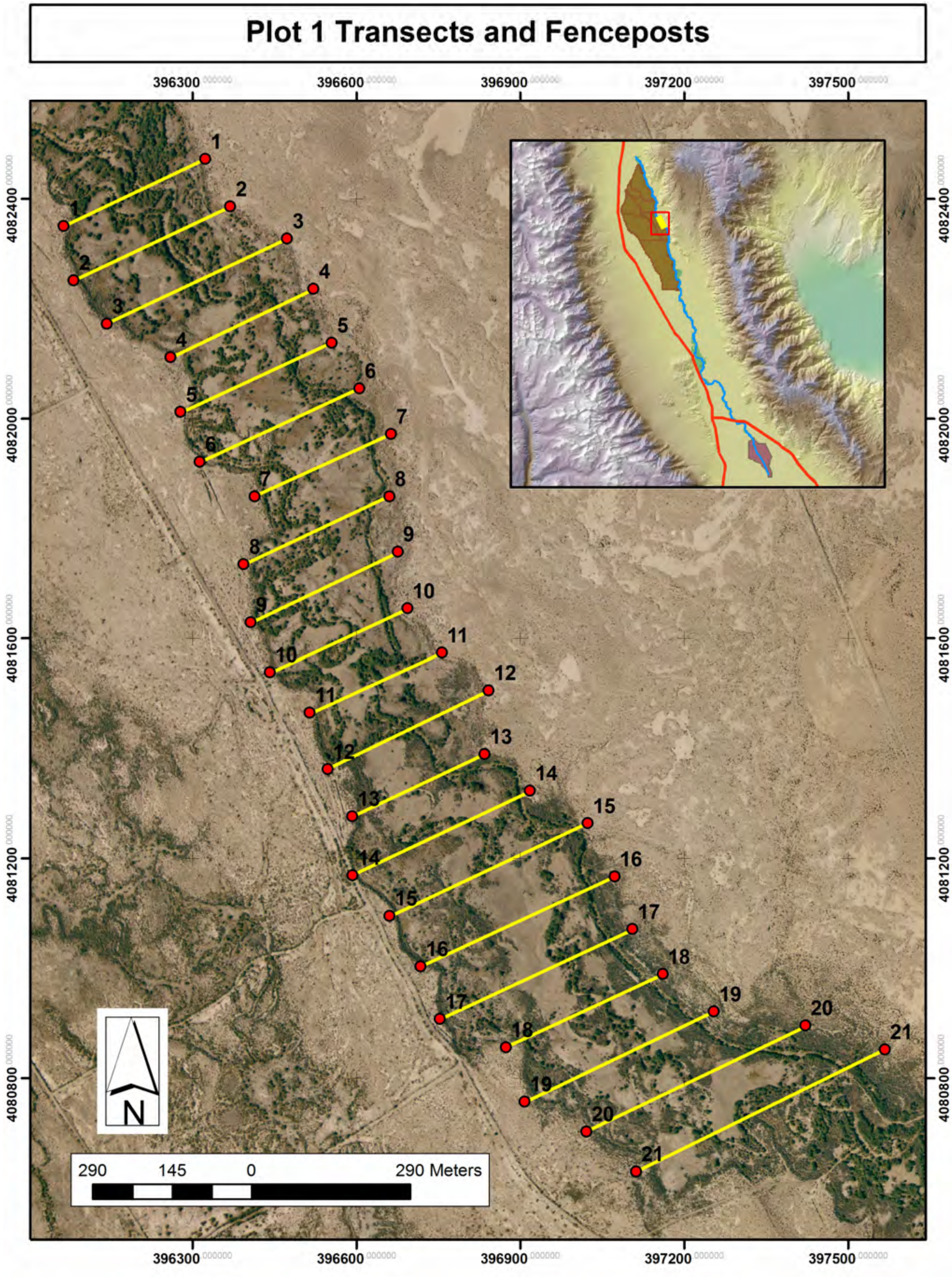
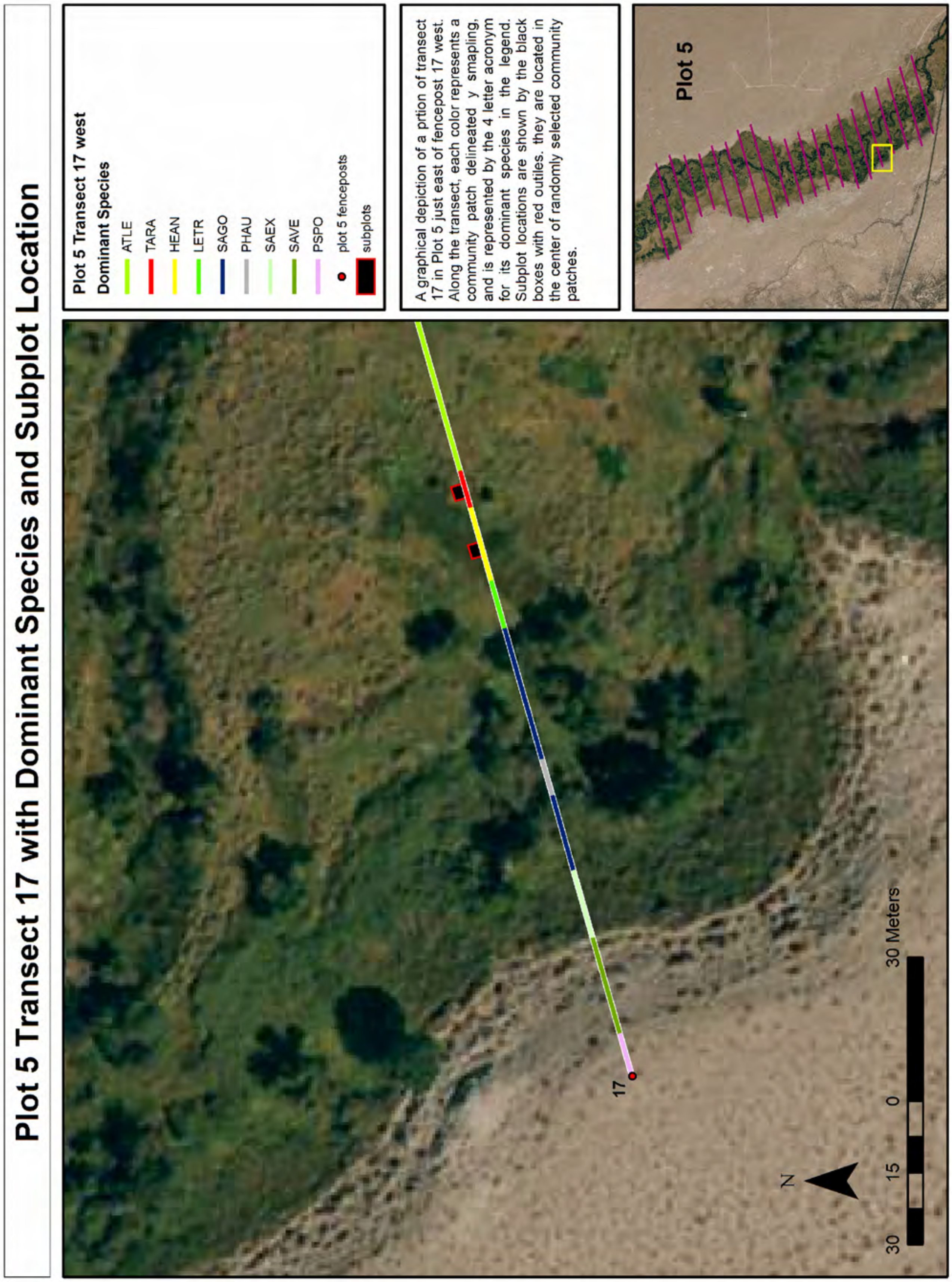


Figure 4.4. Transect layout at site 1.



A graphical depiction of a prtion of transect 17 in Plot 5 just east of fencepost 17 west. Along the transect, each color represents a community patch delineated y smapling, and is represented by the 4 letter acronym for its dominant species in the legend. Subplot locations are shown by the black boxes with red outiles. they are located in the center of randomly selected community patches.

Figure 4.5. Plot 5 Transect 17.

Sites

Study Design and Site Selection

Site scale vegetation monitoring consists of vegetation transect and sub-plot sampling, landform and elevation modeling and vegetation community mapping efforts. These fine scale sampling techniques occur at five 2 km plots in 4 of the 5 reaches of the Riverine-Riparian Area (Table 4.13, Figure 4.3). The study plots were selected to be representative of each reach, encompassing the range of vegetative, geomorphic and environmental conditions, as well as grazing management approaches in the Lower Owens River. For example, two reference plots are 50% inside a grazing lease and 50% outside the lease to enable managers to examine grazing effects on the restoration project. It was determined that because the Islands reach is a short (8.2km) section of river composed of a vast, complex wetland with numerous channels creating access problems, more useful data would be produced by placing a second study plot in the dry reach (reach 1). The dry reach (dry prior to base flow introduction) is four times larger than the Islands reach and will likely respond more dynamically to management actions than the Islands reach. The data were designed to detect change within areas that managers have the ability to effectively manage through flow and land management.

Frequency

Perform a site scale vegetation assessment in the second year after flow implementation, as significant changes in the vegetation communities of the Lower Owens River can be expected with the introduction of water to the system, especially in the dry reach. After the second year, perform site scale vegetation assessments every year that new aerial or satellite imagery is acquired for the project area. If new imagery is not acquired during the life of the project, then perform site scale vegetation assessments in years 2, 5, 7, 10, 15.

Data Analysis and Reporting

Statistical Applications

Error check the raw transect data entered into an Excel spreadsheet. The Excel transect data spreadsheet consists of species ranked by dominance within each of six structural levels for each patch sampled.

Data Management

Technical staff will enter transect and subplot data into Microsoft Excel. Enter the landform elevation data into AutoCAD. Enter mapping data into Arcview GIS, creating shape files and populate attribute tables. Record the name of the staff entering the data on the original field form. The technical staff entering the data will be responsible for reviewing and correcting any data transcription errors.

Abbreviation	Landform	Definition
CB	channel bed	The active channel bed; area frequently inundated with water
SB	stream bank	An inclined area connecting an active channel with a floodplain.
DB	depositional bar	An area of alluvium deposited by hydrologic flow.
FP	floodplain	A relatively flat area periodically inundated by flow events.
BN	bench	An inclined area connecting two landforms.
OM	old meander	A low lying area that is a remnant of a past channel meander.
TR	terrace	A flat area too far above the channel to be frequently inundated. Many formed by ancient fluvial processes.
HL	hill slope	A steeply inclined upland area that confines the channel or the riparian zone.

Table 4.14. Definition of landform terms used in LORP.

Class	Description	
1	seedlings <0.5 m tall	
2	established small shrubs 0.5-1.3 m tall	
3	tall shrubs >1.3 m tall and 0-2.5 cm dbh	
4	young trees 2.5-10 cm dbh	
5	trees 10-20 cm dbh	
		Plant status
6	> 20 cm dbh	a. vigorous
		b. in decline 25-50% of crown dead
		c. in decline >50% of crown dead
		d. Snag – tree is dead
7	> 30 cm dbh	a. vigorous
		b. in decline 25-50% of crown dead
		c. in decline >50% of crown dead
		d. Snag – tree is dead
8	> 40 cm dbh	a. vigorous
		b. in decline 25-50% of crown dead
		c. in decline >50% of crown dead
		d. Snag – tree is dead

Table 4.15. Age/size class classifications for riparian woody

Landform	Description
Channel	Area inundated by water with depth of at least five centimeters.
Streambank	Area of incline between flowing water and crest of active channel or edge of floodplain.
Floodplain	Area of relatively flat land adjacent to streambank, historically inundated by flowing or non-flowing water during periods of high (out of channel) discharge.
Bench	Level or sloped area between floodplain and terrace.
Terrace	Area of elevated terrain outside of riparian area representing the dissected remnants of an abandoned floodplain, Stream bed or valley floor produced during a former stage of deposition.
Cutbank	Area of incline between flowing water and terrace when no other landforms are present.

Table 4.16. Geomorphic Landforms and Definitions.

Transform the raw transect data spreadsheet into a matrix of values recognizable by PC-ORD (or another appropriate statistical software program). Then import the matrix into the software program for analysis. The matrix consisted of ranked species scores for each community patch measured. Assign a ranked score to each species in each transect patch sampled as follows: dominant species = 3, 1st subdominant = 2, 2nd subdominant =1. Assign these ranked scores at each of the 6 structural levels. All non-dominant species receive zeros, which will result in a high number of zeros in the data set. To find groups with the strongest species associations (community types) use hierarchical agglomerative cluster analysis. The basic idea behind this method is to find the two entities (rows or transect patches) that are the closest to each other in species-space, merge them and then find the next two closest entities, merge them and so on until there is eventually one group. The cluster analysis will group the patch data into community types, which can then be cross-walked to any classification system desired, including those used by White Horse Associates, the Green Book or Holland (Calveg).

Enter vegetation subplot data into an excel spreadsheet and then error check. Summarize these data to provide more detail on the vegetation communities delineated through the transect data analysis.

Enter landform and elevation survey base data into an AutoCAD drawing file format. CAD drawings are cross sectional illustrations of each transect and include elevation above sea level for each transect landform and WSE with elevation data to form a three dimensional diagram of each complete plot. Display measurements of heights and distances in meters. Each fencepost location serves as a permanent benchmark from which future changes can be monitored. Once base flows are established for the LORP then WSE can be adjusted for each channel cross section. CAD files can be easily updated with new WSE information. Riparian vegetation and landform and height above WSE associations can aid in the understanding of ecological processes and provide prescriptions for future adaptive management strategies. The data obtained using the above described methods serve as a baseline from which future measurements can be taken. Each cross channel transect was established with fenceposts that serve as benchmarks. The entire transect does not need to be resurveyed during future monitoring efforts. This will allow future change detection to be relatively uncomplicated and straightforward. Enter new elevation data into the existing AutoCAD digital models, update water surface elevation, water spreading and vegetation.

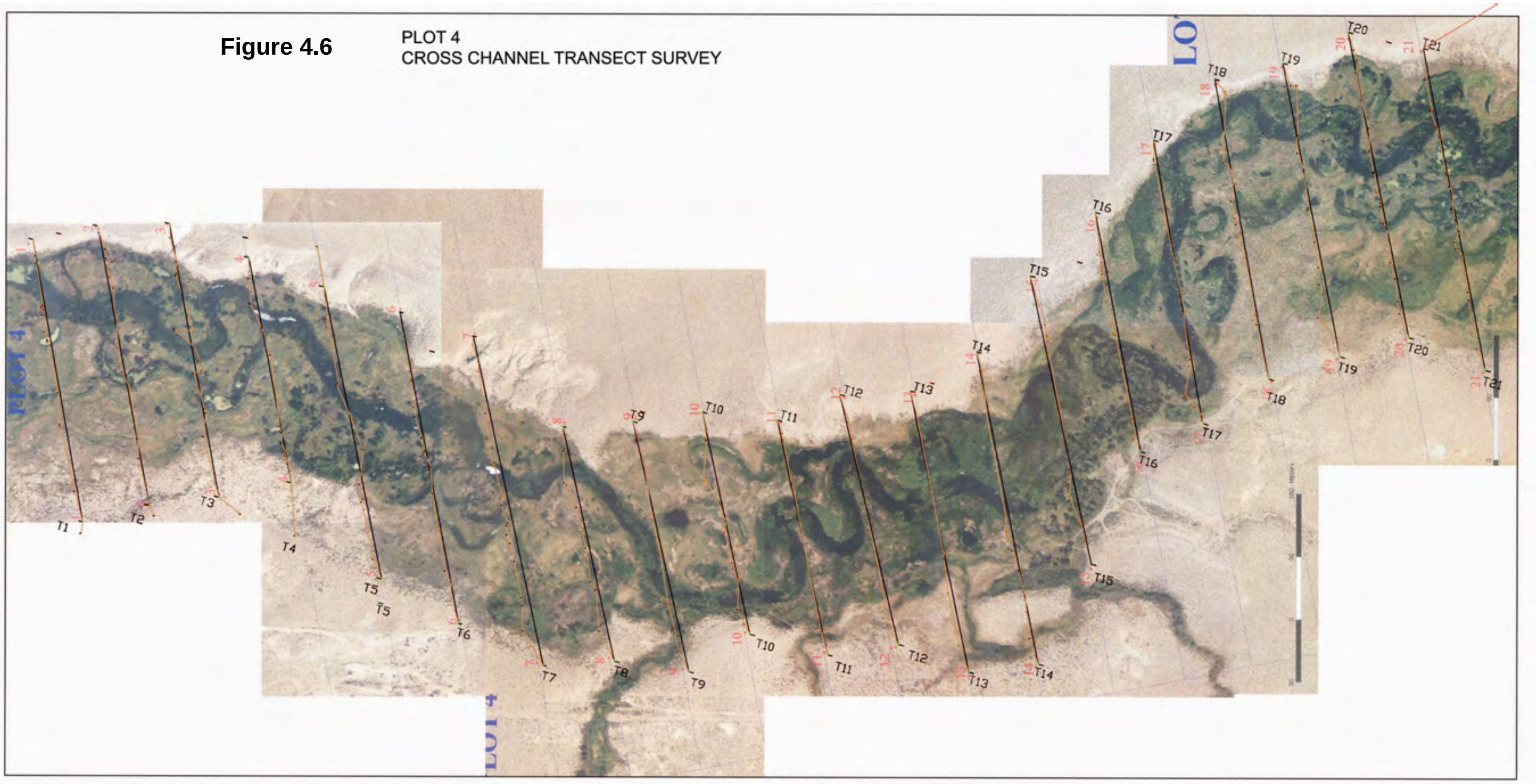
GIS Applications

Import each elevation point along the transects where landform attributes (height and distance locations) were recorded into a GIS (e.g. ESRI ArcView). Convert these points into a shapefile and overly on the plot vegetation plan maps.

Reporting

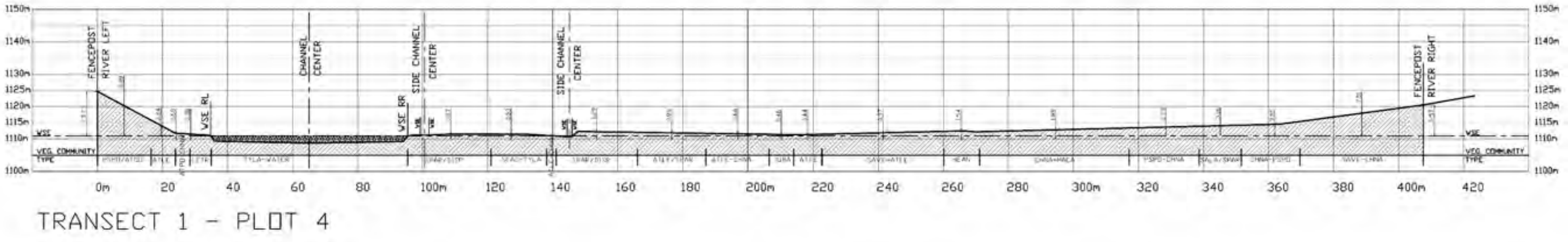
Staff will submit a report following data collection and analysis in each monitoring year. The MOU Consultant will review and compile this information and present it along with adaptive management recommendations to ICWD and LADWP management by the first of November of each monitoring year.

Figure 4.6



(Figure 3.17). All transects are shown in plan form. The bottom of each transect cross sectional view show the vegetation community types (Figure 3.18). The vegetation communities correspond to the landforms and distance along each transect. Cross channel transects are shown as facing downstream with the river left fencepost (east side of river channel) on the left and the river right fencepost (west side of river channel) on the right.

Figure 4. 7 Cross sectional view of river channel



4.2.8 Census Monitoring

Census monitoring in the Riverine-Riparian Area includes both avian and creel censuses.

4.2.8.1 Avian Census

Monitoring Purpose

The purpose of the avian census and vegetation assessment is to track the development of habitat conditions associated with healthy and diverse riparian and aquatic habitats. Avian census data help inform decision making for the following adaptive management areas (see Section 3.7.1): Terrestrial Habitat, Riverine-Riparian Habitat and Range Condition. Staffs will use Songbird Point Count and CWHR vegetation classification[11] in avian monitoring years to inform indicator species analyses.

No thresholds or triggers have been identified with regard to the results of bird monitoring data.

Baseline Data Collected

Point Reyes Bird Observatory (PRBO) conducted baseline monitoring.

Methods

Protocol
The riverine-riparian songbird monitoring protocol consists of two parts: avian point counts and CWHR vegetation classification. This section first describes the avian point count methods and then describes the CWHR vegetation classification protocols.

Avian Census
Census all points three times during the peak breeding season (approx May 25 – June 30), with each of the three censuses at least 10 days apart. Record all birds detected within 5 minutes at each point. Record birds detected within a 50 m radius of the census station separately from those greater than 50 m and note whether detections are inside or outside of the riparian vegetation. Detections are categorized as song, call or visual. Also, record all observations of breeding behavior.

To minimize observer bias when logistically feasible, a different observer conducts each of the three censuses. Additionally, when possible, census points in order from 1 to 15 for two censuses and in the opposite direction (from 15 to 1) for one census in order to minimize the effects of time of day on detection rates. Conduct censuses from within 30 minutes after local sunrise until approximately 3 hours later, and do not conduct in excessively windy or rainy conditions.

Conduct CWHR vegetation classifications within a 50 m radius of the point count, at all point count stations. Assign CWHR habitat type, height class, and canopy closure data to each vegetation type within the 50 m radius (Table 4.17 – 4.21). Note special habitat elements such presence of snags within each habitat type. Field technicians should adhere to the standards and guidelines outlined in CDFG 2000 and the methods for the CWHR system described in CDFG 2005. These two documents are essential reading for field technicians who are responsible for assigning habitat types, height class and canopy closure for vegetation types within the point count 50m radius.

CWHR Vegetation Type/Habitat Type Classification
The CWHR vegetation/habitat type classification comports with and informs the indicator species analyses. The CWHR vegetation/habitat type classification data, collected concurrently with the point counts, describes each habitat types unique attributes that wildlife are thought to respond (CWHR 2005).

The objectives of the CWHR vegetation type/habitat type classification protocols are:
Objective 1: To classify each vegetation type located within a 50 m radius of the point count into a CWHR habitat type.

Objective 2: To assign height and canopy cover stage class data to each habitat type

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[11] Nur et al. 1999, CWHR 2007

polygon within a 50 m radius of the point count.

Objective 3: To note any special habitat elements present within each vegetation type/habitat type polygon within a 50 m radius of the point count.

Step 1. Ensure crosswalk of CWHR habitat type is correct within the 50 m radius of the point count station (Table 4.17 crosswalk).

Existing and future mapping of the vegetation communities of the Lower Owens River consist of vegetation classifications that differ from the CWHR. For example, the baseline LORP vegetation map performed by Whitehorse Associates (WHA) denotes areas of distinctive landtype, soil, hydrologic and vegetative character using a different classification than the CWHR. Yet, WHA's community type descriptions enable technicians to easily crosswalk WHA's vegetation types to CWHR habitat types. Thus, each WHA vegetation type is crosswalked to one of eight CWHR habitat types. The CWHR system uses the following five classification schemes to inform the development of their habitat types: Sawyer & Keeler-Wolf (1995), the USDA Forest Service CalVeg (2001), Holland (1986), Cheatham and Haller (1975) and UNESCO (1996). These five classification systems are also used to crosswalk the WHA vegetation types into CWHR habitat types. Of all the classification schemes, the Holland classification is the most useful as both WHA and CWHR use Holland's classification scheme to describe their respective vegetation types. Therefore, the Holland classification system was used as an intermediary between WHA vegetation and CWHR habitat types (Table 4.17 crosswalk).[12] It is imperative to ensure that the cross walked polygons are correct as subsequent steps describe the unique attributes of the habitat types within a 50 m radius of the point count location.

CWHR Habitat Type	Holland Vegetation Type	WHA Vegetation Type
Alkali Desert Scrub	Rabbitbrush scrub meadow	Rabbitbrush-NV saltbrush scrub/meadow
Desert Riparian	Modoc-GB cottonwood/willow riparian forests	Riparian Forest (cottonwood)
	Modoc-GB cottonwood/willow riparian forests	Riparian forest (willow)
	Riparian scrub	Riparian forest shrub (rose)
	Riparian scrub	Riparian shrub (willow)
Perennial Grassland	Alkali meadow	Alkali meadow
Freshwater Emergent Marsh	Transmontane alkali marsh	Marsh
	N/A	Reedgrass
	Rush/sedge meadow	Wet alkaline meadow
Riverine	Permanent lakes and reservoir	Water

Table 4.17. Sample Crosswalk CWHR to Holland to WHA

Step 2. Assign appropriate size and cover stage classes to WHA's polygons.

Each CWHR habitat type is divided into sub-categories based on vegetation layers which are representative of unique attributes to which wildlife are thought to respond (CWHR 2005). They include tree dominated, shrub dominated, herbaceous dominated, aquatic, and developed habitat categories. Each sub-category has corresponding structural components, such as height and canopy cover that are grouped into standardized size and stage classes (Tables 4.18 – 4.20 crosswalk). Size and stage classes refer to vegetation age and vigor conditions.

The CWHR habitat types Barren, Pasture and Urban do not have defined size and stage classes. CWHR defines size and stage classes as structural components based on native vegetation composition and non-managed habitat (Oxbow Environmental 2006). Barren is classified as having a minimal amount of vegetation (≤ 2%) and is therefore not applicable to this classification scheme. Pasture and Urban habitat types are considered to be devoid of native vegetation (Urban), or non-managed habitat (Pasture) (Oxbow Environmental 2006), and are therefore not structurally defined by their vegetation.

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[12] Oxbow Environmental 2006

Standards for Height Classes			Standards for Canopy Closure		
CWHR Code	**Size Class**	**Crown Decadence**	**CWHR Code**	**Closure Class**	**Ground Cover (Canopy Closure)**
1	Seedling Shrub	Seedlings or Sprouts <3 Years	S	Sparse Cover	2-9%
2	Young Shrub	None	P	Open Cover	10-39%
3	Mature Shrub	1-25%	M	Moderate Cover	40-59%
4	Decadent Shrub	>25%	D	Dense Cover	60-100%

Table 4.18 Size (age) and stage (canopy closure) classes for the CWHR shrub dominated habitat subdivision. Standards are relevant to Alkali Desert Scrub habitat.

Standards for Height Classes			Standards for Canopy Closure		
CWHR Code	**Size Class**	**Plant Height**	**CWHR Code**	**Closure Class**	**Ground Cover (Canopy Closure)**
1	Seedling Tree / Shrub	<2'	S	Sparse Cover	2-9%
2	Small Tree / Shrub	2-10'	P	Open Cover	10-39%
3	Medium Tree / Shrub	10-20'	M	Moderate Cover	40-59%
4	Large Tree	>20'	D	Dense Cover	60-100%

Table 4.19 Size (height) and stage (canopy closure) classes for the CWHR tree dominated habitat subdivision. Standards listed are relevant to the Desert Riparian habitat type

Standards for Height Classes			Standards for Canopy Closure		
CWHR Code	**Size Class**	**Plant Height at Maturity**	**CWHR Code**	**Closure Class**	**Ground Cover (Canopy Closure)**
1	Short Herb	<12”	S	Sparse Cover	2-9%
2	Tall Herb	>12”	P	Open Cover	10-39%
			M	Moderate Cover	40-59%
			D	Dense Cover	60-100%

Table 4.20 Size (height) and stage (canopy closure) classes for the CWHR herbaceous dominated habitat subdivision. Standards are relevant to Fresh Emergent Wetland and Perennial Grassland herbaceous

Avian Census Point Count Stations	Riverine Riparian
LADWP Bird Observation Points	0
GANDA Transects	76
PRBO Point Count Locations	166
Total	242

Table 4.21 point count stations in the Riverine Riparian Area of the LORP.

Cross-walked CWHR habitat polygons within a 50 m radius of each point count location must be described using the CWHR height and cover stage data (Tables 4.18 – 4.20). Therefore, a map and data sheet must be prepared prior to performing the point counts. The map should depict each point count station with its corresponding 50 m radius overlaid on the applicable CWHR habitat type polygons. A data sheet consisting of the point count location name, polygon ID, CWHR habitat type, and columns where height and stage cover class data can be entered. Height and stage data will be added to the attribute table of the CWHR habitat shapefile after performing the field work (see section 4.2.6.1 for more information). Photo points of each point count location should be incorporated into the field protocol. Photo points are an important monitoring component of any field study and necessary to document change over time.

Sites

Utilize both established stations and new point count stations for the project. Established point count stations consist of a transect that runs upstream of Mazourka Canyon Road (15 points), that has been monitored since 1999, and 150 additional independent points (10 transects of 15 points each) located within the LORP Riverine Riparian area that were monitored in 2002. Transect starting points were established so that the major riverine habitat types were covered in proportion to their existence, when possible. New point count stations have been established to facilitate the CWHR. Table 4.21 point count stations lists the number of point count locations in the Riverine-Riparian Area. These point counts represent a subset of the GANDA transect locations and are located in areas devoid of established point count stations.

To insure independence, point count stations are at least 250 m apart. Fifteen points is the standard number of points that can be covered in one morning survey. Use a GPS to determine distance between points. Mark all points with flagging, a standard metal tag, and a GPS location. A written description to each point and transect accompanies the PRBO baseline data.

Frequency

Avian census will be conducted on monitoring years 2, 5, 7, 10 and 15 (monitoring year 2 is 2010). Census all avian points three times during the peak breeding season (approx May 25 – June 30), with each of the three censuses at least 10 days apart.

CWHR vegetation type classification data must be collected during the breeding season of the first year of any point count project, and as often as possible after that (usually not more than once per season). In stable habitat types it may only be necessary to do sampling every few years, while in flood, burn or restoring habitats it is generally necessary to do them each season. If new sites are added to a project, sample them the first year, and then on the same schedule as the other stations.

Data Management

The Task Leader is responsible for collecting all completed field forms and delivering them to LADWP offices in Bishop in person. Assign all original field forms with document control number. Field forms are filed and retained for a minimum of 15 years at LADWP offices in Bishop. In addition to retention of hard copies, all field forms are scanned and retained in an electronic format (e.g., PDF) for the life of the project on a hard drive at LADWP offices.

Persons conducting the surveys should be able to identify all regularly-occurring species, especially wetland bird species, by sight and sound. The Task Leader is to confirm the qualifications of surveyors. Surveyors should receive training on the methodologies prior to conducting surveys. Training is conducted in the field by the Task Leader before the first sampling activity or as needed.

Quality assurance activities for the avian census monitoring project consists of the following:

- At the survey site, surveyor reviews field forms to ensure that they are complete, legible, accurate, and in standard format. Errors are corrected with a line drawn through them and replaced with the correct term or value. Qualify data considered as suspect using a flag variable.
- Staffs enter the data into spreadsheets in tabular form and record their name on the original field form. Staffs entering the data are responsible for reviewing for and correcting any data transcription errors.
- Task Leader reviews all flagged suspect data and makes the ultimate decision of excluding any data from use in further analysis.

Data Analysis and Reporting

Statistical Applications

Apply statistical tests appropriate to the data type to the bird monitoring data. Staffs may analyze data in terms of trends in bird species diversity, percent composition of habitat indicator species, total detections of habitat indicator species, and habitat use versus availability. Use data on bird habitat selection, season of use, and pattern of use (foraging, nesting, etc) to evaluate the response of birds to management activities.

GIS Applications

The locations of each point count station will be transferred to aerial photos in order to provide visual representation of survey activities. Bird use data may be useful in modeling the effects of various land management activities through time.

Reporting

The TL is responsible for utilizing staffs to compile and produce a draft report before the end of September of each monitoring year. The report will include maps showing all point count locations, a summary of the field data consisting of but not limited to a list of species recorded, abundance and diversity indices per point count and route, and suggested management actions. The MOU Consultant will review this information and present its recommended management actions to ICWD and LADWP management by November 1st.

4.2.8.2 Creel Census

Monitoring Purpose

The creel census helps track the development and health of the warm-water or game fishery (ponds, lakes, slow moving streams) as the LORP is implemented. Creel census data help to inform decision making for the fishery and water quality adaptive management areas (see Section 3.7.1). It provides information about the abundance and distribution of game fish throughout the LORP area. Fish habitat within the LORP includes the river channel, oxbows, side channels, off-channel lakes and ponds, springs and artesian well ponds. The main purpose of the creel census is to evaluate the response of game fish to managed stream flows over time and to document compliance with LORP warm-water fisheries goals. The data collection for the creel census to determine baseline conditions has been completed. Future monitoring will be conducted using the same methods that were used to establish baseline conditions and are described below.

This census only follows the development and condition of the recreational fish population and does not track the status of the native fish population. Key fish species included in this census include:

- Largemouth Bass (*Micropterus salmonides*)
- Smallmouth Bass (*Micropterus dolomieui*)
- Bluegill (*Leopomis machrochirus*)
- Channel Catfish (*Ictalurus punctatus*)
- Brown Trout (*Salmo trutta*)

Information on the following native species is not included: Owens Sucker (*Catostomus fumeiventris*), Owens Pupfish (*Cyprinodon radiosus*), Owens Tui Chub (*Gila bicolor snyderi*) and Owens Speckled Dace (*Rhinichthys osculus*).

The fishing census covers the Lower Owens River from the LAA Intake diversion structure downstream to and including, the storage pool behind the pump-back station dam; it also includes off-river lakes and ponds managed as fisheries within the LORP area.

Baseline Data Collected

Data collection for the creel census began in 2003. Creel census baseline data include:

- Recreational fish counts and distribution data.
- Fish size, sex, species, health and length.
- Digital photographs of fish and sampling locations when appropriate.

Methods

<u>Protocol</u>

The fisherpersons used for the creel census are volunteers as directed by the Scientific Team. The 24 volunteers are assigned a numerical identification number. To help reduce bias caused by competition among participating volunteers, fisherperson information and all results reported are referenced by identification number only. If for some reason it becomes unmanageable to keep volunteers, then the Scientific Team can recommend paying the fisherpersons a nominal fee.

Assign each volunteer the same fishing area each year and to use the same fishing technique. Direct volunteer fisherperson about how to participate in the fishing census, how to measure and identify fish caught, how to rate the condition of each fish caught, how to record the information on data forms provided and where to send the information forms for analysis.

Each of the 24 volunteers can fish within only one of the five selected fishing areas, unless that fisherperson volunteers for two or more fishing slots, in which case s/he would receive two or more fishing identification numbers. Five volunteers are assigned to fish in each of the fishing areas, except Area #5, which only uses four volunteers.

Each volunteer fishes twice in the spring (during May) and twice in the fall (during September). The first spring fishing period is from May 1 through May 15, with each volunteer fishing one day during this period. The second spring fishing period is from May

16 to May 31, with each volunteer fishing one day during this period. The first fall fishing period occurs between September 1 and September 15, with each volunteer fishing one day during this period. The second fall fishing period occurs between September 16 and September 30 with each volunteer fishing one day during this period. No census fishing can occur during any period outside of May and September.

Volunteers fish 3.5 hours on each fishing day. All fish caught by volunteers during the census period are released alive in the area they were caught. Volunteers must abide by all applicable State of California fishing rules and regulations.

During each of the census days, volunteers can fish only within his or her assigned area during the day of fishing. They can, however, fish anywhere within that assigned area. As mentioned above, a fisherperson may volunteer to fish in more than one area. This is allowed because it may be difficult to find and hold 24 volunteers over the life of the census period. If it becomes difficult to accomplish this, ICWD and LADWP, based upon recommendations from the MOU Consultant, may decide to pay fisherpersons a nominal fee.

The 3.5 hours that each volunteer can fish on each fishing day can be used up at one time or spread out over the fishing day, but cannot exceed 3.5 total hours. Two fishing days per designated month (May and September) by each volunteer are needed to fulfill the fishing requirements. With 24 volunteers fishing 3.5 hours each, four times a year, the total annual fishing sample size used to determine fishing census statistics is 336 hours plus 56 hours from double fishing (Fisherpersons 1# through #4) for a total of 392 hours. All volunteers must adhere to appropriate California State fishing regulations.

Sites

The LORP area was stratified into five separate fishing areas for the creel census (See Figure 4.8). Four of the fishing areas are located on the Lower Owens River while the fifth covers designated off-channel lakes and ponds. Figure 4.8 illustrates and describes in detail the location of these fishing areas. Volunteer identification numbers for each of the five fishing areas are as follows:

Area #1 --- (From pump station dam upstream to the Lone Pine Station Road)
Fisherperson #1 – Fish with any type of fishing gear except bait
Fisherperson #2 – Fish with any type of fishing gear except bait
Fisherperson #3 – Fish with any type of fishing gear except bait
Fisherperson #4 – Fish with bait only
Fisherperson #5 – Fish with bait only

Area #2 --- (Owens River from the Lone Pine Station Road upstream to the Manzanar-Reward Road)
Fisherperson #6 – Fish with any type of fishing gear except bait
Fisherperson #7 – Fish with any type of fishing gear except bait
Fisherperson #8 – Fish with any type of fishing gear except bait
Fisherperson #9 – Fish only with bait
Fisherperson #10 – Fish only with bait

Area #3 --- (Owens River form Manzanar-Reward Road upstream to the Mazourka Canyon Road)
Fisherperson #11 – Fish with any type of fishing gear except bait
Fisherperson #12 – Fish with any type of fishing gear except bait
Fisherperson #13 – Fish with any type of fishing gear except bait
Fisherperson #14 – Fish with bait only
Fisherperson #15 – Fish with bait only

Area #4 --- (Owens River from Mazourka Canyon Road upstream to the Aqueduct Intake)
Fisherperson #16 – Fish with any type of fishing gear except bait
Fisherperson #17 – Fish with any type of fishing gear except bait
Fisherperson #18 – Fish with any type of fishing gear except bait
Fisherperson #19 – Fish with bait only
Fisherperson #20 – Fish with bait only

Area #5 --- (Upper and Lower Twin, Billy and Goose Lakes)
Fisherperson #1 and #21 – Fish Upper Twin Lake with any type of fishing gear
Fisherperson #2 and #22 – Fish Lower Twin Lake with any type of fishing gear
Fisherperson #3 and #23 – Fish Goose Lake with any type of fishing gear
Fisherperson #4 and #24 – Fish Billy Lake with any type of fishing gear

Fisherpersons #1 through #4 have to volunteer to donate the time needed to fish 8 days per year. Fisherpersons #1 through #4 have to fish both the Owens River and designated lakes and ponds.

Frequency
The creel census is being conducted on monitoring years 2, 5, 7, 10, 15 (monitoring year two is 2010). The baseline census year (2003) covered only the wetted river areas and designated lakes and ponds that supported a fishery. Data collected during the census year prior to the implementation of LORP activities provided the baseline data, which will be useful for comparing data acquired after the implementation of the LORP. Starting on monitoring year two (2010), the fishing area will be expanded to include all of the Lower Owens River within the LORP area above the pumpback station dam (four designated reaches). Designated lakes and ponds will be fished all census years.

Data Management
Each volunteer must record their daily fishing results on the census forms provided. Each fishing census includes: fisherperson identification number, area fished, number of fish caught, fish catch rate per hour, individual fish size, average fish size, maximum and minimum size, species caught, fish health and individual fish total length (to the nearest inch- from the tip of the nose to the end of the tail). If the fish caught looks healthy and robust, the fish is recorded as being in good condition (GC). If the fish is overly thin, looks sick or contains any body damage or lesions, the fish is recorded as being in poor condition (PC).

Data Analysis and Reporting

Statistical Applications
Statistical test appropriate to the data type will be applied, but analysis will focus on trends.

GIS Applications
None required.

Reporting
Within a month after each seasonal fishing effort, Staffs are to prepare a report summarizing creel census results. The MOU Consultant reviews the results and any associated analyses and makes recommendations for adaptive management to ICWD and LADWP for inclusion in the annual report.

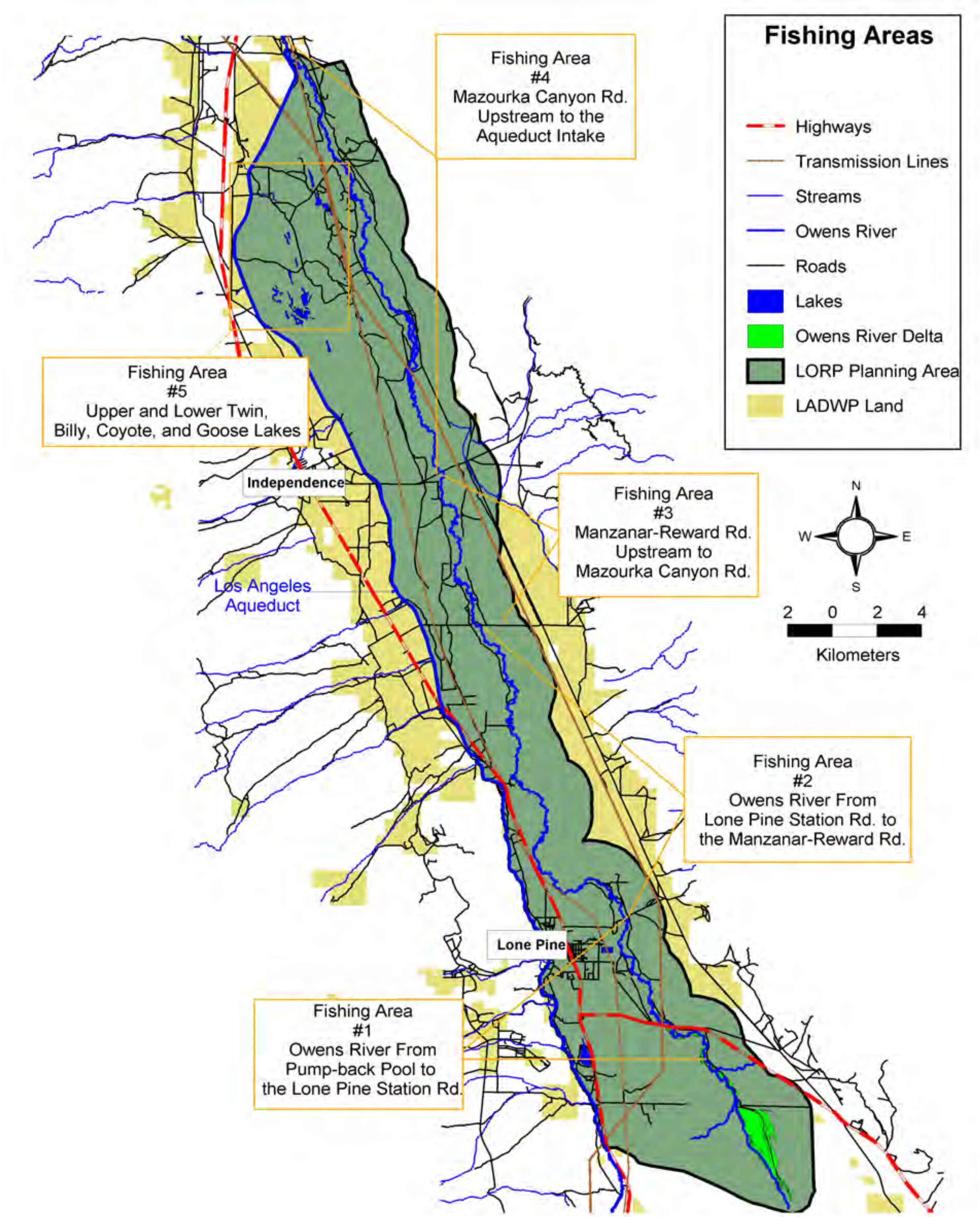

Figure 4.8. Fishing Areas

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4.3 Blackrock Waterfowl Management Area Monitoring

The BWMA consists of four separate management units: Drew, Waggoner, Winerton and Thibaut, identified and described in Section 2.1.2 and displayed in Figure 2.5. In years when runoff is forecasted to be average or above average, approximately 500 acres of the four management units in the Blackrock Area are flooded at any given time. In years of less than average runoff, the water supply to the area (discharge released from the Aqueduct spillgates and diversion points) is reduced in general proportion to the forecasted runoff in the watershed. (The runoff forecast for each year will be LADWP's runoff year forecast for the Owens River Basin, which is based upon the results of its annual April 1 snow survey of the watershed.) Even in the driest years, available water will be used in the most efficient manner to maintain the habitat. The BWMA is subject to periodic cycles of wetting and drying so that one to three of the management units are wholly or partially flooded at any given time.

4.3.1 Flow and Wetland Area Monitoring

Monitoring Purpose

Monitor water inflows and water levels in each of the management units to ensure diverse natural habitats are created and maintained for waterfowl and other wildlife species and to meet MOU goals for the BWMA. Flow and wetland area monitoring will help to inform decision making for the following adaptive management areas (see Section 3.7.1): Terrestrial Habitat, Tule/Cattail Control and BWMA Wetlands.

Baseline Data Collected

No baseline data were collected for flow and wetland area monitoring in the BWMA.

Methods

During the first 10-15 years of the LORP, flooding of the BWMA will occur in two cycles (subject to modification through adaptive management). Cycle 1 includes:

1) Discontinue existing water releases to the Waggoner unit so as to begin a dry phase to remove emergent vegetation. Reduce the open water and vegetated wetland habitat in the unit from 268 acres to 0.
2) Flood approximately 354 acres in the Thibaut unit.
3) Flood approximately 165 acres in the Winerton unit to achieve 500 acres of flooded area.

When the Winerton unit achieves 50 percent cover of emergent vegetation, implement Cycle 2, which includes:

1) Discontinue or reduce flooding of the Winerton unit. This unit is expected to revert to the existing 76 acres of open water and vegetated wetland within the area that will be flooded during Cycle 1.
2) Depending upon conditions in the Thibaut and Winerton units, flood between 100-150 acres in the Waggoner Unit to achieve 500 acres of flooded area.
3) Continue to flood the Thibaut Unit at 354 acres, unless the area of emergent vegetation reaches 50 percent of the flooded area, at which time the unit would be shifted to a dry phase and flooded areas in one or more of the three units would be increased to meet MOU requirements.

The Drew unit will not be flooded at any time, unless it is needed to create additional flooded area to achieve the 500 acre MOU requirement or to meet MOU habitat goals for the four units.

Protocol
Establish gaging stations in the four management units to indicate the area of flooding in each of the units. During implementation of Cycles 1 and 2, monitor water levels closely (in the form of staff gage

elevations) and record water discharges (cfs) so that water release schedules can be developed to meet MOU requirements.

Use aerial photos from a helicopter to help establish a relationship between staff gages and flooded extent. Calibrate the staff gages two times per year. Once established, this will be repeated in years 2, 5, 7 and 10. Use the wetted perimeter to assess the flooded extent. Small islands do not need to be mapped and are included as part of the wetted area. Large islands are subtracted from the wetted area. Modify the frequency of the sampling when reliability of the measurements is determined. Regardless of precision, measurements are made at least quarterly.

Monitor water levels at the gaging stations and flows at spillgates and diversions that supply the four management units. Record changes in water levels as the cells fill and empty as well as during the residence period. Install staff gages solidly to prevent errors caused by changes in elevation of the supporting structure. Use Staff Gage Style C (with graduated marks every 100th of a foot and numerical marks every foot and every tenth of a foot) from Stevens Water Monitoring System, Inc. (2005) or a similar model.

Supply water to the Blackrock Area from the Aqueduct via the Blackrock Spillgate (Drew, Winerton and Waggoner units) and the Thibaut Spillgate (Thibaut unit). Equip the Blackrock Spillgate with a Langemann Gate to monitor and allow releases of a pre-determined flow. The Langemann Gate allows for measurement with sufficient precision needed to assess consistency with the proposed flow regimes. It continuously records flow velocity (fps), water surface level data (feet) and discharge (cfs) on a real-time basis based on channel cross-section geometry. Use the staff gage readings to determine whether additional flow releases from the spillgates are required to create and maintain the total extent of flooded areas established for that year.

During the initial years of project implementation, analyze the relationship between the extent of flooding and the staff gage readings. Determine the extent of flooding using one or more of the following methods: reviewing aerial photography, helicopter fly-over, mapping by traveling the perimeter of the flooded areas and recording the UTM coordinates using a GPS unit. Once the relationships between the extent of flooding and the staff gage readings are established, conduct monitoring of the flooded extent using staff gage measurements.

Take photographs of newly installed staff gages and general site conditions to document baseline field conditions. Document any substantial changes in site conditions in field notebooks.

Sites
Establish a system of gaging stations in each of the four management units. Site staff gages along the perimeter of the expected extent of flooding as well as in the interior of the area to be flooded. Locate gaging stations at Aqueduct spillgates (Blackrock and Thibaut spillgates) and diversion points (Winerton, Drew, Waggoner, Drew Return, Thibaut – east and south gates and Twin Lakes) supplying the BWMA. Record UTM coordinates of staff gage locations in the field using a GPS unit upon initial installation and at each sampling event.

Frequency
Conduct flow monitoring activities over the life of the LORP. Monitor water levels and flows weekly for the first year to assess whether the actual extent of flooding is consistent with the expected extent of flooding. After the first year of monitoring, the frequency will be reevaluated and may be reduced.

Data Management
Data from the automatic gaging stations is stored in a data recorder at each station and is transmitted by telemetry to a computer at the LADWP Bishop office on an hourly basis. Copies of the data are stored daily on a backup tape. If data transmitted by telemetry are not received, download data a minimum of biweekly from the recorder at each station onto a laptop and transport back to the LADWP Bishop office.

Record data collected in the field such as water surface elevations and general site conditions on standard field forms. Follow the data management and quality control procedures described in Sections 4.0.1 and 4.0.2. Compile flow data in tabular form.

Data Analysis and Reporting

Statistical Applications
Calculate the monthly average, maximum and minimum for each staff gage.

GIS Applications
Establish a GPS network of the staff gages in the four units to monitor the aerial extent of flooding. Map the GPS locations and display using ArcView GIS.

Reporting
Follow applicable reporting tasks described in Section 4.1.2. The Task Leader reports water level monitoring data and flows in the annual report. Flow data, which display real-time flows, are also reported on the LORP website.

4.3.2 Rapid Assessment Survey

Monitoring Purpose

Rapid Assessment Surveys (RAS) are conducted to document problems or potential management issues in LORP Blackrock Waterfowl Management Area and provide qualitative project-level feedback regarding changes within the project area. The intent of the RAS is to identify management issues during intervals between monitoring years and between monitoring sites before they manifest themselves into larger, more expensive management problems. The results of the RAS are primarily used to alert project managers to areas of special concern or land use impacts that may not be compatible with goals of the LORP. Rapid Assessment Surveys help to inform the following adaptive management areas (see Section 3.7.1): Fishery, Terrestrial Habitat, Tule/Cattail Control, Exotic/Invasive Plants, BWMA Wetlands, Range Condition and Recreation.

Baseline Data Collected

Baseline RAS data were collected for the Blackrock Waterfowl Management Area from August 14 to September 6, 2007. Data compilation, data analysis and report writing took place in September and October for the same year. Baseline data were collected following the protocols described below.

Methods

Protocol
Train personnel on data collection protocol, sensitive plant species identification, impact record decision making, map and GPS use. Personnel should have the following items available for use in the field:

1. Four wheel drive vehicles
2. Handheld GPS units (extra batteries)
3. Digital cameras (extra batteries)
4. The following data sheets: Rapid Assessment Datasheet, Tamarisk Documentation Form and Noxious Weed Reporting Form.
5. Clipboard and writing utensils
6. Field maps including aerial imagery of the day’s survey route, with pertinent features including fencelines, management unit and flooded extent shapefiles, as well as a colored pen for making notes on maps.
7. Noxious weed habitat and morphology descriptions and photographs (see the noxious weed ratings table in Appendix A.6).
8. Waypoints of areas of management interest that need to be revisited as well as river and river mile shapefiles loaded on to GPS units.
9. Plastic bags for plant samples.
10. Cell phone or two-way radio for communication.

Technical staff should turn the tracking function on their GPS units on with the tracking function set at 0.01 km or “normal or more frequent than normal” sensitivity settings. As workers walk along their assigned route, they should scan the floodplain for at least the following impacts: recreation impacts (including new or those located near sensitive habitats), damage to livestock fences, beaver activity, the presence of noxious weeds and areas of new woody recruitment (see the noxious weed ratings table in Appendix A.6). Survey each management unit on foot or horseback, if necessary, generally following the water's edge, while examining as much of the unit as possible. For example, if a tamarisk stand is spotted in the unit, but away from the water's edge, workers should walk to the stand and document the stand on the appropriate data sheet.

Take a GPS point at each area of management concern. Record each point on the appropriate data sheet (described below) and assign the appropriate impact code. To save time in the field, use the GPS point name automatically assigned by the GPS unit. Record detailed notes on each point as appropriate. Areas of interest not accessible by foot or those that are large and contiguous may be recorded with one point and the extent of the area drawn on field maps. Take photographs of areas of interest or management concern as needed. Set the camera to the high resolution setting. Examples of situations in which a photograph is appropriate include the documentation of visible impact from roads, proximity of roads to sensitive habitats, obstructions in the running channel, proximity of tamarisk slash piles wetland habitats, woody recruitment or conditions supporting weed infestations. Record the reason the photograph was taken, its digital file name assigned by the camera, the GPS point associated with the photograph and the information the photograph is meant to relay.

Three data sheets are required for the RAS. Record the following general information on each data sheet include the date observer(s), the field map associated with the data, the area or river mile surveyed and the beginning and ending time of the survey. The information recorded on these data sheets is described below.

Rapid Assessment Data Sheet

The Rapid Assessment Data Sheet is used to document all impacts or area of interest except for tamarisk plants. Note the impact code associated with each impact. Use the following impact codes: Noxious weeds (EXW), Recreation (REC), Beaver Activity (BEA), Fencing (FEN), Livestock Management Issues (GRZ), Woody Recruitment (WDY) or other (OTH). These impacts are described below.

Woody Recruitment

Record any native woody recruitment sites encountered. Take general notes on recruitment patches including number of individuals, approximate height, site conditions and the presence of non-native species such as tamarisk. Woody species of particular interest include all willow species [e.g. Goodding's Black Willow (*Salix gooddingii*), Red Willow (*S. laevigata*), Coyote Willow (*S. exigua*)] and Fremont cottonwood (*Populus fremontii*).

Recreation

Record adverse impacts associated with recreation observed outside of established "recreation areas" such as parking areas and fence walk-throughs. Examples of these impacts include off-road motorized vehicle travel, trash, vandalism of signs and evidence of overnight camping. In addition, record all roads within the Blackrock Waterfowl Management Area that allow access to the floodplain.

Beaver Activity

Beaver activity can include dams, tree cutting, huts or other evidence of beaver activity such as excessive pooling of water. Note observations of these activities on the data sheet and take a GPS point. Evidence may include but not be limited to fresh chew marks on trees, fresh material on dams or fresh material on huts. In some situations, beaver dams may not be visible, but the sound of falling water over the top of a dam may be heard or the pooling of water behind the dam may be observed. Beaver often respond to the presence of humans by slapping their tails against the water. Record indirect evidence of beaver activity such as these.

Fencing

Record any vandalism or damage to fences. Identify if the fence has been cut, impacted by wildlife or livestock or is old and in disrepair due to age. Assess whether the repair is high priority based on the presence of livestock in the area, visible impacts or proximity to wetland habitats. If recreators, anglers or livestock appear to be repeatedly accessing the floodplain at a given point, note the need for an additional access point (walk-through or wildlife crossing point). If true fence lines differ from those on field maps, note the true location for database improvement or fence construction.

Livestock Management Issues
Document livestock management issues such as presence of livestock or supplement sites in the floodplain, excessive trampling of vegetation, excessive high lining of vegetation or water gaps where livestock are trampling streambanks to access water.

Other
Record and describe other impacts as necessary. Other impacts may include presence of tamarisk slash piles on the river banks or in the channel, burned areas or evidence of wildlife utilization of the floodplain. Workers should use their judgment to discern if an impact should be recorded.

Tamarisk Documentation Form
Tamarisk is the most widespread and common noxious weed found within the LORP area. For this reason, record all tamarisk in all life stages and forms on the tamarisk Documentation Form. Record the distance form the river to the plant, the number of plants associated with the GPS point, whether the plant is a resprout, a seedling or a fully grown plant and the approximate height. Record any other pertinent information in the notes column.

Noxious Weed Reporting Form
Record any noxious weed encountered that is listed by the California Department of Food and Agriculture as “A” or “B” (see the noxious weed ratings table in Appendix A.6). Review the noxious weed’s morphology and habitat preferences before going into the filed and bring this information into the field to aid with identification. Take a photograph of every noxious weed occurrence. Take samples and store them in plastic bags if necessary.

Sites
Perform RAS in all of the Blackrock Waterfowl Management Area units (Drew, Wagoner, Thibaut and Winerton).

Frequency
Perform the RAS once per year in July or August for the first 10 years following implementation. After the first 10 years, assess whether the RAS should continue into the future.

Data Management
Check field data sheets for completeness by field personnel as well as the TL. Each field person is responsible for downloading the GPS and digital camera data and on a daily basis. This information should be sent electronically to the TL for compilation. The TL should assign each data sheet with a control number in a consistent manner with the prefix “RA.” Tamarisk documentation forms should have the suffix “TARA.” Photocopy and scan every data sheet for storage at the LADWP office in Bishop. Transmit GPS track and waypoint files electronically to ICWD.

Data Analysis and Reporting

Statistical Applications
There are no applicable statistical applications for the RAS.

GIS Applications
Transfer all spatial data to ArcGIS platform and save as ArcGIS shapefiles. Create ArcMap documents for each management area. Hand-digitize notations and drawings made on field maps.

Reporting
The TL is responsible for utilizing staffs to compile and produce a summary report at the conclusion of the survey. The report will include maps showing all pertinent data, a summary of findings and suggested management actions. The MOU Consultant will review this information with the advisory committee and present its recommended adaptive management actions to ICWD and LADWP management by the first of November.

In addition, ICWD will fill out noxious weed location forms and send them to Inyo/Mono County Agricultural Commissioner’s Office. The TL will send tamarisk locations and information to the ICWD tamarisk control project manager and fill out and send LADWP Fence Repair Request Forms LORP Project Manager.

4.3.3 Habitat Monitoring

Indicator Species

Monitoring Purpose
Indicator species' habitat monitoring is designed to document changes in habitat conditions in the BWMA of the LORP. Indicator species represents a subset of the entire array of species that could possibly reside within the LORP. Changes in the quantity and quality (suitability) of habitat for a particular species or guild indicates that the system is changing compared to baseline conditions. Changes in habitat for indicator species will be analyzed using the California Wildlife Habitat Relationship (CWHR) system.

The CWHR System is the most extensive compilation of wildlife habitat information in California today. The CWHR is a community level matrix model that predicts wildlife habitat relationships for 692 regularly occurring terrestrial vertebrates in California. Habitat suitability predictions are based on geographic range, relationships to 59 habitat types (27 tree, 12 shrub, 6 herbaceous, 4 aquatic, 8 agricultural, 1 developed and 1 non-vegetated.) averaging 12 stages each and use of 124 special habitat elements.[13] CWHR wildlife experts have assigned wildlife suitability values for each habitat type species occupy. Within the BWMA, suitability values will be derived for indicator species and guilds (species similar in their habitat needs and response to habitat changes) (See Table 4.22).

Each species CWHR model has expert-applied suitability ratings for three life-requisites - breeding, cover and feeding. For each species, every habitat stage is rated as high, medium, low or unsuitable for each of the three life requirements. Each special habitat element is also assessed as essential, secondarily essential, preferred or not rated for the species (CDFG 2000).

The CWHR System rests on a set of general assumptions. In addition, there are a number of specific assumptions which model raters must adhere to when assigning suitability values to habitats and importance levels to elements for any given species. General and specific system assumptions are listed below (CDGF 2000).

1. Wildlife species occurrence and abundance are strongly influenced by habitat conditions.
2. Wildlife habitat can be described by a set of environmental characteristics.
3. Relative suitability values (i.e., high, moderate, low, unsuitable) of habitats and the relative importance of special habitat elements may be determined for each species.
4. Habitat suitability value is uniform for a species throughout its range in California for the specified habitat.

The CWHR with the software application BioView enables managers to build habitat suitability (HSI) models for each indicator species and guild, thus evaluating the quality of the LORP habitats for each species or guild. Additionally, the CWHR with BioView application HSI value output can be added to a GIS layer allowing managers to quantify the acreage of suitable habitat for each species or guild. Further information on this monitoring component can be found in section 3.12. Indicator species' habitat monitoring helps to inform the following adaptive management areas (see Section 3.7.1): Seasonal Habitat Flows, Fishery, Fishery, Terrestrial Habitat, Tule/Cattail Control, Exotic/Invasive Plants, BWMA Wetlands and Range Condition.

Baseline Data Collected
Baseline conditions of indicator species' habitat quantity and quality (suitability) will be analyzed prior to monitoring in 2010; all available data sources will be used to assign height and canopy cover stages to the vegetation GIS polygons (Vegetation Mapping section 4.3.4). The available data sources are:

1. Riparian Habitat Development (GANDA 2003b)
2. Range Trend – section 4.6
3. PRBO vegetation assessment – separate report
4. HCP HSI model data collection – separate report

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[13] CWHR 2007

Additionally, baseline avian point count data (PRBO) is available and will inform managers of the presence/absence of indicator species within the project area.

Methods

As mentioned above, habitat quantity and quality (suitability) in the LORP for each indicator species and guild will be evaluated using the CWHR system with the BioView application. LORP specific CWHR habitats (Desert Riparian, Alkali Desert Scrub, Fresh Water Emergent Wetland and Perennial Grassland) will be evaluated to derive habitat suitability values (e.g. high, moderate, low) for each indicator species and guild. LORP habitats will be described using field data that describes specific habitat elements (vegetation type, structural elements, cover classes and special elements) outlined by the CWHR. Most important to the CWHR with BioView application is the CWHR habitat type and that habitat type's size (height and age) and cover stages. Stages are defined for virtually all habitats and are a combination of size and cover class for tree-dominated habitats, age and cover class for shrub habitats, height and cover class for herb habitats and depth and substrate for aquatic habitats (Tables 4.24 – 4.26).

<u>*Protocol*</u>

The 4 step process described below outlines the protocol required to prepare data for use in CWHR's BioView and how to run BioView to produce suitability values for indicator species and guilds.

Step 1. Crosswalk WHA's LORP mapping to the CWHR (Table 4.23). Whitehorse Associates (WHA) mapped the Lower Owens River Riparian Vegetation based on 2000 aerial photos. WHA's vegetation types are described in Whitehorse Associates 2004c. WHA's map units (polygons) denote areas of distinctive landtype, soil, hydrologic and vegetative character, that enable technicians to easily crosswalk WHA's vegetation types to CWHR habitat types.

Specific Species
Northern harrier (*Circus cyaneus*)
Western least bittern (*Ixobrychus exlilis hesperis*)
Marsh wren (*Cistothorus palustris*)
Osprey (*Pandion haliaetus*)
Rails
Virginia rail (*Rallus limicola*)
Sora (*Porzana carolina*)
Resident, migratory and wintering waterfowl
Mallard (*Anas platyrhynchos*)
Northern pintail (*Anas acuta*)
Gadwall (*Anas strepera*)
Cinnamon teal (*Anas cyanoptera*)
Green-winged teal (*Anas crecca*)
Redheads (*Aythya americana*)
Northern shoveler (*Anas clypeata*)
American wigeon (*Anas americana*)
Canvasback (*Aythya valisineria*)
Ruddy duck (*Oxyura jamaicensis*)
Canada geese (*Branta canadensis*)
Tundra swan (*Cygnus columbianus*)
Resident, migratory and wintering wading birds and shorebirds
American coot *(Fulica americana)*
American bittern (*Botaurus lentiginosus*)
Great blue heron (*Ardea herodias*)
Great egret (*Ardea alba*)
Snowy egret (*Egretta thula*)
Black-crowned night heron (*Nycticorax nycticorax*)
White-faced ibis (*Plegadis chihi*)
Black-bellied plover (*Pluvialis squatarola*)
Semipalmated plover (*Charadrius semipalmatus*)
Killdeer (*Charadrius vociferus*)

Table 4.22. Wildlife habitat indicator species for the Blackrock Waterfowl Habitat Area and Off-River Lakes and Ponds (MOU 1997).

Black-necked stilt (*Himantopus mexicanus*)
American avocet (*Recurvirostra americana*)
Greater yellowlegs (*Tringa melanoleuca*)
Lesser yellowlegs (*Tringa flavipes*)
Solitary sandpiper (*Tringa solitaria*)
Willet (Catoptrophorus semipalmatus)
Spotted sandpiper (*Actitis macularia*)
Whimbrel (*Numenius phaeopus*)
Long-billed curlew (*Numenius americanus*)
Western sandpiper (*Calidris mauri*)
Least sandpiper (*Calidris minutilla*)
Dunlin (*Calidris alpina*)
Short-billed dowitcher (*Limnodromus griseus*)
Long-billed dowitcher (*Limnodromus scolopaceus*)
Common snipe (*Gallinago gallinago*)
Red-necked phalarope (*Phalaropus lobatus*)
Wilson's phalarope (*Phalaropus tricolor*)

Table 4.22. (Continued) Wildlife habitat indicator species for the Blackrock Waterfowl Habitat Area and Off-River Lakes and Ponds (MOU 1997).

Thus, each WHA vegetation type will be cross walked to one of eight CWHR habitat types. The CWHR system uses the following five classification schemes to inform the development of their habitat types: Sawyer & Keeler-Wolf (1995), the USDA Forest Service CalVeg (2001), Holland (1986), Cheatham and Haller (1975) and UNESCO (1996). These five classification systems were also used to crosswalk the WHA vegetation types into CWHR habitat types. Of all the classification schemes, the Holland classification was the most useful because both WHA and CWHR use Holland's classification scheme to describe their respective vegetation types. Therefore, the Holland classification system was used as an intermediary between WHA vegetation and CWHR habitat types (Table 4.23) (Oxbow Environmental 2006). The result of this step is a new GIS shapefile that describes the spatial location and acreage of CWHR habitat types within the Lower Owens River Project area.

Future vegetation mapping may not be performed by WHA. Therefore, future vegetation mapping must be able to be cross walked to CWHR habitat types.

Step 2. Assign appropriate size and cover stage classes to WHA's polygons.

Each CWHR habitat type is divided into sub-categories based on vegetation layers which are representative of unique attributes to which wildlife are thought to respond (CWHR 2005). They include tree dominated, shrub dominated, herbaceous dominated, aquatic and developed habitat categories. Each sub-category has corresponding structural components, such as height and canopy cover that are grouped into standardized size and stage classes (Tables 4.23 – 4.26). Size and stage classes refer to vegetation age and vigor conditions. By standardizing size and stage classes, comparisons in suitability values may be made between different habitat types (Oxbow Environmental 2006).

The CWHR habitat types Barren, Pasture and Urban do not have defined size and stage classes (Table 4.27). CWHR defines size and stage classes as structural components based on native vegetation composition and non-managed habitat (Oxbow Environmental 2006). Barren is classified as having a minimal amount of vegetation (≤ 2%) and is therefore not applicable to this classification scheme. Pasture and Urban habitat types are considered to be devoid of native vegetation (Urban) or non-managed habitat (Pasture) (Oxbow Environmental 2006) and are therefore not structurally defined by their vegetation.

Size and cover stage classes will be added to WHA polygons by adding fields to the WHA attribute table and populating those fields with the appropriate CWHR classes. The CWHR program requires data to be in classes (Tables 4.24 – 4.26); therefore quantitative field data must be converted to CWHR classes before being applied to the WHA polygons. Converting raw field data to classes is beneficial as it will reduce the problems caused by using multiple data sources collected by many individuals. Most likely monitoring data will not cover every single polygon in WHA's LORP mapping.

To alleviate this problem, technicians must make estimates based on aerial/satellite imagery and comparing to existing data to add stage classes to the GIS CWHR habitat layer created in step 1.

Several monitoring data can be used to add CWHR size and stage class data to the CWHR habitat GIS layer (e.g. Irrigated Pasture Scoring, Utilization Monitoring and Range Trend).

The result of step 2 is a GIS layer containing polygons depicting CWHR habitat types with stage class data. Technicians will need to export the database file (*.dbf) of the GIS layer from ArcView and import it into BioView to perform the suitability modeling.

Step 3. Run CWHR Version 8.1 with BioView using database file exported from Step 2.

CWHR Version 8.1 with BioView derives suitability values for indicator species based on habitat type and stage class data. The database file exported from step 2 must contain four fields: ID which is a unique identifier, CWHR habitat type and size and stage class. The database file exported from ArcView in Step 2 must be imported into BioView. After importing the database file suitability values can be defined for each indicator species selected by the technician. Suitability values can be derived in two formats: Standard Habitat Suitability Values and Habitat

Suitability Values Using Fuzzy Logic. The major difference between Standard Habitat Suitability Values and Fuzzy Logic is Fuzzy Logic uses quantitative measurements while Standard Habitat Suitability Values relies on stage class data.

CWHR rates suitability of habitat within three potential use categories: breeding, feeding and cover. Unlike previous versions of the CWHR program, CWHR Version 8.1 with BioView assigns a value to a given habitat type when one or two of the use types are suitable. Those habitat types with no suitability value for any of the three use categories are assigned a 0.

CWHR Habitat Type	Holland Vegetation Type	WHA Vegetation Type
Alkali Desert Scrub	Rabbitbrush scrub meadow	Rabbitbrush-NV saltbrush scrub/meadow
Desert Riparian	Modoc-GB cottonwood/willow riparian forests	Riparian Forest (cottonwood)
	Modoc-GB cottonwood/willow riparian forests	Riparian forest (willow)
	Riparian scrub	Riparian forest shrub (rose)
	Riparian scrub	Riparian shrub (willow)
Perennial Grassland	Alkali meadow	Alkali meadow
Freshwater Emergent Marsh	Transmontane alkali marsh	Marsh
	N/A	Reedgrass
	Rush/sedge meadow	Wet alkaline meadow
Riverine	Permanent lakes and reservoir	Water

Table 4.23. Sample Crosswalk CWHR to Holland to WHA

When one or two of the use categories are suitable, a value of 1 is assigned. This distinguishes habitats that have no suitability from those that may have provided some value, although minimal. Habitat types with undefined size and stage classes (i.e. Barren, Pasture and Urban) are assigned a value of "1" for size class and "0" for stage class. This is necessary for BioView to be able to process these habitat types and calculate suitability values for each habitat type and indicator species.

It is recommended that technicians adhere to the standards and guidelines outlined in CDFG 2000 and the methods for the CWHR system described in CDFG 2005. These two documents are essential reading for LORP habitat suitability modelers.

The result of step 3 is one database file (*.dbf) per indicator species. The database file is compatible with ArcView and will be joined to the CWHR Habitat GIS layer created in step 2.

Standards for Height Classes			Standards for Canopy Closure		
CWHR Code	**Size Class**	**Plant Height**	**CWHR Code**	**Closure Class**	**Ground Cover (Canopy Closure)**
1	Seedling Tree / Shrub	<2’	S	Sparse Cover	2-9%
2	Small Tree / Shrub	2-10’	P	Open Cover	10-39%
3	Medium Tree / Shrub	10-20'	M	Moderate Cover	40-59%
4	Large Tree	>20'	D	Dense Cover	60-100%

Table 4.24. Size (height) and stage (canopy closure) classes for the CWHR tree dominated habitat subdivision. Standards listed are relevant to the Desert Riparian habitat type

Standards for Height Classes			Standards for Canopy Closure		
CWHR Code	**Size Class**	**Crown Decadence**	**CWHR Code**	**Closure Class**	**Ground Cover (Canopy Closure)**
1	Seedling Shrub	Seedlings or Sprouts <3 Years	S	Sparse Cover	2-9%
2	Young Shrub	None	P	Open Cover	10-39%
3	Mature Shrub	1-25%	M	Moderate Cover	40-59%
4	Decadent Shrub	>25%	D	Dense Cover	60-100%

Table 4.25 Size (age) and stage (canopy closure) classes for the CWHR shrub dominated habitat subdivision. Standards are relevant to Alkali Desert Scrub habitat.

Standards for Height Classes			Standards for Canopy Closure		
CWHR Code	**Size Class**	**Plant Height at Maturity**	**CWHR Code**	**Closure Class**	**Ground Cover (Canopy Closure)**
1	Short Herb	<12”	S	Sparse Cover	2-9%
2	Tall Herb	>12”	P	Open Cover	10-39%
			M	Moderate Cover	40-59%
			D	Dense Cover	60-100%

Table 4.26 Size (height) and stage (canopy closure) classes for the CWHR herbaceous dominated habitat subdivision. Standards are relevant to Fresh Emergent Wetland and Perennial Grassland herbaceous

Step 4. Join indicator species database file, created in step 3, to the CWHR Habitat GIS layer created in step 2.

BioView is compatible with ArcView by joining the exported database file from step 3 to the CWHR Habitat GIS layer created in step 2. One GIS layer per indicator species will be created, thus it is possible that 109 (number of indicator species) individual shapefiles will be created. Each indicator species database file exported from BioView will be imported into ArcView and joined to the CWHR Habitat GIS layer created in step 2. Once joined, the shapefile will need to be saved and named per indicator species. Each polygon’s area (acres) will need to be added to each individual shapefile to determine the quantity of suitable habitat per species in the LORP. It is recommended that technicians use the XTOOLS program to calculate the area of each polygon in each indicator species shapefile. The output from this step enables managers to examine year to year changes in the quantity and quality of habitat for indicator species in the LORP. Significant changes in an indicator species’ habitat quality or quantity may warrant adaptive management action.

Sites

Indicator Species CWHR habitat suitability results will cover three physical environmental features of the LORP (Riverine-Riparian, Blackrock and Delta) Thus, there are no actual individual sites for the indicator species’ habitat monitoring.

Frequency

Indicator species’ habitat monitoring will occur in years 2, 5, 7, 10 and 15.

Data Management

Designated (by Scientific Team) TL is responsible for ensuring that each of the steps described above are carried out correctly. Resultant data from BioView and ArcView applications should be saved per physical environmental feature of the LORP and per monitoring year.

Data Analysis and Reporting

Statistical Applications

Statistical applications performed for this monitoring task occur in BioView and ArcView and are outlined in the protocols section above.

Future Field Work
It should be noted that HSI models, like the CWHR, are a useful way to reduce large complex data sets to one understandable metric, but they can be flawed. The models are developed from correlations between habitat attributes and species abundance. In many cases the model assumptions are inappropriate for site-specific reasons.[14] For this reason, subsequent habitat suitability data collection efforts in the LORP should be CWHR specific and focus on standardizing the methods to best fit the CWHR model.

Future field work should be focused on collecting data pertinent to the CWHR. Previous data collection efforts, specifically the Riparian Habitat Development methodology performed by GANDA, is not cost effective for such a large monitoring effort. The methodology is intensive and time consuming and not commensurate with the needs of LORP monitoring and adaptive management process. In lieu of repeating the Riparian Habitat Development methodology, quality data that specifically supports the CWHR could be collected at a fraction of the cost. Additionally, much of the data collected using the GANDA methods is duplicate data, as similar data are collected under the Range Trend, Irrigated Pasture Scoring, Utilization Monitoring and Site Scale Vegetation Assessment methods. Thus these data can be used to describe the stage classes outlined above. If these monitoring data are insufficient to inform the CWHR with BioView application then supplemental data can be collected. Supplementary data should be area and CWHR specific. A subset of the GANDA transects would be most applicable for future sample sites. Any supplemental field data collection must be defined by the CWHR, as CDFG provides a field sampling protocol, which is well-established for determining stages in all vegetated habitats (CDFG 2007). Future monitoring should include taking digital photographs of sampling locations when appropriate. Special habitat elements are also defined and include live and decadent vegetation elements such as snags, physical elements such as banks and burrows, aquatic elements, vegetative and animal diet elements and human-made elements (CDFG 2007).

Reporting
Reporting will occur in each monitoring year following data collection and analysis. Staffs will prepare a report documenting the quality and quantity of habitat for each indicator species and guild by the end of September of monitoring years. The MOU consultant will use the report to make adaptive management recommendations to LADWP and ICWD management by November 1 of each monitoring year.

CWHR Habitat Type	Size Class	Stage Class
Barren	None Defined	None Defined
Pasture	None Defined	None Defined
Urban	None Defined	None Defined

4.27 CWHR habitat types with no defined size and stage classes

4.3.4 Landscape Vegetation Mapping

Monitoring Purpose
The purpose of the Landscape Scale Vegetation Mapping is to provide managers with a landscape scale measurement of the riverine-riparian vegetation. This assessment will be able to accurately (though not necessarily precisely) monitor the entire project area. Landscape Vegetation Mapping helps to inform decision making for the following adaptive management areas (see Section 3.7.1): Seasonal Habitat Flows, Terrestrial Habitat, Tule/Cattail Control, Exotic/Invasive Plants, BWMA Wetlands, Range Condition and Recreation.

Baseline Data Collected
Baseline vegetation monitoring data consist of mapping, field review and description, accuracy assessment and the correlation of map legends. Because of the nature of vegetation assessment technology, baseline data are described below along with the methods used. Protocols for each step are based upon those defined by Whitehorse Associates in the Blackrock Vegetation

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[14] United States Fisheries and Wildlife Service 1982

Inventory, 2000 Conditions[15] and are described below.

Methods

In recent years mapping methods have changed dramatically with the advent of mapping software like ESRI's ArcGIS and the widespread use of remote sensing technology (satellite imagery and digital orthophotography). These two advances in mapping technology have not only reduced the amount of time it takes to map an area, but have also increased the accuracy of maps. The advances in mapping techniques will continue in the future and thus all mapping techniques must be considered for future monitoring in the LORP including the Blackrock area. Prior to each monitoring program that contains a mapping component, the Scientific Team will perform a survey of mapping techniques and the most cost effective and accurate technique should be identified. The Scientific Team will instruct staff or outside consultants, if necessary, to perform the mapping procedure.

The mapping methods used to collect baseline data are presented in this document. Since mapping techniques and methods are subject to change in the future based on emerging technology, future monitoring will likely involve using different methods.

Protocol

Baseline mapping was conducted using high-resolution (2 foot pixels) digital orthophotos. These orthophotos were plotted at 1:6,000 (1 inch=500 feet) scale on glossy photo-paper at 600 dpi using a HP Designjet 3500 Color Plotter. Areas with distinctive landform/soil, hydrologic and vegetative character were delineated based on the author's previous experience mapping riparian/wetland features in the Owens Valley[16] and other areas of the western United States. Distinctive areas were delineated using an ultra-fine point Sharpie marker on the 1:6,000 scale plots backlit on a light table. Delineations were digitized on a large-format digitizer with a magnifier puck set to record continuous points (0.5 mm point spacing). Mapping was compiled and plotted on the same 1:6,000 scale images, which are reviewed in the field. Subsequent map editing was done using "heads-up" digitizing of scales up to 1:1,000.

Map units denote areas of distinctive landtype/soil, hydrologic and vegetative character. Landtypes were distinguished by form and position relative to hydrologic gradients. Hydrologic character was distinguished by color indicative of dominant understory vegetation, viewed in the context of landforms and specified in terms of water regimes. Water regimes were defined based on the frequency and duration of flooding and/or depth to seasonal water table. Vegetation character was defined in terms of physiognomic class and plant species composition. Stream reaches with distinctive valley-form, stream channel morphology and hydrologic character were also identified. Concepts for map units and stream reaches were refined through subsequent field reconnaissance and descriptions.

With preliminary mapping completed, baseline field reviews were conducted in October 2002 and March and April 2003. Map boundaries and labels were verified and/or refined. The field reviews served to refine mapping throughout the Blackrock area. Maps of study areas plotted at 1:2,000 scale served as a basis for further refining mapping and for selecting sites where vegetation, soil and hydrologic attributes were described. Map concepts developed in study areas were extrapolated to reaches (or parts of reaches). Vegetation, soil and hydrologic attributes were described for the dominant map units in each of the 12 study areas. A total of 50 sites were described. These descriptions, coupled with other field observations, are the basis for qualitative descriptions of landtypes, water regimes and vegetation types.

Representative map delineations were traversed to compile a list of plant species. A canopy cover class (T=<1%; P=<5%; 1=5-15%; 2=15-25%; 3=25-35%; etc.) was assigned to each plant species based on ocular estimates. Wetland status for each species was determined from a list prepared for California by the Fish and Wildlife Service. Hydrophytic vegetation was deemed present if the status of

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[15] WHA 2004a

[16] WHA 1997

more than half of the dominant species was facultative (FAC), facultative wetland (FACW) or obligate (OBL) hydrophytes.

Soil was described at each site that was not flooded. The layer designation, moist Munsell color, texture, degree of wetness (dry, most, wet, saturated) and the abundance, contrast and color of mottles were recorded for each soil horizon to a depth of 3 feet or to the alluvial ground water level if less than 3 feet. Hydric soil indicators (e.g., aquic moisture regime, reducing conditions and glayed color) were also noted. Hydrologic parameters (e.g., depth of flooding, depth to free water, depth to saturation) and wetland hydrology indicators were also recorded. Vegetative, soil and hydrologic criteria listed in the Wetland Delineation Manual were used to determine the wetland status of each site.

An average wetland status score was computed for each WHA description site, ICWD polygon and Resource Concepts, Inc. (RCI) polygon (RCI 1999). A numeric rank (Table 4.12) was assigned to each plant species based on the wetland status for California listed in the wetland plant list. The average wetland status score was calculated based on the rank of all species in the site or polygon, weighted by percent composition. An average wetland status class was assigned to each site and polygon based on the average wetland status score.

A cross-section schematic was developed for each of the 12 study areas. Horizontal measures of the distance of map parcels were compiled from the GIS mapping. Relative elevations were interpreted from survey transects conducted by Ecosystem Sciences (1993), 1:24,000 scale digital elevation models, aerial photo interpretation and field observations. Cross-section schematics were compiled using Adobe Illustrator.

For the accuracy assessment, it is important to note the three common types of mapping error:

1. Delineation error – putting the boundary of a parcel here when it should be there.
2. Label error – labeling a feature #1 when it should be #2.
3. Inclusions – areas of contrasting types that are too subtle, small or complex to delineate.

The scale of mapping and the specificity of the map unit largely determine the magnitude of delineation error. For broadly defined categories (e.g., vegetation complexes) mapped at small spatial scales (i.e. 1:40,000), the magnitude of potential error is relatively large (100s to 1000s of feet). For more specific categories (e.g., landforms and vegetation types) mapped at large scales (e.g. 1:6,000), the magnitude of potential error is small (< 20 feet). At 1:6,000 scale the narrowest parcels that can be delineated is about 50 feet; at 1:3,000 scale 25 feet; at 1:1,000 scale less than 10 feet. The 2000 digital orthophotos can be viewed at scales up to about 1:1,000 with good resolution. The goal was an average delineation error, relative to the 2000 digital orthophotos, less than 5 meters.

Label error (e.g., labeling a parcel “marsh,” when it is actually “wet meadow”) is influenced by the specificity at which map units are defined and the medium from which they are drawn. Distinguishing very specific classes of vegetation that appear similar on aerial photos (e.g., communities dominated by *Salix gooddingii* versus *Salix laevigata*) would result in a high degree of label error. Label error can be controlled by appropriate design of distinguishable map units. The frequency of label errors is also influenced by the resolution of the map base (e.g., aerial photos) and the experience of the interpreter. The goal was less than 5 percent overall label error.

Inclusions of contrasting types are typically common in all map units. Inclusions may include gradual transitions between similar vegetation types and/or small areas of contrasting vegetation scattered in the parcel. The goal was less than 15 percent inclusion of any contrasting type and less than 30 percent inclusion of similar types.

A product of the study was a map with consecutively numbered parcels, each labeled with vegetation type, landtype and water regime. Parcels were randomly selected for a field accuracy assessment using the following sequence:

1. Parcels were sorted by size (area) and those less than 1 acre were eliminated from further consideration.
2. Parcels were sorted by vegetation type and sequenced by parcel number (#).
3. A random number generator was used to select 20 parcels of each vegetation type based on the sequence for that type.
4. The 20 selected parcels of each vegetation type were evaluated for accessibility. Parcels that were difficult to access were eliminated from further consideration.
5. A random number generator was again used to select 10 of the accessible parcels of each major vegetation type and 3 parcels of each minor vegetation type for the field accuracy assessment.
6. The outlines of selected parcels were plotted on an aerial photo background and labeled with the parcel number (#) for use in the field. The UTM coordinates were also listed to facilitate use of a GPS to confirm the location of the parcels in the field.

The dominant landform, water regime and vegetation type was determined for each parcel. The accuracy of map boundaries and inclusions of contrasting types were also noted during field assessments.

In the office, field determinations of landform, water regime and vegetation type were compared with map attributes. The percent label error was tabulated for each vegetation type. The overall label error was estimated as the average error for all vegetation types, weighted by the total number of parcels of each type. An overall error rate for wetland versus upland was also estimated. The target overall error rate was less than 5 percent.

Descriptions of vegetation types were pooled for the DHA, LORP, MORP, BWMA, Baker and Hogback project areas. Plant species cover and frequency for combinations of vegetation type, landtype and water regime served as a basis for correlating map legends and served as a basis for testing classifications of vegetation *associations and*/or more general vegetation *series.* WHA and selected ICWD (1998-2000), Garcia and Associates (GANDA) and RCI vegetation data were assembled into a common format. Selected transects were those that occurred entirely within a single WHA parcel. Where multiple ICWD and RCI transects were present within a single WHA parcel, cover values were averaged for the parcel prior to pooling. The pooled vegetation data for 307 parcels served as a basis for discriminate analysis to test the vegetation classifications.

Discriminate analysis was conducted using a reduced data set of selected plant species. Selection entailed the following sequential steps:

1. Similar species that are diagnostic of the same type (i.e., occur in similar habitats) were combined into a broader species class
    a. SALIX = SALGOO + SALLAE + SALIX [TREE]);
    b. SCIRPUS-TYPHA = SCIACU + SCIAME + SCIMAR + TYPLAT + TYPDOM + TYPHA;
    c. JUNCUS = JUNBAL + JUNCUS + JUNMEX;
    d. ELOCH = ELEMAC + ELEOCH + ELEPAL+ ELPAR + ELEROS;
2. The percent <u>composition</u> of plant species was calculated for understory (grass-like + forb) and overstory (shrub + tree) layers for each of the 307 parcels.
3. Species that comprised < 10 percent <u>composition</u> in all 307 parcels were not considered.
4. Species with ≤ 5 percent <u>cover</u> in all 307 parcels were not considered.

The selection reduced the number of species used for ordination analysis from 189 to 58.

<u>*Sites*</u>
Encompass the entire Blackrock Waterfowl Management Area in the landscape scale vegetation mapping.

<u>*Frequency*</u>
Conduct landscape scale vegetation mapping in monitoring years 2, 5, 7, 10, 15. Monitoring year 2 is 2010.

Data Management
Store the digital imagery obtained in its original media format (CD-ROM or DVD) (which will not be modified) and on the project server located at LADWP's Bishop office (for use in analysis). Store the landform classification maps derived from the imagery as ESRI shapefiles on the project server.

Data Analysis and Reporting
Statistical Applications
In addition to the analyses described in the methods section above, generate summary statistics for each monitoring year. Present descriptive statistics like acres of vegetation type, landtype and water regime for the reach, lease and management area scales. Calculate the difference in acres of each vegetation type and water regime. Measure patch diversity per reach using the Shannon-Weiner diversity index (H') (Shannon index) to monitor biodiversity in the LORP area.

The Shannon index is calculated as:

$$H' = - \sum_{i=1}^{s}(p_i)(\ln p_i)$$

Where S = # of acres per reach, p_i = the proportion of S consisting of the i^{th} community.

GIS Applications
See above.

Reporting
Staffs are to submit a report immediately following data collection and analysis in each monitoring year. The MOU Consultant will review this information and present it's recommendations to ICWD and LADWP management by the first of November.

4.3.5 Wetland Avian Census

Monitoring Purpose
The purpose of the wetland avian census is to track the development and maintenance of habitat conditions within the Blackrock Waterfowl Habitat Area (BWHA) and the Delta Habitat Area (DHA) that attract resident and migratory waterfowl and shorebirds, as well as other indicator species. The staff will conduct area count and point count surveys of waterfowl and shorebirds to assess habitat conditions. Avian census data help to inform decision making for the following adaptive management areas (see Section 3.7.1): Terrestrial Habitat, BWMA Wetlands and Range Condition.

No thresholds or triggers have been identified with regard to the results of bird monitoring data.

Adjustments to the timing of flows or releases, the decision to begin a drying/wetting cycle or other management actions may be made based on the response of bird species.

Baseline Data Collected
Wetland avian surveys were conducted in the BWHA and the DHA to document baseline conditions with regard to the bird species using these areas, their habitat associations and when possible, the breeding status of these species. These surveys include a combination of point count methods and area searches. Staffing limitations have restricted the total number of surveys conducted at each site and may limit the scope of the project in the future. Surveys were conducted by LADWP staff, ICWD staff and local volunteers. LADWP staff provided training for volunteers and ICWD staff on field methodology.

Six surveys of both wetland areas were completed between April 2002 and January 2003. The surveys conducted during this first year of baseline were well-spaced throughout the year and provided an inventory of bird use in each area in late-April, late-May, mid-June, mid-August and mid-October and the end of January. The late-April and mid-August survey dates were selected with the purpose of detecting migrant shorebirds. The late-May and mid-June surveys were selected to detect breeding species, while the October and January dates were selected to detect migrating and wintering waterfowl species, respectively. Following an evaluation of the data from the initial baseline inventory effort, LADWP staff recommended increasing the survey effort in order to increase detection of waterfowl and shorebirds during spring and fall migration periods. This increased effort involved four spring surveys at two-week intervals starting the end of March/beginning of April and ending mid-May. Two surveys in June were conducted to detect or confirm breeding. Five fall surveys were conducted at two-week intervals starting the first week of August and ending the end of September. Due to staff limitations, both the BWMA and DHA could not be surveyed simultaneously. As a result, in 2004, eleven surveys were conducted in the BWMA, while the DHA was surveyed at this increased sample effort in 2005. The specific data recorded during each survey included the species and number of individuals observed, the activity the bird was engaged in and the habitat being used and observations that either confirmed or suggested breeding. After the 2002/2003 surveys, the habitat types used for documenting habitat use were changed to correspond to the vegetation mapping conducted by White Horse Associates (White Horse Associates 2004, 2004a). A crosswalk was developed in order to incorporate the 2002/2003 data on habitat use into the categories used in 2004/2005.

Methods

Following the initial year of baseline monitoring, slight modifications were made to the protocol. These changes involved standardizing the method of recording breeding observations, a change in the habitat classification system used and a refinement in the recording of the location of the bird, relative to the observer. The methodologies presented below represent the current protocol, with all changes incorporated.

Protocol

Conduct survey routes as point count surveys or area counts. Point count surveys involve observation and recording from a fixed location for an established amount of time. Area counts involve continuous walking of the survey route. Record all birds encountered along the route as they are encountered. Because birds seen between point count stations are also recorded when conducting point counts, the data can be considered comparable to that obtained during area count survey. Point count surveys are preferred as they may allow the observer to detect more species and observe additional behaviors that might otherwise be missed by continuous walking along the survey route.

Conduct point count surveys at each permanent station, which were established during the 2003-2004 surveys. Point counts are five minute in duration. Observer is to record species or individuals seen between points, if observer is certain that the species or individual had not already been recorded. If only one observer is available, conduct area count surveys, as carried out in the DHA in 2005. Conduct surveys within one hour of local sunrise time. Alternate the starting point for each transect with each visit. Do not conduct surveys during heavy rain or excessive winds. Take digital photographs of sampling locations when appropriate.

Complete each survey within 5 hours and complete all six survey routes in the BWHA and DHA within one to three days of each other. Three person-days are required to complete the four BWMA routes: 1) one person day for the Thibaut route, 2) one person to complete the Winerton route plus the northern part of Wagoner 3) one person day to complete Drew plus the southern part of Wagoner. For the two Delta routes, two person days are required. Survey the two Delta routes on the same day and in the same direction on those days (i.e. both observers survey north to south on one visit, then south to north the next). One surveyor is needed to conduct area count surveys of the DHA by walking both survey routes in one day. Alternate starting location (either Delta West or Delta East route) between surveys.

Record bird activity and the habitat the bird was using at initial detection using the habitat types listed below. Define bird activity as: singing, calling, flying, flyover, foraging, perching, breeding or flushed. If bird activity is “breeding”, use one of 10 breeding codes to document the specific evidence of breeding seen. Some examples of breeding codes include “FC” for food carry and “MC” for material carry. The breeding observations codes are the same as those used by Heath and Gates (2002).

Habitat Types Used in Monitoring

Code Habitat

1. Mud flat
2. Shallow Open-water wetland – use this code if the bird is in or on the water; a shallow open-water wetland would be a shallow pond that has short sedges or rushes that have developed around the wetland.
3. Deep Open-water wetland – use this code if the bird is in or on the water; a deep open water wetland would be indicated by the presence of cattails or tules surrounding the water.
4. Emergent – essentially marsh vegetation; use this code if the bird is using tules, cattails or other tall to medium height sedges.
5. Wet Alkali Meadow – generally characterized by lush growth of saltgrass, rushes and sedges; saltcedar may be present; this habitat type is semi-permanently flooded, seasonally flooded or just saturated; may not be wet on the surface at all times of the year, but distinguished from dry alkali meadow from more lush growth and a greater variety of plants.
6. Dry Alkali Meadow – dominated by saltgrass; vegetation cover is generally low (20-70%); may be seasonally flooded.
7. Seasonal wetland – natural depressions that are seasonally inundated with water.
8. Open herbaceous flooded – herbaceous vegetation (e.g. sunflower, alkali mallow) that has sparse vegetation and is flooded; this vegetation type will be infrequently encountered, but may occur at the edges of seasonal wetlands or areas of emergent vegetation.
9. Open herbaceous not flooded – like the above but not flooded.
10. Closed herbaceous flooded – like open herbaceous flooded, but herbaceous vegetation is more dense and forms a closed canopy.
11. Closed herbaceous not flooded – like closed herbaceous but not flooded.
12. Playa – alkaline areas on the Owens lakebed that are dry.
13. Playa flooded – alkaline areas on the Owens lakebed that are flooded.
14. Alkali Sink Scrub – shrublands composed of Saltbrush (*Atriplex* spp.), Greasewood (*Sarcobatus*), Inkweed (*Suaeda*); generally occurs in more alkaline locations than Great Basin Scrub.
15. Great Basin Scrub – this includes shrublands composed of Great Basin Big Sagebrush (*Artemisia tridentada*) and/or rabbitbrush (*Chrysothamnus nauseosus*); the amount of grass understory present may vary considerably.
16. Riparian –includes riparian scrub stands (e.g. coyote willow) or tree willow stands along river or stream courses; if the bird is using a lone willow tree in the middle of a wet alkali meadow, the habitat type would be WAM, but put “willow” in notes column.

Sites

Ecosystem Sciences initially identified general survey routes (also referred to as transects) for the Blackrock and Delta Areas. Permanent point count stations were selected by LADWP and ICWD personnel along each route using a handheld Garmin GPS V unit. Point count stations are a minimum of 250 meters apart and up to 300 meters apart in very open habitats. The GPS locations were downloaded into an ArcView database file and overlaid onto year 2000 aerial photos of each area. These point count stations are marked with a white-tipped green fence post and an aluminum tag identifying the project (LORP AVIAN), the management area and the point number (e.g., “THIBAUT_4”).

Blackrock Waterfowl Management Area Transects

Each of the four Blackrock Area management units includes one transect, with a total of forty five point count stations: Drew (8 stations), Winterton (9 stations), Waggoner (13 stations) and Thibaut (15 stations).

Owens River Delta Habitat Area Transects

The Owens River Delta area (Delta West and Delta East) includes two transects. The Delta West transect follows the west side of the Owens River channel, from the powerline crossing to approximately 300 meters past the last point of vegetation, based on 2002 conditions and therefore includes some of the "delta-to-brine pool transition area". The Delta East route follows the east arm of the river, then traverses the extensive alkaline meadow habitat east of the river channel and ends at the current confluence of the east delta area and the Owens River channel. The Delta West transect consists of 25 point count stations, while the Delta East transect has 17 stations, for a total of 42 stations in the Owens River Delta area.

Frequency
Avian census will be conducted on monitoring years 2, 5, 7, 10, 15 (monitoring year 2 is 2010). Census all avian points three times during the peak breeding season (approx May 25 – June 30), with each of the three censuses at least 10 days apart.

Conduct vegetation data collection during the breeding season of the first year of any point count project and as often as possible after that (usually not more than once per season). In stable habitat types it may only be necessary to do sampling every few years, while in flood, burn or restoring habitats it is generally necessary to do them each season. If new sites are added to a project, sample them the first year and then on the same schedule as the other stations.

Data Management
The Task Leader is responsible for collecting all completed field forms and delivering them to LADWP offices in Bishop in person. Assign all original field forms with document control number. Field forms are filed and retained for a minimum of 15 years at LADWP offices in Bishop. In addition to retention of hard copies, all field forms are scanned and retained in an electronic format (e.g., PDF) for the life of the project on a hard drive at LADWP offices.

Persons conducting the surveys should be able to identify all regularly-occurring species, especially wetland bird species, by sight and sound. The Task Leader is to confirm the qualifications of surveyors. Surveyors should receive training on the methodologies prior to conducting surveys. Training is conducted in the field by the Task Leader before the first sampling activity or as needed.

Quality assurance activities for the wetland bird monitoring project consists of the following:

- At the survey site, surveyor reviews field forms to ensure that they are complete, legible, accurate and in standard format. Errors are corrected with a line drawn through them and replaced with the correct term or value. Qualify data considered as suspect using a flag variable.
- Staffs enter the data into spreadsheets in tabular form and record their name on the original field form. Staffs entering the data are responsible for reviewing for and correcting any data transcription errors.
- Task Leader reviews all flagged suspect data and makes the ultimate decision of excluding any data from use in further analysis.

Data Analysis and Reporting
Statistical Applications
Apply statistical tests appropriate to the data type to the bird monitoring data. Staffs may analyze data in terms of trends in bird species diversity, percent composition of habitat indicator species, total detections of habitat indicator species and habitat use versus availability. Use data on bird habitat selection, season of use and pattern of use (foraging, nesting, etc) to evaluate the response of birds to management activities.

GIS Applications
The locations of each point count station will be transferred to aerial photos in order to provide visual representation of survey activities. Bird use data may be useful in modeling the effects of various land management activities through time; however this potential aspect of the project has not been explored to date.

Reporting
Staffs are to prepare and submit monitoring results by the end of September of each monitoring year. The MOU Consultant is to review results and present conclusions as well as recommended adaptive management prescriptions to ICWD and LADWP management by the first of November.

4.4 Delta Habitat Area Monitoring

Flow is monitored in the Delta Habitat Area to enhance and maintain existing wetland habitat and establish new habitats for indicator species associated with the Delta. The Delta Habitat Area is identified and described in Section 2.1.3and displayed in Figure 2.6 The Delta contains two major channels with numerous shallow braided channels and pools scattered throughout a flat alluvial fan. These channels and pools vary in depth from about 6 feet to less than 1 inch. Flows from the river that top the channel banks spread across the Delta and create small, shallow (less than 6 inches deep) seasonal water bodies used by shorebirds and wading birds.

4.4.1. Delta Flow Monitoring

Monitoring Purpose

Flows are monitored in the Delta Habitat Area to maintain and enhance existing wetland areas and establish new wetland habitats and to meet MOU requirements as described in Section 3.16. Flow monitoring will help to inform decision making for the following adaptive management areas (see Section 3.7.1): Terrestrial Habitat, Tule/Cattail Control and Delta Habitat Area.

Baseline Data Collected

No baseline data for Delta flows was recorded.

Methods

Delta Habitat Area flow monitoring is described in Technical Memorandum #8 *Owens River Delta Habitat Area*, the Ecosystem Management Plan, FEIR and the Lahontan Water Quality Control Board Order for the LORP.

Flow management in the Delta Habitat Area consists of three types of flow releases: (1) base flows; (2) four pulse flows; and (3) bypass of annual seasonal habitat flows. Seasonal habitat flows consist of higher flows (up to 200 cfs) that may pass through the pumpback station to the Delta. As specified in the MOU, base flows with an average annual flow of 6 to 9 cfs (with a minimum base flow of approximately 3 cfs at any time) are established in the Delta to create and enhance habitats. Flows released to the Delta are controlled by the pumpback station, located between Keeler Bridge and the Lower Owens River Delta. The base flow does not include any flows that bypass the pumpback station during the seasonal habitat flows in the river.

Four pulse flows of 20 to 30 cfs (within the 6-9 cfs annual average flow) will also be released to the Delta beginning in 2009 for short periods of time to increase the distribution and amount of water in the Delta to benefit certain vegetation growth periods and shorebird activity.

Protocol
Protocols specific to each flow release type are described below. Since ICWD staff does not have appropriate equipment to do so, it is the responsibility of LADWP staff to perform all tasks related to Delta Flow Monitoring.

Base flows
During Establishment of Base Flows: Monitor the inflow (releases from the pumpback station) to the Delta and the outflow from the Delta. Collect data on velocity (fps), water surface level (feet) and discharge (cubic feet per second-cfs). Monitor inflows to determine whether adjustments to flow releases are needed to ensure that the annual average of flows released from the pumpback station to the Delta is approximately 6-9 cfs, and the minimum flow at any time is approximately 3 cfs. Monitor outflows to determine whether adjustments to flows released from the pumpback station are necessary to maintain

outflows from the Delta at approximately 0.5 cfs.

Establish base flows and manage releases from the pumpback station to maintain an average daily outflow of approximately 0.5 cfs from the vegetated portion of the Delta Habitat Area, as described in the bulleted items below. (An outflow of 0.5 cfs was selected since it is the smallest flow rate that can be measured reliably and can be used to confirm that water is overflowing from the Delta). During the first year, the daily releases from the pumpback station to maintain the 0.5 cfs outflow will serve as the schedule of releases to be made in subsequent years. These releases may be modified as part of adaptive management if monitoring results indicate a reduction in habitat quantity and/or quality. During the first year of project implementation:

- Release an initial base flow of 5.3 cfs to the Delta Habitat Area. This initial base flow was established based on an estimate of evapotranspiration demand of the vegetation.[17] Install temporary stream gages equipped with recording devices where the vegetation ends in the channel of the lower west branch and the lower east branch.
- Record outflow hourly and collect biweekly.
- If the total average daily outflow from the two gages (at the east and west branches) for any 14-day monitoring period is approximately 0.5 cfs, no action is required.
- If the total average daily outflow from the two gages for any 14-day monitoring period is less than or greater than 0.5 cfs, adjust flow releases from the pumpback station to the Delta until the average flow is approximately 0.5 cfs.

Compile a record of base flows needed to maintain approximately 0.5 cfs average daily outflow for 14-day monitoring periods. Use this record to calculate the amount of base flows for each of the following periods: May 1 to September 30, October 1 to November 30, December 1 to February 28 and March 1 to April 30. Use direct measurements of outflows to establish seasonal base flows (which reflect assumed water demand for vegetation resources that exist in the first year). No pulse flows are released to the Delta during the first year when the base flow regime is being determined.

Adjustment of Base Flows (Subsequent Years): Once the base flows have been established, it is anticipated that the vegetation in the Delta will eventually consume all of the base flow releases during the growing season and that outflow from the vegetated Delta wetlands may occur only during the four pulse flow periods and with minimal outflows during the cooler periods of the year when evapotranspiration is not occurring or is minimal.

Once seasonal base flow releases are established, adjust base flow releases within the 6 to 9 cfs annual average range in subsequent years based upon the following monitoring triggers:

(1) A decrease of 10 percent or more during any 3-year period (i.e., the present year and the previous two years) from the "Delta conditions" (total acreage of vegetated wetlands plus water as defined above) as estimated from aerial or satellite imagery or other appropriate methods.
(2) A 20 percent or greater reduction in habitat suitability index (aerial extent and habitat quality) as measured at 5-year intervals after the commencement of releases of base flows to the Delta.
(3) A reduction in base flows to the Delta may be considered if monitoring indicates: 1) an increase of 10 percent or more in area during any 3-year period from the "Delta conditions" and 2) an increase of 20 percent or more in habitat suitability index as measured at 5-year intervals.

Use a Langemann® Gate (by Aqua Systems 2000, Inc.) at the pumpback station to monitor and control flow releases. The Langemann Gate functions as a vertically adjustable weir. It has a water-level sensing and control system, which

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[17] GBUAPCD 1997

adjusts the weir based on upstream conditions to release a pre-determined flow to downstream locations. The programmed flow rate can be modified remotely and on a real-time basis from LADWP's offices in Bishop. The Langemann Gate at the pumpback station is used to release an annual average of approximately 6 to 9 cfs to the Delta, with flow releases at any time ranging from approximately 3 to 50 cfs. Flows higher than 50 cfs are conveyed over the top of the diversion structure (and therefore are not measured by the Langemann Gate).

Collect discharge data at the other measuring stations at the Delta outflows using an automated Doppler current meter (Argonaut-SW from SonTek/YSI, Inc.). Argonaut-SW is suitable for flow monitoring in shallow water conduits (up to 16 feet), including natural streams, pipes and culverts. Each measuring station is equipped with the Argonaut-SW metering unit, a data recorder, telemetry equipment (RUGID) and a solar panel for power supply. For stations located at existing culverts, mount the metering unit at the bottom of the culvert. At other locations, secure a geotextile or wooden box to the channel to create a stable channel cross-sectional area and shape, and mount the metering unit on the geotextile or the box.

Measurements with an Argonaut-SW have the precision needed to assess consistency with the proposed flow regimes. Argonaut-SW has a measurement range of ± 16 feet per second (fps), a resolution of 0.003 fps and an accuracy of ±1 percent of measured velocity (SonTek/YSI, 2004). The measurement range for water level is 0.6 to 16 feet, with an accuracy of ±0.1 percent of measured level (SonTek/YSI, 2004).

The metering equipment (Langemann Gate and Argonaut-SW) continuously records flow velocity (fps) and water surface level (feet) data. The equipment also computes the discharge (cfs) on a real-time basis based on channel cross-section geometry.

Pulse Flows

Beginning in 2009, four pulse flow periods will be released to enhance water distribution and habitat. Pulse flows will be applied for four periods as follows:

- Period 1: Release flows of 25 cfs for 10 days (496 acre-feet) at the onset of the plant-growing season (late-March to mid-April) to replenish the freshwater lens prior to plant emergence from dormancy and enhance saltgrass production (the dominant species in alkali meadows) because it can utilize water more effectively and efficiently at this time.[18] This pulse flow will also enhance foraging areas along the vegetation-playa-water interface to attract migratory species.
- Period 2: Release flows of 20 cfs for 10 days (397 acre-feet) in the late spring to mid-summer (late-June to early-July) when evapotranspiration rates are high. This pulse flow will help ensure that adequate water is available to sustain plants during the critical summer period and will provide direct and indirect benefits to invertebrates and wildlife.
- Period 3: Increase flows to 25 cfs for 10 days (496 acre-feet) in September during the late growing season to enhance wetland habitat for early migrants.
- Period 4: Release a late fall – early winter (November – December) pulse of 30 cfs for 5 days (298 acre-feet) to benefit wildlife and recharge the freshwater lens.

Pulse Flow	Dates	Duration (days)	cfs/day	Ecological Purpose
Period 1	Mar-Apr	10	25	Early growth of saltgrass
Period 2	June-July	10	20	General wetland support
Period 3	Sept	10	25	Wetlands and early migrating birds
Period 4	Nov-Dec	5	30	Wintering birds
Total		35		

Table 4.28. Summary of Proposed Pulse Flows to the Delta

* This table does not include seasonal habitat flows that could reach the Delta.

The magnitudes and durations of these flows are summarized in Table 4.28. The total amount of water allocated to pulse flows is 1,687 acre-feet per year. However, this amount may be modified since the amount, duration and timing of both base flows and pulse flows

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[18] Jim Paulus, GBUAPCD, personal communication

may be adjusted (within the range of 6 to 9 cfs annual average) as part of adaptive management.

Sites
Record inflow measurements at the flow measuring station at the pumpback station located about 4.5 river miles south of Keeler Bridge. Record outflow measurements at two temporary gaging stations at the downstream ends of the east and west branches of the Delta.

Frequency
Record inflows to the Delta continuously and transmit hourly to the LADWP Bishop office. Record outflows continuously and transmit hourly to LADWP Bishop office for the first year only. During the initial establishment of base flows and the releases of seasonal habitat flows, review flow data daily or more frequently, as needed, to enable timely adjustment of flows. Review flow data weekly after the base flow has been established.

Data Management
Transmit data from the automated gaging stations by telemetry to a computer at the LADWP Bishop office. Use of the automated data improves accuracy of the data by eliminating errors associated with manual data entry/transcription. Store a copy of the data daily on a backup tape. If data transmitted by telemetry are not received, download data a minimum of biweekly from the recorder at each station onto a laptop and transport back to the LADWP Bishop office.

Follow the applicable data quality control tasks described in Section 4.1.1.

Data Analysis and Reporting

Statistical Applications
No significant statistical applications are performed on the Delta Habitat Area flow data. Compile data in tabular form in a spreadsheet program and calculate 14-day running average flows for the Owens River through the Delta. Also calculate the monthly and annual mean, median, maximum and minimum base flows and present in tabular format.

GIS Applications
No GIS applications are necessary for monitoring flow in the Delta Habitat Area.

Reporting
The Lahontan Water Quality Control Board Order requires that LADWP report daily flow rates and cumulative monthly volumetric flows (in cubic feet or acre feet) for water discharged to the Owens Lake Delta.

4.4.2 Rapid Assessment Surveys

Monitoring Purpose
Rapid Assessment Surveys (RAS) are conducted to document problems or potential management issues in LORP Delta Habitat area and provide qualitative project-level feedback regarding changes within the project area. The intent of the RAS is to identify management issues during intervals between monitoring years and between monitoring sites before they manifest themselves into larger, more expensive management problems. The results of the RAS are primarily used to alert project managers to areas of special concern or land use impacts that may not be compatible with goals of the LORP. Rapid Assessment Surveys help to inform the following adaptive management areas (see Section 3.7.1): Fishery, Terrestrial Habitat, Tule/Cattail Control, Exotic/Invasive Plants, Delta Habitat Area, Range Condition and Recreation.

Baseline Data Collected
Baseline RAS data were collected for the Delta Habitat area from August 14 to September 6, 2007. Data compilation, data analysis and report writing took place in September and October for the same year. Baseline data was collected following the protocols described below.

Methods
Protocol
Train personnel on data collection protocol, sensitive plant species identification, impact record decision making, map and GPS use. Personnel should have the following items available for use in the field:

1. Four wheel drive vehicles
2. Handheld GPS units (extra batteries)

3. Digital cameras (extra batteries)
4. The following data sheets: Rapid Assessment Datasheet, Tamarisk Documentation Form and Noxious Weed Reporting Form.
5. Clipboard and writing utensils
6. Field maps including aerial imagery of the day's survey route, with pertinent features including fencelines, river and river mile shapefiles, as well as a colored pen for making notes on maps.
7. Noxious weed habitat and morphology descriptions and photographs (see the noxious weed ratings table in Appendix A.6).
8. Waypoints of areas of management interest that need to be revisited as well as river and river mile shapefiles loaded on to GPS units.
9. Plastic bags for plant samples.
10. Cell phone or two-way radio for communication.

Technical staff should turn the tracking function on their GPS units on with the tracking function set at 0.01 km or "normal or more frequent than normal" sensitivity settings. As workers walk along their assigned route, they should scan the floodplain for the including but to limited to the following impacts: Recreation impacts (including new or those located near sensitive habitats), damage to livestock fences, beaver activity, the presence of noxious weeds and areas of new woody recruitment. Survey both sides of the river from the intake to the pumpback station generally following the water edge, while examining as much of the floodplain as possible. For example, if a tamarisk stand is spotted in the floodplain, but away from the river's edge, workers should walk to the stand and document the stand on the appropriate data sheet.

Take a GPS point at each area of management concern. Record each point on the appropriate data sheet (described below) and assign the appropriate impact code. To save time in the field, use the GPS point name automatically assigned by the GPS unit. Record detailed notes on each point as appropriate. Areas of interest not accessible by foot or those that are large and contiguous may be recorded with one point and the extent of the area drawn on field maps. Take photographs of areas of interest or management concern as needed. Set the camera to the high resolution setting. Examples of situations in which a photograph is appropriate include the documentation of visible impact from roads, proximity of roads to sensitive habitats, obstructions in the running channel, proximity of tamarisk slash piles to Delta Habitat habitats, woody recruitment or conditions supporting weed infestations. Record the reason the photograph was taken, its digital file name assigned by the camera, the GPS point associated with the photograph and the information the photograph is meant to relay.

Three data sheets are required for the RAS. Record the following general information on each data sheet include the observation date, the field map associated with the data, the area or river mile surveyed and the beginning and ending time of the survey. The information recorded on these data sheets is described below.

<u>Rapid Assessment Data Sheet</u>

The Rapid Assessment Data Sheet is used to document all impacts or area of interest except for tamarisk plants. Note the impact code associated with each impact. Use the following impact codes: Noxious weeds (EXW), Recreation (REC), Beaver Activity (BEA), Fencing (FEN), Livestock Management Issues (GRZ), Woody Recruitment (WDY) or other (OTH). These impacts are described below.

Woody Recruitment

Record any native woody recruitment sites encountered. Take general notes on recruitment patches including number of individuals, approximate height, site conditions and the presence of non- native species such as tamarisk. Woody species of particular interest include all willow species [e.g. Goodding's Black Willow (*Salix gooddingii*), Red Willow (*S. laevigata*), Coyote Willow (*S. exigua*)] and Fremont cottonwood (*Populus fremontii*).

Recreation

Record adverse impacts associated with recreation observed outside of established "recreation areas" such as parking areas and fence walk-throughs. Examples of these impacts include off-road motorized vehicle travel, trash, vandalism of signs and evidence of overnight camping. In addition, record all roads within the Delta Habitat area that allow access to the floodplain.

Beaver Activity

Beaver activity can include dams, tree cutting, huts or other evidence of beaver activity such as excessive pooling of water. Note observations of these activities on the data sheet and take a GPS point. Evidence may include but not be limited to fresh chew marks on trees, fresh material on dams or fresh material on huts. In some situations, beaver dams may not be visible, but the sound of falling water over the top of a dam may be heard or the pooling of water behind the dam may be observed. Beaver often respond to the presence of humans by slapping their tails against the water. Record indirect evidence of beaver activity such as these.

Fencing

Record any vandalism or damage to fences. Identify if the fence has been cut, impacted by wildlife or livestock or is old and in disrepair due to age. Assess whether the repair is high priority based on the presence of livestock in the area, visible impacts or proximity to Delta Habitat habitats. If recreators, anglers or livestock appear to be repeatedly accessing the floodplain at a given point, note the need for an additional access point (walk-through or wildlife crossing point). If true fence lines differ from those on field maps, note the true location for database improvement or fence construction.

Livestock Management Issues

Document livestock management issues such as presence of livestock or supplement sites in the floodplain, excessive trampling of vegetation, excessive high lining of vegetation or water gaps where livestock are trampling streambanks to access water.

Other

Record and describe other impacts as necessary. Other impacts may include presence of tamarisk slash piles on the river banks or in the channel, burned areas or evidence of wildlife utilization of the floodplain. Workers should use their judgment to discern if an impact should be recorded.

Tamarisk Documentation Form

Tamarisk is the most widespread and common noxious weed found within the LORP area. For this reason, record all tamarisk in all life stages and forms on the tamarisk Documentation Form. Record the distance form the river to the plant, the number of plants associated with the GPS point, whether the plant is a resprout, a seedling or a fully grown plant and the approximate height. Record any other pertinent information in the notes column.

Noxious Weed Reporting Form

Record any noxious weed encountered that is listed by the California Department of Food and Agriculture as “A” or “B” (see the noxious weed ratings table in Appendix A.6). Review the noxious weed’s morphology and habitat preferences before going into the filed, and bring this information into the field to aid with identification. Take a photograph of every noxious weed occurrence. Take samples and store them in plastic bags if necessary.

Sites

Perform the RAS for Delta Habitat area on both sides of both the north and south branches of the Delta Habitat Area.

Frequency

Perform the RAS once per year in July or August for the first 10 years following implementation. After the first 10 years, assess whether the RAS should continue into the future.

Data Management

Check field data sheets for completeness by field personnel as well as the TL. Each field person is responsible for downloading the GPS and digital camera data and on a daily basis. This information should be sent electronically to the TL for compilation. The TL should assign each data sheet with a control number in a consistent manner with the prefix “RA.” Tamarisk documentation forms should have the suffix “TARA.” Photocopy and scan every data sheet for storage at the LADWP office in

Bishop. Transmit GPS track and waypoint files electronically to ICWD.

Data Analysis and Reporting

Statistical Applications

There are no applicable statistical applications for the RAS.

GIS Applications

Transfer all spatial data to ArcGIS platform and save as ArcGIS shapefiles. Create ArcMap documents for each management area. Hand-digitize notations and drawings made on field maps.

Reporting

The TL is responsible for utilizing staffs to produce compile and produce a monitoring and results summary report at the conclusion of the summary. The report will include maps showing all pertinent data, a summary of findings and suggested management actions. The MOU Consultant will review this information with the advisory committee and present its recommended management actions to ICWD and LADWP management by the first of November. In addition, ICWD will fill out noxious weed location forms and send them to Inyo/Mono County Agricultural Commissioner's Office. The TL will send tamarisk locations and information to the ICWD tamarisk control project manager and fill out and send LADWP Fence Repair Request Forms LORP Project Manager.

4.4.3 Habitat Monitoring

Delta Indicator Species

Monitoring Purpose

Indicator species' habitat monitoring is designed to document changes in habitat conditions in the DHA of the LORP. Indicator species represents a subset of the entire array of species that could possibly reside within the LORP. Changes in the quantity and quality (suitability) of habitat for a particular species or guild indicates that the system is changing compared to baseline conditions. Changes in habitat for indicator species will be analyzed using the California Wildlife Habitat Relationship (CWHR) system. The CWHR System is the most extensive compilation of wildlife habitat information in California today. The CWHR is a community level matrix model that predicts wildlife habitat relationships for 692 regularly occurring terrestrial vertebrates in California. Habitat suitability predictions are based on geographic range, relationships to 59 habitat types (27 tree, 12 shrub, 6 herbaceous, 4 aquatic, 8 agricultural, 1 developed and 1 non-vegetated.) averaging 12 stages each and use of 124 special habitat elements (CWHR 2007). CWHR wildlife experts have assigned wildlife suitability values for each habitat type species occupy. Within the Lower Owens, suitability values will be derived for indicator species and guilds (species similar in their habitat needs and response to habitat changes) (Table 4.29).

Each species CWHR model has expert-applied suitability ratings for three life-requisites - breeding, cover and feeding. For each species, every habitat stage is rated as high, medium, low or unsuitable for each of the three life requirements. Each special habitat element is also assessed as essential, secondarily essential, preferred or not rated for the species (CDFG 2000). The CWHR System rests on a set of general assumptions. In addition, there are a number of specific assumptions which model raters must adhere to when assigning suitability values to habitats and importance levels to elements for any given species. General and specific system assumptions are listed below (CDGF 2000):

1. Wildlife species occurrence and abundance are strongly influenced by habitat conditions.
2. Wildlife habitat can be described by a set of environmental characteristics.
3. Relative suitability values (i.e., high, moderate, low, unsuitable) of habitats and the relative importance of special habitat elements may be determined for each species.
4. Habitat suitability value is uniform for a species throughout its range in California for the specified habitat.

The CWHR with the software application BioView enables managers to build habitat suitability (HSI) models for each indicator species and guild, thus evaluating the quality of the LORP habitats for each species or guild. Additionally, the CWHR with BioView application HSI value output can be added to a GIS layer allowing managers to quantify the acreage of suitable habitat for each species or guild. Further information on this monitoring component can be found in Section 3.12. Indicator species' habitat monitoring helps to inform the following adaptive management areas (see Section 3.7.1): Seasonal Habitat Flows, Fishery, Fishery, Terrestrial Habitat, Tule/Cattail Control, Exotic/Invasive Plants, Delta Habitat Area and Range Condition.

Baseline Data Collected

Baseline conditions of indicator species' habitat quantity and quality (suitability) will be analyzed prior to monitoring in 2010; all available data sources will be used to assign height and canopy cover stages to the vegetation GIS polygons (Vegetation Mapping section 4.4.4). The available data sources are:

1. Riparian Habitat Development (GANDA 2003b)
2. Range Trend – section 4.6
3. PRBO vegetation assessment – separate report
4. HCP HSI model data collection – separate report

Additionally, baseline avian point count data (PRBO) is available and will inform managers of the presence/absence of indicator species within the project area.

Methods

As mentioned above, habitat quantity and quality (suitability) in the LORP for each indicator species and guild will be evaluated using the CWHR system with the BioView application. LORP specific CWHR habitats (Desert Riparian, Alkali Desert Scrub, Fresh Water Emergent Wetland and Perennial Grassland) will be evaluated to derive habitat suitability values (e.g., high, moderate, low) for each indicator species and guild. LORP habitats will be described using field data that describes specific habitat elements (vegetation type, structural elements, cover classes and special elements) outlined by the CWHR. Most important to the CWHR with BioView application is the CWHR habitat type and that habitat type's size (height and age) and cover stages. Stages are defined for virtually all habitats and are a combination of size and cover class for tree-dominated habitats, age and cover class for shrub habitats, height and cover class for herb habitats and depth and substrate for aquatic habitats (Tables 4.31 – 4.33).

Protocol

The 4 step process described below outlines the protocol required to prepare data for use in CWHR's BioView and how to run BioView to produce suitability values for indicator species and guilds.

Step 1. Crosswalk WHA's LORP mapping to the CWHR (Table 4.30). Whitehorse Associates (WHA) mapped the Lower Owens River Riparian Vegetation based on 2000 aerial photos. WHA's vegetation types are described in Whitehorse Associates 2004c. WHA's map units (polygons) denote areas of distinctive landtype, soil, hydrologic and vegetative character, that enable technicians to easily crosswalk WHA's vegetation types to CWHR habitat types. Thus, each WHA vegetation type will be cross walked to one of eight CWHR habitat types. The CWHR system uses the following five classification schemes to inform the development of their habitat types: Sawyer & Keeler-Wolf (1995), the USDA Forest Service CalVeg (2001), Holland (1986), Cheatham and Haller (1975) and UNESCO (1996). These five classification systems were also used to crosswalk the WHA vegetation types into CWHR habitat types. Of all the classification schemes, the Holland classification was the most useful because both WHA and CWHR use Holland's classification scheme to describe their respective vegetation types. Therefore, the Holland classification system was used as an intermediary between WHA vegetation and CWHR habitat types (Tables 4.31 – 4.33) (Oxbow Environmental 2006). The result of this step is a new GIS shapefile that describes the spatial location and acreage of CWHR habitat types within the Lower Owens River Project area. Future vegetation mapping may not be performed by WHA. Therefore, future vegetation mapping must be able to be cross walked to CWHR habitat types.

Step 2. Assign appropriate size and cover stage classes to WHA's polygons. Each CWHR habitat type is divided into sub-categories based on vegetation layers which are representative of unique attributes to which wildlife are thought to respond (CWHR 2005). They include tree dominated, shrub dominated, herbaceous dominated, aquatic and developed habitat categories. Each sub-category has corresponding structural components, such as height and canopy cover that are grouped into standardized size and stage classes (Tables 4.31 – 4.33). Size and stage classes refer to vegetation age and vigor conditions.

By standardizing size and stage classes, comparisons in suitability values may be made between different habitat types (Oxbow Environmental 2006). The CWHR habitat types Barren, Pasture and Urban do not have defined size and stage classes (Table 4.34). CWHR defines size and stage classes as structural components based on native vegetation composition and non-managed habitat (Oxbow Environmental 2006). Barren is classified as having a minimal amount of vegetation (≤ 2%) and is therefore not applicable to this classification scheme. Pasture and Urban habitat types are considered to be devoid of native vegetation (Urban) or non-managed habitat (Pasture) (Oxbow Environmental 2006), and are therefore not structurally defined by their vegetation.

Size and cover stage classes will be added to WHA polygons by adding fields to the WHA attribute table and populating those fields with the appropriate CWHR classes. The CWHR program requires data to be in classes (Tables 4.31 – 4.33); therefore quantitative field data must be converted to CWHR classes before being applied to the WHA polygons. Converting raw field data to classes is beneficial as it will reduce the problems caused by using multiple data sources collected by many individuals. Most likely monitoring data will not cover every single polygon in WHA's LORP mapping. To alleviate this problem, technicians must make estimates based on aerial/satellite imagery and comparing to existing data to add stage classes to the GIS CWHR habitat layer created in step 1.

Several monitoring data can be used to add CWHR size and stage class data to the CWHR habitat GIS layer (e.g. Irrigated Pasture Scoring, Utilization Monitoring and Range Trend).

Red-Throated Loon *(Gavia stellata)*
Pacific Loon *(Gavia pacifica)*
Common Loon *(Gavia immer)*
Pied-Billed Grebe *(Podilymbus podiceps)*
Horned Grebe *(Podiceps auritus)*
Red-Necked Grebe *(Podiceps grisegena)*
Eared Grebe *(Podiceps nigricollis)*
Western Grebe *(Aechmophorus occidentalis)*
Clark's Grebe *(Aechmophorus clarkia)*
American White Pelican *(Pelecanus erythrorhynchos)*
Double-Crested Cormorant *(Phalacrocorax auritus)*
Tundra Swan *(Cygnus columbianus)*
Greater White-Fronted Goose *(Anser albifrons)*
Snow Goose *(Chen caerulescens)*
Ross' Goose *(Chen rossii)*
Brant *(Branta bernicla)*
Canada Goose *(Branta canadensis)*
Wood Duck *(Aix sponsa)*
Green-Winged Teal *(Anas crecca)*
Mallard *(Anas platyrhynchos)*
Northern Pintail *(Anas acuta)*
Blue-Winged Teal *(Anas discors)*
Cinnamon Teal *(Anas cyanoptera)*
Northern Shoveler *(Anas clypeata)*
Gadwall *(Anas strepera)*
American Wigeon *(Anas americana)*
Canvasback *(Aythya valisineria)*
Redhead *(Aythya americana)*
Lesser Scaup *(Aythya affinis)*
Common Goldeneye *(Bucephala clangula)*
Bufflehead *(Bucephala albeola)*
Hooded Merganser *(Lophodytes cucullatus)*
Common Merganser *(Mergus merganser)*
Red-Breasted Merganser *(Mergus serrator)*
Ruddy Duck *(Oxyura jamaicensis)*
American Bittern *(Botaurus lentiginosus)*
Least Bittern *(Ixobrychus exilis)*
Great Blue Heron *(Ardea herodias)*
Great Egret *(Ardea alba)*
Snowy Egret *(Egretta thula)*
Cattle Egret *(Bubulcus ibis)*
Green Heron *(Butorides virescens)*

Table 4.29. Wildlife habitat indicator species for the Owens River Delta Habitat Area (Resident, migratory and wintering waterfowl, wading birds and shorebirds).

CWHR Habitat Type	Holland Vegetation Type	WHA Vegetation Type
Alkali Desert Scrub	Rabbitbrush scrub meadow	Rabbitbrush-NV saltbrush scrub/meadow
Desert Riparian	Modoc-GB cottonwood/willow riparian forests	Riparian Forest (cottonwood)
	Modoc-GB cottonwood/willow riparian forests	Riparian forest (willow)
	Riparian scrub	Riparian forest shrub (rose)
	Riparian scrub	Riparian shrub (willow)
Perennial Grassland	Alkali meadow	Alkali meadow
Freshwater Emergent Marsh	Transmontane alkali marsh	Marsh
	N/A	Reedgrass
	Rush/sedge meadow	Wet alkaline meadow
Riverine	Permanent lakes and reservoir	Water

Table 4.30. Sample Crosswalk CWHR to Holland to WHA

The result of step 2 is a GIS layer containing polygons depicting CWHR habitat types with stage class data. Technicians will need to export the database file (*.dbf) of the GIS layer from ArcView and import it into BioView to perform the suitability modeling.

Step 3. Run CWHR Version 8.1 with BioView using database file exported from Step 2.

CWHR Version 8.1 with BioView derives suitability values for indicator species based on habitat type and stage class data. The database file exported from step 2 must contain four fields; ID which is a unique identifier, CWHR habitat type and size and stage class. The database file exported from ArcView in Step 2 must be imported into BioView. After importing the database file suitability values can be defined for each indicator species selected by the technician. Suitability values can be derived in two formats: Standard Habitat Suitability Values and Habitat Suitability Values Using Fuzzy Logic. The major difference between Standard Habitat Suitability Values and Fuzzy Logic is Fuzzy Logic uses quantitative measurements while Standard Habitat Suitability Values relies on stage class data.

CWHR rates suitability of habitat within three potential use categories: breeding, feeding, and cover. Unlike previous versions of the CWHR program, CWHR Version 8.1 with BioView assigns a value to a given habitat type when one or two of the use types are suitable. Those habitat types with no suitability value for any of the three use categories are assigned a 0. When one or two of the use categories are suitable, a value of 1 is assigned. This distinguishes habitats that have no suitability from those that may have provided some value, although minimal. Habitat types with undefined size and stage classes (i.e. Barren, Pasture and Urban) are assigned a value of “1” for size class and “0” for stage class. This is necessary for BioView to be able to process these habitat types and calculate suitability values for each habitat type and indicator species. It is recommended that technicians adhere to the standards and guidelines outlined in CDFG 2000 and the methods for the CWHR system described in CDFG 2005. These two documents are essential reading for LORP habitat suitability modelers. The result of step 3 is one database file (*.dbf) per indicator species. The database file is compatible with ArcView and will be joined to the CWHR Habitat GIS layer created in step 2.

Step 4. Join indicator species database file, created in step 3, to the CWHR Habitat GIS layer created in step 2.

BioView is compatible with ArcView by joining the exported database file from step 3 to the CWHR Habitat GIS layer created in step 2. One GIS layer per indicator species will be created, thus it is possible that 109 (number of indicator species) individual shapefiles will be created. Each indicator species database file exported from BioView will be imported into ArcView and joined to the CWHR Habitat GIS layer created in step 2. Once joined, the shapefile will need to be saved and named per indicator species. Each polygon’s area (acres) will need to be added to each individual shapefile to determine the quantity of suitable habitat per species in the LORP. It is recommended that technicians use the

XTOOLS program to calculate the area of each polygon in each indicator species shapefile. The output from this step enables managers to examine year to year changes in the quantity and quality of habitat for indicator species in the LORP. Significant changes in an indicator species' habitat quality or quantity may warrant adaptive management action.

Sites
Indicator Species CWHR habitat suitability results will cover all physical environmental features of the LORP (Riverine-Riparian, Blackrock and Delta.) Thus, there are no actual individual sites for the indicator species' habitat monitoring.

Frequency
Indicator species' habitat monitoring will occur in years 2, 5, 7, 10 and 15.

Data Management
Designated (by Scientific Team) TL is responsible for ensuring that each of the steps described above are carried out correctly. Resultant data from BioView and ArcView applications should be saved per physical environmental feature of the LORP and per monitoring year.

Data Analysis and Reporting
Statistical Applications
Statistical applications performed for this monitoring task occur in BioView and ArcView and are outlined in the protocols section above.

Future Field Work
It should be noted that HSI models, like the CWHR, are a useful way to reduce large complex data sets to one understandable metric, but they can be flawed. The models are developed from correlations between habitat attributes and species abundance. In many cases the model assumptions are inappropriate for site-specific reasons.[19] For this reason, subsequent habitat suitability data collection efforts in the LORP should be CWHR specific and focus on standardizing the methods to best fit the CWHR model. Future field work should be focused on collecting data pertinent to the CWHR. Previous data collection efforts, specifically the Riparian Habitat Development methodology performed by GANDA, is not cost effective for such a large monitoring effort. The methodology is intensive and time consuming and not commensurate with the needs of LORP monitoring and adaptive management process. In lieu of repeating the Riparian Habitat Development methodology, quality data that specifically supports the CWHR could be collected at a fraction of the cost. Additionally, much of the data collected using the GANDA methods is duplicate data, as similar data are collected under the Range Trend, Irrigated Pasture Scoring, Utilization Monitoring and Site Scale Vegetation Assessment methods. Thus these data can be used to describe the stage classes outlined above. If these monitoring data are insufficient to inform the CWHR with BioView application then supplemental data can be collected. Supplementary data should be area and CWHR specific. A subset of the GANDA data would be most applicable for future sample sites. Any supplemental field data collection must be defined by the CWHR, as CDFG provides a field sampling protocol, which is well-established for determining stages in all vegetated habitats (CDFG 2007). Future monitoring should include taking digital photographs of sampling locations when appropriate. Special habitat elements are also defined and include live and decadent vegetation elements such as snags, physical elements such as banks and burrows, aquatic elements, vegetative and animal diet elements and human-made elements (CDFG 2007).

Reporting
Reporting will occur in each monitoring year following data collection and analysis. Staffs will prepare a report documenting the quality and quantity of habitat for each indicator species and guild by the end of September of monitoring years. The MOU consultant will use the report to make adaptive management recommendations to LADWP and ICWD management by November 1 of each monitoring year.

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[19] United States Fisheries and Wildlife Service 1982

Standards for Height Classes			Standards for Canopy Closure		
CWHR Code	**Size Class**	**Plant Height**	**CWHR Code**	**Closure Class**	**Ground Cover (Canopy Closure)**
1	Seedling Tree / Shrub	<2’	S	Sparse Cover	2-9%
2	Small Tree / Shrub	2-10’	P	Open Cover	10-39%
3	Medium Tree / Shrub	10-20'	M	Moderate Cover	40-59%
4	Large Tree	>20'	D	Dense Cover	60-100%

Table 4.31. Size (height) and stage (canopy closure) classes for the CWHR tree dominated habitat subdivision. Standards listed are relevant to the Desert Riparian habitat type

Standards for Height Classes			Standards for Canopy Closure		
CWHR Code	**Size Class**	**Crown Decadence**	**CWHR Code**	**Closure Class**	**Ground Cover (Canopy Closure)**
1	Seedling Shrub	Seedlings or Sprouts <3 Years	S	Sparse Cover	2-9%
2	Young Shrub	None	P	Open Cover	10-39%
3	Mature Shrub	1-25%	M	Moderate Cover	40-59%
4	Decadent Shrub	>25%	D	Dense Cover	60-100%

Table 4.32. Size (age) and stage (canopy closure) classes for the CWHR shrub dominated habitat subdivision. Standards are relevant to Alkali Desert Scrub habitat.

Standards for Height Classes			Standards for Canopy Closure		
CWHR Code	**Size Class**	**Plant Height at Maturity**	**CWHR Code**	**Closure Class**	**Ground Cover (Canopy Closure)**
1	Short Herb	<12”	S	Sparse Cover	2-9%
2	Tall Herb	>12”	P	Open Cover	10-39%
			M	Moderate Cover	40-59%
			D	Dense Cover	60-100%

Table 4.33. Size (height) and stage (canopy closure) classes for the CWHR herbaceous dominated habitat subdivision. Standards are relevant to Fresh Emergent Wetland and Perennial Grassland herbaceous habitats.

CWHR Habitat Type	Size Class	Stage Class
Barren	None Defined	None Defined
Pasture	None Defined	None Defined
Urban	None Defined	None Defined

Table 4.34. CWHR habitat types with no defined size and stage

4.4.4 Landscape Vegetation Mapping

Monitoring Purpose

The purpose of the landscape vegetation mapping of the Delta Habitat Area (DHA) is to document and monitor change in the water and vegetated wetlands of the Lower Owens River Delta. Future mapping of the Delta Habitat Area will be mapped from high-resolution satellite images. Landscape Vegetation Mapping helps to inform decision making for the following adaptive management areas (see Section 3.7.1): Seasonal Habitat Flows, Terrestrial Habitat, Tule/Cattail Control, Exotic/Invasive Plants, Delta Habitat Area, Range Condition and Recreation.

Baseline Data Collected

The Delta Habitat Area was mapped in 2006 using IKONOS images dated August 2005. This mapping effort, conducted by White Horse Associates (WHA) will serve as the baseline conditions for the DHA. WHA 2006 describes the rationale for mapping the Lower Owens River Delta in 2006 by stating:

> *As specified in the LORP-FEIR:*
>
> *Prior to implementation of LORP, the water and vegetated wetlands in the Delta Habitat Area will be mapped from aerial photographs … This map will serve as the description of the “Delta conditions”. The aerial photographs that will be used to develop the “Delta conditions” map (as well as those to be used in future monitoring) will be taken between June and September. The Delta Habitat Area (DHA) will be mapped from high-resolution (0.6 meter pixels) Ikonos images dated August 2005. The inventory of 2005 conditions will define the “Delta conditions”. (WHA 2006)*

Methods

In recent years mapping methods have changed dramatically with the advent of mapping software like ESRI’s ArcGIS and the widespread use of remote sensing technology (satellite imagery and digital orthophotography). These two advances in mapping technology have not only reduced the amount of time it takes to map an area, but have also increased the accuracy of maps. The advances in mapping techniques will continue in the future and thus all mapping techniques must be considered for future monitoring in the DHA. Prior to each monitoring program that contains a mapping component, the Scientific Team will perform a survey of mapping techniques, and the most cost effective and accurate technique should be identified. The Scientific Team will instruct staff or outside consultants, if necessary, to perform the mapping procedure.

The mapping methods used to collect baseline data are presented in this document. Since mapping techniques and methods are subject to change in the future based on emerging technology, future monitoring will likely involve using different methods. All mapping efforts in the LORP and specifically the DHA, should use the legend created by White Horse Associates. Although, mapping techniques continue to evolve the communities of the LORP remain constant. Thus, to retain consistency among mapping efforts that may entail different methods, White Associates legend (community types) should be adopted by in future efforts.

<u>Protocol</u>

The protocols outlined below are taken directly from WHA 2006, Delta Habitat Area Inventory 2005 Conditions. As mentioned above these protocols are subject to change with future monitoring efforts as mapping technology changes. Further information regarding these protocols can be found in White Horse Associates (2006) Delta Habitat Area Inventory 2005 Conditions.

The overall objective is to map riparian/wetland resources in the DHA. Tasks designed to achieve the overall objective are:

1. Refine spectral analysis
2. Preliminary mapping
3. Field review
4. Refine mapping
5. Report

Discrete tasks are subsequently discussed.

Refine Spectral Analysis

Preliminary spectral analyses were conducted using ERDAS Imagine (version 8.6) software and Ikonos (4 band) high-resolution (0.8 meter pixels) imagery dated August, 2005 and projected to UTM NAD83, Zone 11. Preliminary spectral analyses were conducted to identify two classes from the Ikonos imagery: 1) hydric vegetation; and 2) water. The preliminary product was a shapefile outlining areas of hydric vegetation and water covered by the Ikonos image that may serve as a basis for further stratification of hydric vegetation for selected geomorphic classes. Results of the preliminary spectral analysis of the Lake bed geomorphic class were qualified as follows:

> *The preliminary classification of hydric vegetation in the lake bed does not include sparse saltgrass communities transitional from vigorous wetlands and barren playa. These omission errors could be corrected by developing a more rigorous spectral signature specific to the lake bed.*

More rigorous spectral signatures specific to major vegetation series in the DHA (i.e., water, marsh, wet meadow, alkali meadow, Parry saltbush, rabbitbrush/Nevada saltbush and playa) were developed using supervised classifications of the 4 band Ikonos images. The refined spectral analysis served as the basis for preliminary mapping.

Preliminary Mapping

Products of the refined spectral analysis (Task 1) were edited in arc-map at scales up to 1:1,000. Parcels less than 20 square meters were dissolved based on the longest shared boundary. Each of the 3,700 + parcels was assigned vegetation series, vegetation association, landtype and water regime codes and names. Each parcel was also assigned a wetland status (wetland versus upland). Vegetation series and associations described in a previous study of the DHA (WHA 2004a) were combined as follows:

- *Alkali marsh* and *Goodding-red willow/alkali marsh* were combined as *alkali marsh complex* at the vegetation association level and *marsh complex* at the series level. Tree willows were dead or decadent and difficult to distinguish on the 2005 image. Both associations are saturated water regime.

- *Parry saltbush-Torrey seepweed* and *dune* were combined as *eolian complex* at the association level and *Parry saltbush complex* at the series level. These similar vegetation types are both upland eolian land. Dunes, distinguished by deeper sand deposits and Parry saltbush scrub are contiguous with diffuse boundaries that were difficult to distinguish on the 2005 image.

- *Playa* and *brine pool* were combined as *playa complex* at both series and association levels. These similar types of lacustrine land are unvegetated. The brine pool, parts of which are intermittently flooded, is the lowest part of the lake bed, mostly below the DHA.

The products of this task were large-scale field maps with labeled parcels and a UTM grid. Preliminary mapping was refined through subsequent tasks.

Field Review
With preliminary mapping in hand, a field review was conducted on an ATV. Map boundaries and labels were verified and/or refined based on field observations. Field observations served to further “train” the photo interpreter. About 100 photo-points were established. A GPS location and bearing was recorded for each photo-point.

Refine Mapping
Mapping was refined based on field observations by the “trained” photo interpreter using heads-up editing at scales up to about 1:1,000. The product was a refined ArcMap polygon shapefile with landtype, water regime, vegetation series, vegetation association and wetland status attributes. The shapefile is compatible with GIS shapefiles provided for other study areas in Owens Valley.

Report
A digital report was compiled as WORD (doc) and Adobe (pdf) files on disk. Access tables and Arc-View shapefiles were also compiled. Digital products may serve as a baseline for monitoring changes to the DHA in response to implementation of LORP. Principal component analyses of spectral signatures for specific vegetation types (or groups of vegetation types) may also be useful for spectral analyses of subsequent images. Products are compatible with other mapping studies completed in Owens Valley (WHA 2006a and b; 2005a and b; 2004 a, b, c, d, e, f and g) (WHA 2006).

<u>Sites</u>
The project area was identified in Delta Habitat Area Vegetation Inventory, 2000 conditions (WHA 2004a) as:

> *The Delta Habitat Area (DHA) is in the mouth of the Lower Owens River on the Owens Lake bed and includes the area between the Dust Control Road and Pipeline Corridors1, between Zones 1 and 2 of the Dust Control Project, and north of the brine pool. The north boundary of the DHA corresponds with the downstream edge of the road crossing the Owens River and linking corridors 1 and 2. The elevated corridors and dikes along the perimeters of the dust control project zones confine the north, east and west boundaries of the DHA. The southern boundary corresponds with a subtle transition from vegetated wetland confined by shallow dunes and playa to the broadly depressed, unconfined brine pool.*

The DHA is 3,578 acres.

<u>Frequency</u>
Landscape Vegetation Mapping of the Delta Habitat Area will occur in monitoring years 3, 4, 6, 8, 9, 11, 12, 13 and 14.

<u>Data Management</u>
Store the digital imagery obtained in its original media format (CD-ROM or DVD) (which will not be modified) on the project server located at LADWP’s Bishop office (for use in analysis). Store the vegetation classification maps derived from the imagery as ESRI shapefiles on the project server.

Data Analysis and Reporting

Statistical Applications

In addition to the analyses described in the methods section above, generate summary statistics for each monitoring year. Present descriptive statistics like acres of vegetation type, landtype and water regime for the reach, lease and management area scales. Calculate the difference in acres of each vegetation type and water regime. Measure patch diversity per lease or other management unit using the Shannon-Weiner diversity index (H') (Shannon index).

The Shannon index is calculated as:

$$H' = - \sum_{i=1}^{s}(p_i)(\ln p_i)$$

Where S = # of acres per reach, p_i = the proportion of S consisting of the i^{th} community.

GIS Applications

See above.

Reporting

Reporting will occur in each monitoring year following data collection and analysis. The MOU Consultant will review this information and prepare adaptive management recommendations to be presented to LADWP and ICWD management.

4.4.5 Wetland Avian Census

Monitoring Purpose

The purpose of the wetland avian census is to track the development and maintenance of habitat conditions within the Blackrock Waterfowl Habitat Area (BWHA) and the Delta Habitat Area (DHA) that attract resident and migratory waterfowl and shorebirds, as well as other indicator species. The staff will conduct area count and point count surveys of waterfowl and shorebirds to assess habitat conditions. Avian census data help to inform decision making for the following adaptive management areas (see Section 3.7.1): Terrestrial Habitat, Delta Habitat Area and Range Condition.

No thresholds or triggers have been identified with regard to the results of bird monitoring data.

Adjustments to the timing of flows or releases, the decision to begin a drying/wetting cycle or other management actions may be made based on the response of bird species.

Baseline Data Collected

Wetland avian surveys were conducted in the BWHA and the DHA to document baseline conditions with regard to the bird species using these areas, their habitat associations and when possible, the breeding status of these species. These surveys include a combination of point count methods and area searches. Staffing limitations have restricted the total number of surveys conducted at each site and may limit the scope of the project in the future. Surveys were conducted by LADWP staff, ICWD staff and local volunteers. LADWP staff provided training for volunteers and ICWD staff on field methodology.

Six surveys of both wetland areas were completed between April 2002 and January 2003. The surveys conducted during this first year of baseline were well-spaced throughout the year and provided an inventory of bird use in each area in late-April, late-May, mid-June, mid-August and mid-October and the end of January. The late-April and mid-August survey dates were selected with the purpose of detecting migrant shorebirds. The late-May and mid-June surveys were selected to detect breeding species, while the October and January dates were selected to detect migrating and wintering waterfowl species, respectively.

Following an evaluation of the data from the initial baseline inventory effort, LADWP staff recommended increasing the survey effort in order to increase detection of waterfowl and shorebirds during spring and fall migration periods. This increased effort involved four spring surveys at two-week intervals starting the end of March/beginning of April and ending mid-May. Two surveys in June were conducted to detect or confirm breeding. Five fall surveys were conducted at two-week intervals starting the first week of August and ending the end of September. Due to staff limitations, both the

BWMA and DHA could not be surveyed simultaneously. As a result, in 2004, eleven surveys were conducted in the BWMA, while the DHA was surveyed at this increased sample effort in 2005.

The specific data recorded during each survey included the species and number of individuals observed, the activity the bird was engaged in and the habitat being used and observations that either confirmed or suggested breeding.

After the 2002/2003 surveys, the habitat types used for documenting habitat use were changed to correspond to the vegetation mapping conducted by White Horse Associates (White Horse Associates 2004, 2004a). A crosswalk was developed in order to incorporate the 2002/2003 data on habitat use into the categories used in 2004/2005.

Methods

Following the initial year of baseline monitoring, slight modifications were made to the protocol. These changes involved standardizing the method of recording breeding observations, a change in the habitat classification system used and a refinement in the recording of the location of the bird, relative to the observer. The methodologies presented below represent the current protocol, with all changes incorporated.

Protocol

Conduct survey routes as point count surveys or area counts. Point count surveys involve observation and recording from a fixed location for an established amount of time. Area counts involve continuous walking of the survey route. Record all birds encountered along the route as they are encountered. Because birds seen between point count stations are also recorded when conducting point counts, the data can be considered comparable to that obtained during area count survey. Point count surveys are preferred as they may allow the observer to detect more species and observe additional behaviors that might otherwise be missed by continuous walking along the survey route.

Conduct point count surveys at each permanent station, which were established during the 2003-2004 surveys. Point counts are five minute in duration. Observer is to record species or individuals seen between points, if observer is certain that the species or individual had not been already been recorded. If only one observer is available, conduct area count surveys, as carried out in the DHA in 2005. Conduct surveys within one hour of local sunrise time. Alternate the starting point for each transect with each visit. Do not conduct surveys during heavy rain or excessive winds. Take digital photographs of sampling locations when appropriate. Complete each survey within 5 hours and complete all six survey routes in the BWHA and DHA within one to three days of each other. Three person-days are required to complete the four BWMA routes: 1) one person day for the Thibaut route, 2) one person to complete the Winerton route plus the northern part of Wagoner 3) one person day to complete Drew plus the southern part of Wagoner. For the two Delta routes, two person days are required. Survey the two Delta routes on the same day and in the same direction on those days (i.e., both observers survey north to south on one visit, then south to north the next). One surveyor is needed to conduct area count surveys of the DHA by walking both survey routes in one day. Alternate starting location (either Delta West or Delta East route) between surveys.

Record bird activity and the habitat the bird was using at initial detection using the habitat types listed below. Define bird activity as: singing, calling, flying, flyover, foraging, perching, breeding or flushed. If bird activity is "breeding", use one of 10 breeding codes to document the specific evidence of breeding seen. Some examples of breeding codes include "FC" for food carry and "MC" for material carry. The breeding observations codes are the same as those used by Heath and Gates (2002).

<u>Habitat Types Used in Monitoring</u>

Code Habitat

1. <u>Mud flat</u>
2. <u>Shallow Open-water wetland</u> – use this code if the bird is in or on the water; a shallow open-water wetland would be a shallow pond that has

short sedges or rushes that have developed around the wetland.

3. Deep Open-water wetland– use this code if the bird is in or on the water; a deep open water wetland would be indicated by the presence of cattails or tules surrounding the water.
4. Emergent – essentially marsh vegetation; use this code if the bird is using tules, cattails or other tall to medium height sedges.
5. Wet Alkali Meadow – generally characterized by lush growth of saltgrass, rushes and sedges; saltcedar may be present; this habitat type is semi-permanently flooded, seasonally flooded or just saturated; may not be wet on the surface at all times of the year, but distinguished from dry alkali meadow from more lush growth and a greater variety of plants.
6. Dry Alkali Meadow – dominated by saltgrass; vegetation cover is generally low (20-70%); may be seasonally flooded.
7. Seasonal wetland– natural depressions that are seasonally inundated with water.
8. Open herbaceous flooded – herbaceous vegetation (e.g., sunflower, alkali mallow) that has sparse vegetation and is flooded; this vegetation type will be infrequently encountered, but may occur at the edges of seasonal wetlands or areas of emergent vegetation.
9. Open herbaceous not flooded – like the above but not flooded.
10. Closed herbaceous flooded – like open herbaceous flooded, but herbaceous vegetation is more dense and forms a closed canopy.
11. Closed herbaceous not flooded – like closed herbaceous but not flooded.
12. Playa – alkaline areas on the Owens lakebed that are dry.
13. Playa flooded – alkaline areas on the Owens lakebed that are flooded.
14. Alkali Sink Scrub – shrublands composed of Saltbrush (*Atriplex* spp.), Greasewood (*Sarcobatus*), Inkweed (*Suaeda*); generally occurs in more alkaline locations than Great Basin Scrub.
15. Great Basin Scrub – this includes shrublands composed of Great Basin Big Sagebrush (*Artemisia tridentada*) and/or rabbitbrush (*Chrysothamnus nauseosus*); the amount of grass understory present may vary considerably.
16. Riparian –includes riparian scrub stands (e.g., coyote willow) or tree willow stands along river or stream courses; if the bird is using a lone willow tree in the middle of a wet alkali meadow, the habitat type would be WAM, but put “willow” in notes column.

Sites

Ecosystem Sciences initially identified general survey routes (also referred to as transects) for the Blackrock and Delta Areas. Permanent point count stations were selected by LADWP and ICWD personnel along each route using a handheld Garmin GPS V unit. Point count stations are a minimum of 250 meters apart and up to 300 meters apart in very open habitats. The GPS locations were downloaded into an ArcView database file and overlaid onto year 2000 aerial photos of each area. These point count stations are marked with a white-tipped green fence post and an aluminum tag identifying the project (LORP AVIAN), the management area and the point number (e.g., “THIBAUT_4”).

Blackrock Waterfowl Management Area Transects

Each of the four Blackrock Area management units (Figure 2.5) includes one transect, with a total of forty five point count stations: Drew (8 stations), Winerton (9 stations), Waggoner (13 stations) and Thibaut (15 stations).

Owens River Delta Habitat Area Transects

The Owens River Delta area (Delta West and Delta East, Figure 2.6) includes two transects. The Delta West transect follows the west side of the Owens River channel, from the powerline crossing to approximately 300 meters past the last point of vegetation, based on 2002 conditions and therefore includes some of the “delta-to-brine pool transition area”. The Delta East route follows the east arm of the river, then traverses the extensive alkaline meadow habitat east of the river channel and ends at the current confluence of the east delta area and the Owens River channel. The Delta West transect consists of 25 point count stations, while the Delta East transect has 17 stations, for a total of 42 stations in the Owens River Delta area.

Frequency
Avian census will be conducted on monitoring years 2, 5, 7, 10, 15 (monitoring year 2 is 2010). Census all avian points three times during the peak breeding season (approx May 25 – June 30), with each of the three censuses at least 10 days apart.

Conduct vegetation data collection during the breeding season of the first year of any point count project and as often as possible after that (usually not more than once per season). In stable habitat types it may only be necessary to do sampling every few years, while in flood, burn or restoring habitats it is generally necessary to do them each season. If new sites are added to a project, sample them the first year and then on the same schedule as the other stations.

Data Management
The Task Leader is responsible for collecting all completed field forms and delivering them to LADWP offices in Bishop in person. Assign all original field forms with document control number. Field forms are filed and retained for a minimum of 15 years at LADWP offices in Bishop. In addition to retention of hard copies, all field forms are scanned and retained in an electronic format (e.g., PDF) for the life of the project on a hard drive at LADWP offices. Persons conducting the surveys should be able to identify all regularly-occurring species, especially wetland bird species, by sight and sound. The Task Leader is to confirm the qualifications of surveyors. Surveyors should receive training on the methodologies prior to conducting surveys. Training is conducted in the field by the Task Leader before the first sampling activity or as needed.

Quality assurance activities for the wetland bird monitoring project consists of the following:

- At the survey site, surveyor reviews field forms to ensure that they are complete, legible, accurate and in standard format. Errors are corrected with a line drawn through them and replaced with the correct term or value. Qualify data considered as suspect using a flag variable.
- Staffs enter the data into spreadsheets in tabular form and record their name on the original field form. Staffs entering the data are responsible for reviewing for and correcting any data transcription errors.
- Task Leader reviews all flagged suspect data and makes the ultimate decision of excluding any data from use in further analysis.

Data Analysis and Reporting
Statistical Applications
Apply statistical tests appropriate to the data type to the bird monitoring data. Staffs may analyze data in terms of trends in bird species diversity, percent composition of habitat indicator species, total detections of habitat indicator species and habitat use versus availability. Use data on bird habitat selection, season of use and pattern of use (foraging, nesting, etc) to evaluate the response of birds to management activities.

GIS Applications
The locations of each point count station will be transferred to aerial photos in order to provide visual representation of survey activities. Bird use data may be useful in modeling the effects of various land management activities through time; however this potential aspect of the project has not been explored to date.

Reporting
Staffs are to prepare and submit monitoring results to the MOU Consultant by the end of September of each monitoring year. The MOU Consultant is to present results and conclusions as well as recommended adaptive management prescriptions to ICWD and LADWP management by the first of November.

4.5 Off-River Lakes and Ponds Monitoring

Off-River Lakes and Ponds are maintained to sustain diverse habitat for fisheries, waterfowl, shorebirds and other animals. Flow and wetland area monitoring uses staff gage measurements to ensure sufficient water surface elevations in the Off-River Lakes and Ponds identified and described in Section 2.1.4 and displayed in Figures 2.7.

4.5.1 Flow and Wetland Area Monitoring

Monitoring Purpose

Flows are monitored in the Off-River Lakes and Ponds to ensure sufficient water levels to maintain the existing lakes and ponds and meet MOU requirements as described in Section 3.20. Flow and wetland area monitoring will help to inform decision making for the following adaptive management areas (see Section 3.7.1): Terrestrial Habitat, Tule/Cattail Control and Lakes and Ponds.

Baseline Data Collected

Baseline data collected for Off-River Lakes and Ponds include water surface elevations.

Methods

Off-River Lakes and Ponds flow compliance monitoring is described in the Ecosystem Management Plan and FEIR.

Protocol
Staff is to record the water surface elevation of the Off-River Lakes and Ponds using staff gage measurements. Water levels are to be maintained according to the following levels:

- Upper and Lower Twin Lakes: Maintain existing staff gages between 1.5 and 3.0 feet.
- Upper and Lower Goose Lakes: Keep the lakes at levels between 1.5 and 3.0 feet in order to provide spill over and a continuous spill to the river.
- Billy Lake: Keep Billy Lake full in order to maintain a continuous spill to the river.
- Thibaut Ponds: Keep the ponds full.
- Coyote/Grass Lakes: Keep the lakes at the existing levels.

Monitor the existing staff gages at the Coyote/Grass Lakes, Billy Lake, Upper and Lower Twin Lakes and Upper and Lower Goose Lakes and install new gages at the perimeter of the existing inundated area at the Thibaut Ponds. Record UTM coordinates of staff gage locations in the field using a GPS unit upon initial installation and at each sampling event.

Photograph newly installed gaging stations, associated equipment and general site conditions to document baseline field conditions. Document any substantial change in site conditions observed during field inspection or equipment calibrations in field notebooks.

Sites
Staff gages are located at the Upper and Lower Twin Lakes, the Coyote/Grass Lakes complex, Upper and Lower Goose Lakes and Billy Lake.

Frequency
Take staff gage readings weekly for the first year of project implementation. In subsequent years, reduce the frequency if monitoring from the first year indicates water levels in the lakes and ponds are relatively stable. Continue monitoring throughout the 15 year project.

Data Management
At the sample site, field forms are reviewed by someone other than the data collector to ensure the data are complete, legible, accurate and in standard format. Errors are noted and replaced

with the corrected term or value. Staffs enter the staff gage data and other pertinent information into spreadsheets in tabular form and record their name on the original field form. The Task Leader performs weekly and randomized reviews of spreadsheets to verify accurate transcription of data and to identify suspect data. Follow all data quality control activities described in Section 4.1.1.

Data Analysis and Reporting

Statistical Applications
Calculate the average water surface elevation weekly along with the monthly and annual mean, median, maximum and minimum.

GIS Applications
No GIS applications are required for the Off-River Lakes and Ponds monitoring.

Reporting
Report staff gage data weekly in the initial year of restoration. Reduce the reporting frequency if monitoring indicates water surface elevations remain stable over time.

4.5.2 Rapid Assessment Survey

Monitoring Purpose

Rapid Assessment Surveys (RAS) are conducted to document problems or potential management issues in LORP Off-river Lakes and Ponds area and provide qualitative project-level feedback regarding changes within the project area. The intent of the RAS is to identify management issues during intervals between monitoring years and between monitoring sites before they manifest themselves into larger, more expensive management problems. The results of the RAS are primarily used to alert project managers to areas of special concern or land use impacts that may not be compatible with goals of the LORP. Rapid Assessment Surveys help to inform the following adaptive management areas (see Section 3.7.1): Fishery, Terrestrial Habitat, Tule/Cattail Control, Exotic/Invasive Plants, Range Condition, Lakes and Ponds, Delta Habitat Area and Recreation.

Baseline Data Collected

Baseline RAS data were collected for the Off-river Lakes and Ponds area from August 14 to September 6, 2007. Data compilation, data analysis, and report writing took place in September and October for the same year. Baseline data were collected following the protocols described below.

Methods

Protocol
Train personnel on data collection protocol, sensitive plant species identification, impact record decision making, map and GPS use. Personnel should have the following items available for use in the field:

1. Four wheel drive vehicles
2. Handheld GPS units (extra batteries)
3. Digital cameras (extra batteries)
4. The following data sheets: Rapid Assessment Datasheet, Tamarisk Documentation Form and Noxious Weed Reporting Form.
5. Clipboard and writing utensils
6. Field maps including aerial imagery of the day’s survey route, with pertinent features including fencelines, lake and pond shapefiles, as well as a colored pen for making notes on maps.
7. Noxious weed habitat and morphology descriptions and photographs (see the noxious weed ratings table in Appendix A.6).
8. Waypoints of areas of management interest that need to be revisited as well as river and river mile shapefiles loaded on to GPS units.
9. Plastic bags for plant samples.
10. Cell phone or two-way radio for communication.

Technical staff should turn the tracking function on their GPS units on with the tracking function set at 0.01 km or “normal or more frequent than normal” sensitivity settings. As workers walk along their assigned route, they should scan the floodplain for the including but to limited to the following impacts: Recreation impacts (including new or those located near sensitive habitats), damage to livestock fences, beaver activity, the presence of noxious weeds and areas of new woody recruitment. Survey each off-river lake or pond on foot or in a vehicle, if necessary, generally following the water's edge, while examining as much of the unit as possible. For example, if a tamarisk stand is spotted in the unit, but away from the water's edge, workers should walk to the stand and document the stand on the appropriate data sheet.

Take a GPS point at each area of management concern. Record each point on the appropriate data sheet (described below) and assign the appropriate impact code. To save time in the field, use the GPS point name automatically assigned by the GPS unit. Record detailed notes on each point as appropriate. Areas of interest not accessible by foot or those that are large and contiguous may be recorded with one point and the extent of the area drawn on field maps. Take photographs of areas of interest or management concern as needed. Set the camera to the high resolution setting. Examples of situations in which a photograph is appropriate include the documentation of visible impact from roads, proximity of roads to sensitive habitats, obstructions in the running channel, proximity of tamarisk slash piles to lake and pond habitats, woody recruitment or conditions supporting weed infestations. Record the reason the photograph was taken, its digital file name assigned by the camera, the GPS point associated with the photograph and the information the photograph is meant to relay.

Three data sheets are required for the RAS. Record the following general information on each data sheet include the date observer(s), the field map associated with the data, the area or river mile surveyed and the beginning and ending time of the survey. The information recorded on these data sheets is described below.

Rapid Assessment Data Sheet

The Rapid Assessment Data Sheet is used to document all impacts or area of interest except for tamarisk plants. Note the impact code associated with each impact. Use the following impact codes: Noxious weeds (EXW), Recreation (REC), Beaver Activity (BEA), Fencing (FEN), Livestock Management Issues (GRZ), Woody Recruitment (WDY) or other (OTH). These impacts are described below.

Woody Recruitment

Record any native woody recruitment sites encountered. Take general notes on recruitment patches including number of individuals, approximate height, site conditions and the presence of non-native species such as tamarisk. Woody species of particular interest include all willow species [e.g. Goodding's Black Willow (*Salix gooddingii*), Red Willow (*S. laevigata*), Coyote Willow (*S. exigua*)] and Fremont cottonwood (*Populus fremontii*).

Recreation

Record adverse impacts associated with recreation observed outside of established "recreation areas" such as parking areas and fence walk-throughs. Examples of these impacts include off-road motorized vehicle travel, trash, vandalism of signs and evidence of overnight camping. In addition, record all roads within the Off-river Lakes and Ponds area that allow access to the floodplain.

Beaver Activity

Beaver activity can include dams, tree cutting, huts or other evidence of beaver activity such as excessive pooling of water. Note observations of these activities on the data sheet and take a GPS point. Evidence may include but not be limited to fresh chew marks on trees, fresh material on dams or fresh material on huts. In some situations, beaver dams may not be visible, but the sound of falling water over the top of a dam may be heard or the pooling of water behind the dam may be observed. Beaver often respond to the presence of humans by slapping their tails against the water. Record indirect evidence of beaver activity such as these.

Fencing

Record any vandalism or damage to fences. Identify if the fence has been cut, impacted by wildlife or livestock or is old and in disrepair due to age. Assess whether the repair is high priority based on the presence of livestock in the area, visible impacts or proximity to lake and pond habitats. If recreators, anglers or livestock appear to be repeatedly accessing the floodplain at a given point, note the need for an additional access point (walk-through or wildlife crossing point). If true fence lines differ from those on field maps, note the true location for database improvement or fence construction.

Livestock Management Issues
Document livestock management issues such as presence of livestock or supplement sites in the floodplain, excessive trampling of vegetation, excessive high lining of vegetation or water gaps where livestock are trampling streambanks to access water.

Other
Record and describe other impacts as necessary. Other impacts may include presence of tamarisk slash piles on the river banks or in the channel, burned areas or evidence of wildlife utilization of the floodplain. Workers should use their judgment to discern if an impact should be recorded.

Tamarisk Documentation Form
Tamarisk is the most widespread and common noxious weed found within the LORP area. For this reason, record all tamarisk in all life stages and forms on the tamarisk Documentation Form. Record the distance form the river to the plant, the number of plants associated with the GPS point, whether the plant is a resprout, a seedling or a fully grown plant and the approximate height. Record any other pertinent information in the notes column.

Noxious Weed Reporting Form
Record any noxious weed encountered that is listed by the California Department of Food and Agriculture as "A" or "B" (see the noxious weed ratings table in Appendix A.6). Review the noxious weed's morphology and habitat preferences before going into the filed, and bring this information into the field to aid with identification. Take a photograph of every noxious weed occurrence. Take samples and store them in plastic bags if necessary.

Sites
Perform RAS at all of the Off-river Lakes and Ponds.

Frequency
Perform the RAS once per year in July or August for the first 10 years following implementation. After the first 10 years, assess whether the RAS should continue into the future.

Data Management
Check field data sheets for completeness by field personnel as well as the TL. Each field person is responsible for downloading the GPS and digital camera data and on a daily basis. This information should be sent electronically to the TL for compilation. The TL should assign each data sheet with a control number in a consistent manner with the prefix "RA." Tamarisk documentation forms should have the suffix "TARA." Photocopy and scan every data sheet for storage at the LADWP office in Bishop. Transmit GPS track and waypoint files electronically to ICWD.

Data Analysis and Reporting

Statistical Applications
There are no applicable statistical applications for the RAS.

GIS Applications
Transfer all spatial data to ArcGIS platform and save as ArcGIS shapefiles. Create ArcMap documents for each management area. Hand-digitize notations and drawings made on field maps.

Reporting
The TL is responsible for utilizing staffs to compile and produce a draft report at the conclusion of the survey of each monitoring year. The report will include maps showing all pertinent data, a summary of findings. The MOU Consultant will review this information with the advisory committee and present its recommended adaptive management actions to ICWD and LADWP management by the first of November, annually.

In addition, ICWD will fill out noxious weed location forms and send them to Inyo/Mono County Agricultural Commissioner's Office. The TL will send tamarisk locations and information to the ICWD tamarisk control project manager and fill out and send LADWP

Fence Repair Request Forms LORP Project Manager.

4.5.3 Creel Census

Monitoring Purpose

The creel census helps track the development and health of the warm-water or game fishery (ponds, lakes and slow moving streams) as the LORP is implemented. Creel census data help to inform decision making for the Fishery and Delta Habitat Area adaptive management areas (see Section 3.7.1). It provides information about the abundance and distribution of game fish throughout the LORP area. Fish habitat within the LORP includes the river channel, oxbows, side channels, off-channel lakes and ponds, springs and artesian well ponds. The main purpose of this creel census is to evaluate the response of game fish populations to managed stream flows over time and to document compliance with LORP warm-water fisheries goals. The data collection for the creel census to determine baseline conditions have been completed. Future monitoring will be conducted using the same methods that were used to establish baseline conditions and are described below.

This census only follows the development and condition of the recreational fish population and does not track the status of the native fish population. Key fish species included in this census include:

- Largemouth Bass (*Micropterus salmonides*)
- Smallmouth Bass (*Micropterus dolomieui*)
- Bluegill (*Leopomis machrochirus*)
- Channel Catfish (*Ictalurus punctatus*)
- Brown Trout (*Salmo trutta*)

Information on the following native species is not included: Owens Sucker (*Catostomus fumeiventris*), Owens Pupfish (*Cyprinodon radiosus*), Owens Tui Chub (*Gila bicolor snyderi*) and Owens Speckled Dace (*Rhinichthys osculus*).

The fishing census covers the Lower Owens River from the LAA Intake diversion structure downstream to and including, the storage pool behind the pumpback station dam; it also includes off-river lakes and ponds managed as fisheries within the LORP area.

Baseline Data Collected

Baseline data collection for the creel census was performed in 2003. Creel census baseline data included:

- Recreational fish counts and distribution data;
- Fish size, sex, species, health and length.
- Digital photographs of fish and sampling locations when appropriate.

Methods

<u>*Protocol*</u>
The fisherpersons used for the creel census are volunteers as directed by the Scientific Team. The 24 volunteers are assigned a numerical identification number. To help reduce bias caused by competition among participating volunteers, fisherperson information and all results reported are referenced by identification number only. If for some reason it becomes unmanageable to keep 24 volunteers, then the Scientific Team may decide to pay the fisherpersons a nominal fee.

Assign each volunteer the same fishing area each year and to use the same fishing technique. Direct volunteer fisherperson about how to participate in the fishing census, how to measure and identify fish caught, how to rate the condition of each fish caught, how to record the information on data forms provided and where to send the information forms for analysis.

Each of the 24 volunteers can fish within only one of the five selected fishing areas, unless that fisherperson volunteers for two or more fishing slots, in which case s/he would receive two or more fishing identification numbers. Five volunteers are assigned to fish in each of the fishing areas, except Area #5, which only uses four volunteers.

Each volunteer fishes twice in the spring (during May) and twice in the fall (during September). The first spring fishing period is from May 1 through May 15, with each volunteer fishing one day during this period. The second spring fishing period is from May 16 to May 31, with each volunteer fishing one day during this period. The first fall fishing period occurs between September 1 and September 15, with each volunteer fishing one day during this period. The second fall fishing period occurs between September 16 and September 30 with each volunteer fishing one day during this period. No census fishing can occur during any period outside of May and September.

Volunteers fish 3.5 hours on each fishing day. All fish caught by volunteers during the census period are released alive in the area they were caught. Volunteers must abide by all applicable State of California fishing rules and regulations.

During each of the census days, volunteers can fish only within his or her assigned area during the day of fishing. They can, however, fish anywhere within that assigned area. As mentioned above, a fisherperson may volunteer to fish in more than one area. This is allowed because it may be difficult to find and hold 24 volunteers over the life of the census period.

The 3.5 hours that each volunteer can fish on each fishing day can be used up at one time or spread out over the fishing day, but cannot exceed 3.5 total hours. Two fishing days per designated month (May and September) by each volunteer are needed to fulfill the fishing requirements. With 24 volunteers fishing 3.5 hours each, four times a year, the total annual fishing sample size used to determine fishing census statistics is 336 hours plus 56 hours from double fishing (Fisherpersons 1# through #4) for a total of 392 hours. All volunteers must adhere to appropriate California State fishing regulations.

Sites

The LORP area was stratified into five separate fishing areas for the creel census (See Figure 4.8). Four of the fishing areas are located on the Lower Owens River while the fifth covers designated off-channel lakes and ponds. Figure 4.8 illustrates and describes in detail the location of these fishing areas. Volunteer identification numbers for each of the five fishing areas are as follows:

Area #1 --- (From pumpback station dam upstream to the Lone Pine Station Road)
Fisherperson #1 – Fish with any type of fishing gear except bait
Fisherperson #2 – Fish with any type of fishing gear except bait
Fisherperson #3 – Fish with any type of fishing gear except bait
Fisherperson #4 – Fish with bait only
Fisherperson #5 – Fish with bait only

Area #2 --- (Owens River from the Lone Pine Station Road upstream to the Manzanar-Reward Road)
Fisherperson #6 – Fish with any type of fishing gear except bait
Fisherperson #7 – Fish with any type of fishing gear except bait
Fisherperson #8 – Fish with any type of fishing gear except bait
Fisherperson #9 – Fish only with bait
Fisherperson #10 – Fish only with bait

Area #3 --- (Owens River form Manzanar-Reward Road upstream to the Mazourka Canyon Road)
Fisherperson #11 – Fish with any type of fishing gear except bait
Fisherperson #12 – Fish with any type of fishing gear except bait
Fisherperson #13 – Fish with any type of fishing gear except bait
Fisherperson #14 – Fish with bait only
Fisherperson #15 – Fish with bait only

Area #4 --- (Owens River from Mazourka Canyon Road upstream to the Aqueduct Intake)
Fisherperson #16 – Fish with any type of fishing gear except bait
Fisherperson #17 – Fish with any type of fishing gear except bait
Fisherperson #18 – Fish with any type of fishing gear except bait
Fisherperson #19 – Fish with bait only
Fisherperson #20 – Fish with bait only

<u>Area #5 --- (Upper and Lower Twin, Billy and Goose Lakes)</u>
Fisherperson #1 and #21 – Fish Upper Twin Lake with any type of fishing gear
Fisherperson #2 and #22 – Fish Lower Twin Lake with any type of fishing gear
Fisherperson #3 and #23 – Fish Goose Lake with any type of fishing gear
Fisherperson #4 and #24 – Fish Billy Lake with any type of fishing gear

Fisherpersons #1 through #4 have to volunteer to donate the time needed to fish 8 days per year. Fisherpersons #1 through #4 have to fish both the Owens River and designated lakes and ponds.

Frequency
The creel census is being conducted on monitoring years 2, 5, 7, 10, 15 (monitoring year 2 is 2010). The baseline census year (2003) covered only the wetted river areas and designated lakes and ponds that supported a fishery. Data collected during the census year prior to the implementation of LORP activities provided the baseline data, which will be useful for comparing data acquired after the implementation of the LORP.

Data Management
Each volunteer must record their daily fishing results on the census forms provided. Each fishing census includes: fisherperson identification number, area fished, number of fish caught, fish catch rate per hour, individual fish size, average fish size, maximum and minimum size, species caught, fish health and individual fish total length (to the nearest inch-from the tip of the nose to the end of the tail). If the fish caught looks healthy and robust, the fish is recorded as being in good condition (GC). If the fish is overly thin, looks sick or contains any body damage or lesions, the fish is recorded as being in poor condition (PC).

Data Analysis and Reporting

Statistical Applications
Statistical test appropriate to the data type will be applied, but analysis will focus on trends.

GIS Applications
None required.

Reporting
After each seasonal census effort, Staffs are to prepare a report summarizing creel census results. The MOU Consultant reviews the results and any associated analyses and prepares adaptive management recommendations and presents these to ICWD and LADWP management by the first of November.

4.6 Land Use Monitoring

The MOU requires that land management plans be developed for LADWP-owned lands to address livestock management issues and develop livestock management guidelines to support LORP goals and objectives. The Owens Valley Management Plan contains grazing prescriptions for LADWP leases within the LORP area. It is designed to guide LORP actions and to comply with MOU requirements along the river, in the Blackrock Waterfowl Habitat Management Area and in the Delta Habitat Area. The plan focuses on enhancing native habitat diversity while allowing for sustainable grazing. It addresses riparian areas, irrigated pastures and areas with sensitive species or habitats. The seven leases in the LORP area include: Twin Lakes, Blackrock, Thibaut, Independence, Islands, Lone Pine and Delta.

This section details the three types of monitoring that will take place that are directly related to the management of livestock grazing: irrigated pasture condition scoring, utilization and range trend. Irrigated pasture condition scoring is a tool used by managers to systematically track the condition of irrigated pastures. Utilization monitoring tracks the amount of biomass removed from non-irrigated fields. Range trend tracks the long-term effect of grazing and grazing management prescriptions on the grazing resource. The use condition of lands leased for grazing in the LORP area will be monitored according to protocols laid out in this document. This section describes the parameters to be measured, monitoring methods and reporting mechanisms.

The land management plans establish livestock management guidelines which include grazing utilization standards and/or modifications to the timing or length of use of various fields and irrigated pastures. The plans also include livestock management guidelines such as where to place watering troughs or supplements. These management actions serve to accomplish the objectives of holistic resource management for multiple benefits.

It is important to note that monitoring results of grazed areas will be reported (by Staffs) by lease to the MOU Consultant, which will include this information plus adaptive management recommendations to ICWD and LADWP management. In this way, managers will be able to perceive resource condition differences that may be the result of grazing activities that occur on a particular lease. The Scientific Team will assist by directing Staffs to report data accordingly.

4.6.1 Irrigated Pasture Condition Scoring

Monitoring Purpose

Irrigated pastures are classified as any portion of the lease where the lessee receives an irrigation duty and is charged an additional fee for this irrigation. As appointed by the Scientific Team, Staffs and the lessees will jointly determine irrigated pasture condition using the Natural Resource Conservation Service (NRCS) Pasture Condition Scoring system (See Appendix A.5). The NRCS Pasture Condition Scoring system systematically evaluates pasture health and the effectiveness of management in terms of optimizing plant and livestock productivity while minimizing detrimental effects to soil and water resources. Irrigated Pasture Condition Scoring helps to inform decision making for the following adaptive management areas (see Section 3.7.1): Seasonal Habitat Flows, Terrestrial Habitat, Water Quality, Range Condition and Recreation.

Baseline Data Collected

Baseline irrigated pasture condition scoring data were collected on all LORP leases in order to provide feedback to lessees about current (pre-project) conditions. Knowledge of pre-project pasture conditions may ease the transition to compliance with standards. This baseline period also allowed LADWP staff to refine data collection methodology and develop the tools to effectively and efficiently monitor long-term pasture condition trends. The methods described below represent the current and planned monitoring methods.

Methods

Although neither the Ecosystem Management Plan nor the FEIR include the protocol, Pasture Condition Scoring is included here as a monitoring strategy because it is an efficient and systemized way of tracking long-term pasture health.

Protocol

Field crews walk random transects throughout the entire irrigated pasture or through the entire area of a pasture that is irrigated. Generally, walk the boundary of a pasture first and then crisscross the interior of the pasture. This allows the raters to evaluate the entire pasture and all factors that contribute to the score including the condition and location of irrigation structures and the condition and distribution of the livestock. Topics that are scored include:

- Percent desirable plants
- Plant cover
- Plant residue
- Plant diversity
- Plant vigor
    - Soil fertility
    - Severity of use
    - Site adaptation of desired species
    - Climatic stresses
    - Soil pH
    - Insect and disease pressure
- Livestock concentration areas
    - Uniformity of use
- Erosion
    - Sheet and rill
    - Streambank, shoreline and gully
    - Wind
- Percent legume
- Soil compaction

When the evaluation team has completed their walking assessment, each indicator is scored, the scores are totaled and an overall score is assigned for the pasture. Not all 10 indicators may be appropriate for use in every pasture. In this case, using less than 10 indicators will reduce the possible score, but the percent rating will still be comparable. Take digital photographs of pasture condition when appropriate.

Sites

Each irrigated pasture or that portion of a field that is irrigated is evaluated in its entirety.

Frequency

Annually monitor pastures below the minimum 80 percent score. Pastures between 80 and 90 percent are to be monitored bi-annually. Pastures scoring over 90 percent will be evaluated every 5 years.

Data Management

There are no data management protocols exclusive to pasture condition scoring. See Section 4.1.1 for data management direction. It is the responsibility of the TL to ensure that all data management direction is followed. If problems are encountered, TL is to solicit the Scientific Team for further direction.

Data Analysis and Reporting

Statistical Applications

Pasture condition scoring involves the visual evaluation of 10 indicators, each having five environmental conditions.[20] Rate each indicator separately and combine the scores to get an overall score for the pasture. The overall score for a pasture can then be divided by the total possible score to give a percent rating (overall score ÷ total possible score × 100 = percent rating).

GIS Applications

There are no applicable GIS requirements for irrigated pasture condition scoring.

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[20] Cosgrove et al., 1991

Reporting

Compile data for each pasture evaluated in the Irrigated Pasture Condition Database. TL is to report monitoring results annually (where applicable) by the end of September. The MOU Consultant is to summarize the results and make adaptive management recommendations to ICWD and LADWP management by the first of November each year.

4.6.2 Utilization Monitoring

Monitoring Purpose

The Owens Valley Management Plan developed as part of the LORP identifies grazing utilization standards for upland and riparian areas. Utilization is defined as the percentage of the current year's herbage production consumed or destroyed by herbivores.[21] Grazing utilization standards identify the maximum amount of biomass that can be removed by grazing animals during specified grazing periods.

This section describes the methods used for determining grazing utilization in upland and riparian areas on LORP leases. Land managers can use this data to document the percent of biomass removed by grazing animals and determine whether or not grazing utilization standards are being exceeded. Utilization data collected on a seasonal basis will determine compliance with grazing utilization standards, while long-term utilization data will aid in the interpretation of range trend data and will help guide future grazing management decisions. Utilization monitoring helps to inform decision making for the following adaptive management areas (see Section 3.7.1): Seasonal Habitat Flows, Terrestrial Habitat, Riverine-Riparian Habitat, Water Quality, Delta Habitat Area, Exotic/Invasive Plants, BWMA Wetlands, Range Condition and Recreation.

Baseline Data Collected

Baseline utilization data were collected on all LORP leases in order to provide lessees feedback about current (pre-project) levels of utilization. Knowledge of pre-project utilization levels may ease the transition to compliance with utilization standards. This baseline period also allowed staff to refine data collection methodology and develop the tools needed to effectively and efficiently monitor utilization on a long-term basis. The methodologies described below represent the current and planned monitoring methods with all the refinements incorporated.

LADWP has developed height-weight relationship curves for native forage species in the Owens Valley using locally-collected plants. The grazing season is defined as the temporal period when livestock first enter a pasture and when they are removed from a field. The majority of the fields in the LORP leases are currently grazed continuously from fall to late spring. Baseline utilization data were collected twice during the grazing season in 2004 and 2005 and once at a few locations in 2006. Mid-season utilization monitoring was conducted well before livestock were removed from a field (generally February/March) and again at or near the end of the grazing season (May/June).

Baseline utilization monitoring from 2004-2006 was conducted along non-permanent transects. Monitoring sites associated with a range trend transect were selected as to be representative of the use in the vicinity of that transect. Monitoring sites not associated with a trend transect were selected at random from an aerial photo. This additional sampling was conducted to provide improved coverage in large fields or when use appeared to be unevenly distributed in a field.

Methods

Timing and other aspects of utilization monitoring will be directed by the Scientific Team and conducted jointly by Staffs and lessees of the respective ranching leases. The Scientific Team will appoint one member of

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[21] Holecheck et al. 2004

Staffs to be Task Leader for all utilization monitoring.

Monitor utilization using the height-weight method[22], which is based on the allometric relationship between the height of a plant and the distribution of biomass within the plant. This method results in an estimate of the amount of biomass removed from an area based on knowledge of what the average height of ungrazed plants of a particular species is and a determination of the average height of the grazed plants of that same species. Determining the percent of biomass removed based on the average height of grazed plants requires the use of a height-weight relationship curve and a best-fit regression equation.

LADWP has developed height-weight relationship curves for native forage species in the Owens Valley using locally-collected plants. A description of the methodology used to develop height-weight relationship curves can be found in the "Herbaceous Removal Methods" section of *Utilization Studies and Residual Measurements.*[23]

Utilization monitoring will focus on the use of graminoids (grass and grass-like species), which are the main forage base for livestock in the LORP. The species monitored in each area will depend on the occurrence or abundance of each species along a transect. The forage species typically encountered in the LORP area include alkali sacaton (*Sporobolus airoides*), inland saltgrass (*Distichlis spicata*) and creeping wild rye (*Leymus triticoides*).

<u>*Protocol*</u>

Grazing utilization data are collected by walking along transects, stopping every 6-8 steps and recording the height of plants that are closest to the toe of your shoe. Take digital photographs of sampling locations when appropriate. The distance between measurements (in terms of number of steps) is selected by the observer, based on the size of the field and the spacing of the plants. Information about transect, field or livestock use of the field is noted on the utilization datasheet. Appendix A.6 contains sample Utilization Data Sheets (2 blank + 2 examples) and instructions on filling out the forms.

The following directions are provided for Staffs and lessees conducting utilization monitoring. In order to measure plant heights, follow the following six steps:

1) At each measuring point and for each forage species, select the plant closest to the toe of your shoe for sampling. Plants unavailable to grazing animals (i.e., plants growing in the center of a shrub or beyond the reach of an animal) should not be sampled.
2) Only sample plants within a one-meter radius half-circle, forward of the frontal plane of your body. Collect height data on all forage species at each measuring point. If there are no forage species to sample a particular stopping point, continue another 6-8 steps to the next sample area.
3) For rhizomatous/sod-forming species, select a two-inch diameter bundle of the grass to measure when individual plants cannot be identified. For bunch grasses, sample a two-inch diameter bundle.
4) Determine whether or not the plant has been grazed.
5) If the plant has **not** been grazed, measure the tallest part of the plant. If an inflorescence is present, measure to the tip of the inflorescence. If no inflorescence is present or if the flowering parts are below the height of the tallest leaves, take the measurement after pulling the leaves up along the vertical axis of the plant (so that you are essentially measuring length of the leaves).
6) If the plant has been grazed, determine whether the plant has been evenly- or unevenly grazed (are all grazed parts the same height or not). If the plant has been evenly grazed, measure the height of the grazed plant. If the plant has been unequally-grazed, you must determine the average height of the remaining biomass taking into consideration the distribution of biomass within grass plants (i.e., in most species, the bulk of the biomass is distributed near the base of the plant).

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[22] U.S. BLM 1996a

[23] U.S. BLM 1996a

The average height of ungrazed plants by species is needed in order to calculate utilization using Height-Weight curves. In most cases, ungrazed plant height data will be obtained after the peak of the growing season and before the start of the grazing season. Initially, ungrazed heights will be collected at the majority of permanent utilization transect locations. In an effort to reduce redundant sampling, data will be analyzed for differences in mean ungrazed heights among fields and utilization transects. If the analysis reveals no difference in the mean ungrazed height of a species between two transects and among years, data will be pooled for analysis.

Staffs technicians and lessees should execute the following eight steps to determine average ungrazed heights of forage species:

1) Collect ungrazed heights for forage species after the peak of the growing season and before the start of the grazing season (between late July and October).
2) Navigate to the utilization transect location using a handheld GPS and/or maps.
3) Following the general trajectory of the transect, start walking the transect. It is not necessary to use a sampling tape.
4) Stop every 6-8 steps and locate the plant of each key species closest to the toe of your shoe. If a plant has been grazed by any animal, trampled, run over or does not have a fully-developed or intact inflorescence, choose the next closest plant of the same species to measure.
5) If 80 percent or more of the plants (by species) in an area are culm-producing, then measure only plants that produced a culm.
6) If 80 percent or more of the plants (by species) in an area are not culm-producing, then measure only plants that are culm-less. If the majority of plants are culmless and a culmless curve should be used, this should be noted on the datasheet.
7) Individual plants subject to significantly different localized growing conditions should not be selected for measurement (e.g., “leggy” plants growing in the middle of a shrub, highly shaded plants).
8) Collect a minimum of 20 samples of ungrazed plants of each key species at each transect location.

<u>Sites</u>
Utilization monitoring will be conducted in both upland and riparian areas, with an emphasis on grass-dominated communities such as alkali meadow, wet meadow and shrub-meadow habitats. Priority will be placed on monitoring utilization in the vicinity of range trend transects, the majority of which are located in the Owens River floodplain. At a minimum, one utilization transect will be assessed at each range trend transect location. This will assist in interpretation of range trend in the context of utilization history. Utilization monitoring will also be conducted in other grass-dominated sites or other areas of resource concern. The total number of transects per field or lease will ultimately depend upon data needs.

Baseline utilization monitoring from 2004-2006 was conducted along non-permanent transects. Monitoring sites associated with a range trend transect were selected as to be representative of the use in the vicinity of that transect. Monitoring sites not associated with a trend transect were selected at random from an aerial photo. This additional sampling was conducted to provide improved coverage in large fields or when use appeared to be unevenly distributed in a field.

Permanent utilization transects were established during the 2006/2007 grazing season. These transects will have a permanent starting location and a specified direction of travel, but may vary in length depending upon the spacing of plants and therefore the distance of travel needed to obtain an adequate sample size. Permanent utilization transects are established at all range trend transect locations. Additional permanent utilization transect sites will be selected through a random site selection process using ArcView. As was the case during baseline monitoring, a stratified-random approach will be used to select areas for monitoring utilization whereby vegetation will be stratified by community type and random sites will be selected within grass-dominated communities.

Frequency
Utilization monitoring is conducted annually over the life of the project. The grazing season is defined as the time period when livestock first enter a pasture and when they are removed from a field. The majority of the fields in the LORP leases are currently grazed continuously from fall to late spring.

Data Management
There are no data management protocols exclusive to utilization monitoring. See Section 4.1.1 for general data management direction. It is the responsibility of the TL to ensure that all data management direction is followed. If problems are encountered, TL is to solicit the Scientific Team for further direction.

A Microsoft Access database is being used to manage the utilization data.

Data Analysis and Reporting

Statistical Applications
Utilization for each species along each transect is calculated using species-specific height-weight algorithms. These algorithms calculate the percent of biomass removed as a function of the percent of height that has been removed. The reference height used to determine the percent of height that has been removed from the current year’s growth will be the average ungrazed height values obtained prior to grazing each season. The percent of biomass removed will be calculated for each sample. Ungrazed samples are assigned a percent use of zero, regardless of the height of the plant.

In an effort to reduce redundant sampling, data will be analyzed for differences in mean ungrazed heights among fields and utilization transects. If the analysis reveals no difference in the mean ungrazed height of a species between two transects and among years, data will be pooled for analysis.

Performance curves[24] were used to determine the sample size required to obtain a reliable estimate of the average ungrazed plant heights. Performance curves plot sample number versus the cumulative mean of all samples. Sample size is sufficient when the calculated mean ceases to fluctuate, despite variations in individual samples. The performance curves of approximately 40 samples were examined to determine an adequate sample size for determining mean ungrazed heights. The majority of the curves leveled off between 7-10 samples, however for some locations, 13-15 samples were required. Thus a minimum sample size of 20 was established, which is consistent with recommendations in BLM 1996.[25]

The Grazing Utilization database will allow data to be examined in a number of different ways. Use of individual species on an individual transect will be the most discrete level of analysis. These data can then be scaled to examine average use along a transect, use within individual fields and overall use on a lease.

GIS Applications
The locations of each utilization transect will be transferred to aerial photos in order to provide visual representation of sampling activities. Grazing utilization data may be useful in modeling the impacts and effects of grazing combined with other various land management activities through time; however this potential aspect of the project has not been explored to date.

Reporting
Task Leader is to report summarized utilization monitoring results annually by the end of September, where applicable. MOU Consultant makes adaptive management recommendations to LADWP and ICWD management by the first of November.

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[24] Brower et al 1989

[25] U.S. BLM 1996b

4.6.3 Range Trend Monitoring

Monitoring Purpose

Range trend monitoring uses quantitative sampling techniques to assess the trend in key indices of range condition and health. The Range Trend monitoring program will provide the data necessary to evaluate the response of range condition and trend with respect to grazing management practices. The range trend monitoring program was developed in conjunction with and as a result of, development of the land management plans. The data provided by this monitoring program will help determine whether grazing management activities are supporting the goals of the LORP. Range trend monitoring helps to inform decision making for the following adaptive management areas (see Section 3.7.1): Seasonal Habitat Flows, Terrestrial Habitat, Riverine-Riparian Habitat, Water Quality, Delta Habitat Area, Exotic/Invasive Plants, BWMA Wetlands, Range Condition and Recreation.

Prior to 2002, there were few restrictions on grazing management practices in the leased areas of LADWP-owned lands. Grazing management activities were left primarily up to the discretion of the lessees, with guidelines and restrictions for rare plant and post-fire management areas. The implementation of the land management plans will apply uniformity to management actions, as well as implement resource conservation techniques. The grazing plans are designed to maximize production and utility of the grazing resource while also restoring and preserving ecological value.

Baseline Data Collected

Baseline range trend monitoring at 100-meter permanent transects was initiated in 2002. As of 2006, there were 65 range trend transects on LORP leases. In 2002, the first year of baseline monitoring, 47 range trend transects were established. An additional 12 transects were established in 2003. Baseline data on transects established in 2002 was collected in 2002, 2003 and 2004. Baseline data on transects established in 2003 was collected in 2003, 2004 and 2005. In 2006, 6 additional transects on LORP leases were established and read. Ten additional transects are located on non-LORP leases south of the LAA Intake to the Los Angeles Aqueduct.

Baseline data were collected by LADWP Watershed Resources staff and field crews from Montgomery-Watson Harza.

Baseline data collected on all transects include the nested frequency value for all species, cover estimates for ground substrates and all non-woody species, line intercept for shrub species, shrub age classification, visual obstruction readings and digital photographs of the transect and ground substrate conditions. Minor changes were made to the sampling protocol after the initial year of monitoring. These changes were made to improve the statistical power of the sampling program. The methods presented here represent the current methodologies with all changes incorporated.

Methods

The range trend monitoring program consists of six components: nested frequency sampling, cover estimates for vegetation and surface substrates, line intercept sampling for shrub cover, shrub age classification, vertical obstruction readings and photo documentation. Example datasheets for all 4 protocols are provided in Appendix A.6.

<u>*Protocol*</u>
The following descriptions of how baseline data were collected are to be used as a guide for future monitoring efforts. The Scientific Team may modify future protocols and the TL is responsible for carrying out the protocols and delivering data to the Scientific Team.

Nested Frequency Sampling
Conduct nested frequency sampling using the methods described in the Interagency Technical Reference *Sampling Vegetation Attributes.*[26] Nested frequency sampling provides an index to the abundance of each plant species. This method is highly repeatable and appropriate for use in grass, forb or shrub

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[26] U.S. BLM 1996b

communities. Nested frequency values are less responsive to annual weather variations than some other types of vegetation indices. The following describes how nested frequency sampling was performed and these same protocols are to be followed for future efforts.

Nested frequency sampling was done on the right side of each transect, as viewed from the beginning of the transect (Figure 4. 9). Three different quadrat frame sizes (0.25 m^2, 0.5 m^2 and 1.0m^2) were manufactured for use during sampling. Each quadrat frame was further divided into five subquadrats, such that five different-sized quadrats are “nested” in the frame (Figure 4.10). The subquadrats are assigned a number of 1-5, with the smallest subquadrat assigned number 1. The nested frequency value recorded for each plant species ranges from 1-5 depending on the smallest sub-quadrat in which the plant was rooted.

The specific quadrat frame size used for a transect is a function of the vegetative community being sampled and thus the spacing of plants. In more xeric sites where plants are well-spaced, the 1.0 m^2 frame was used, while a smaller-sized frame was used in more grass-dominated sites where the inter-plant spacing is less. Ideally, nested frequency values for key species should fall between 20 percent and 80 percent in order to be able to detect trends over time. Because it is difficult to have one plot size that will be appropriate for all species (i.e., produce frequency values between 20 and 80 percent), the use of a nested frequency frame allows the sampling of plots of 5 different sizes simultaneously. This allows for the selection of an appropriately-sized plot for long-term monitoring. The same frame size will be used each year that sampling is conducted.

Nested frequency sampling is done every 3 meters for a total of 34 samples per transect. The first sample is at 0 meters and the last sample at 99 meters. The frame is placed flat on the ground with the bottom edge of the frame perpendicular to the tape and subquadrat 1 next to the tape at the sampling location (Figure 4. 9).

Cover estimates for vegetation and surface substrates

Estimates of foliar cover were made for all species (except shrubs) in each nested frequency quadrat frame. As a means of reference, subquadrat 1 ≈ 1.5 percent of the total area of the frame, 2 ≈ 6 percent of the area, 3 ≈ 25 percent of the area and 4 ≈ 50 percent of the area. Total cover values may exceed 100 percent due to overlapping species’ canopies.

Estimates of actual cover were also made for bare ground, litter, rock, dung and cryptogamic crust in each nested frequency quadrat frame. Rock was defined as any substrate > 2 mm in any one dimension; litter is accumulated dead or detached vegetative material; dung is any identifiable animal feces; and cryptogamic crust is defined as any biological soil crust. Total substrate cover may be less than 100 percent to account for shrub basal cover, but should not exceed 100 percent.

Line Intercept Sampling for Shrub Cover

Determine live cover of each shrub species using the line intercept method. Measure line intercept along the 100-meter sampling tape. The observer is to stand directly over the tape and record the intercept of live cover to the nearest 5 cm. Do not count as live cover gaps in the canopy of more than 5 cm. Similarly, do not record dead areas of a shrub as live cover.

Shrub age classification

Shrub age classification provides information about the age classes of the shrubs and the dynamics of the shrub population. In combination with cover values and nested frequency sampling data, shrub age classification information will be used to interpret trend. For example, if cover of a particular shrub species is decreasing over time, the age classification data will indicate if the decrease is due to the death of individual shrubs and whether there is recruitment of younger age classes.

Shrub age classification sampling is conducted in a one-meter belt transect along the left side of the nested transect (as viewed from the beginning of the transect, Figure 4. 9). For ease of sampling, the continuous one-meter belt has been divided into 10, 10-meter x 1-meter plots.

All shrubs rooted within one meter of the transect tape are classified as belonging to one of five age classes: seedling (a young shrub not firmly established and with limited branching); juvenile (more established plant with more complex branching but not sexually mature); mature (complex branching and the shape expected for a mature plant of that species; sexually mature, i.e. would flower in a "good" year); decadent (a shrub of any age composed of 50 percent or more dead biomass by volume); or dead (>50 percent dead biomass by volume).

Visual Obstruction

Visual obstruction measurements provide an index of vertical structure of the vegetation with the use of a Robel pole. Visual obstruction measurements are taken on the left side of the transect, one meter from the sampling tape (Figure 4.9). When taking measurements, one person holds the Robel pole at the sample point, while the observer (person reading the visual obstruction) stands four meters away from the pole and directly in line with the pole.[27] When reading the visual obstruction, the observer must have his/her eye level at a height of one meter above ground. Visual obstruction is measured by recording the highest point on the pole that is at least partially obstructed by vegetation. Visual obstruction is recorded for four vegetation classes: shrubs, current years growth of graminoids, residual graminoids (previous years growth of perennial grasses and grass-likes) and other herbaceous (e.g., broadleaved annuals). Readings are taken on opposite sides of the pole at each observation point, resulting in two samples per point. Robel pole measurements are taken every five meters (25 stations) for a total of 50 samples per transect.

Photo documentation

To document overall vegetation conditions, take general view photos at each sampling transect and take close-up photos to document general soil and ground substrate condition. The purpose of the photos is to provide a visual reference of conditions encountered in the field. General view photos are taken from both ends of the transect. Label a dry erase board with transect information including sampling date, transect ID, Ranch Lease number and the subject (e.g., 100m → 0m). This dry erase board is clipped to the top of the fence post and the photo taken is to insure that the transect information is discernable and the entire transect is visible (Figure 4.12). Close-up photos are taken with the nested frequency frame in place the camera level and the dry erase board with all transect information in the frame of the photo, but out of the sampling frame. Close-up photos are taken at 0 m, 51 m and 99 m (Figure 4.11).

<u>Sites</u>

Range trend monitoring sites were selected through a stratified-random process. The principal vegetation communities selected for monitoring included all Type C Green Book vegetation communities.[28] Type C communities are grass-dominated and include alkali meadow, alkali seep, rabbitbrush meadow and Nevada saltbush-meadow communities. These communities were selected for monitoring because they provide a forage base for livestock and are expected to be areas of livestock use on an annual basis.

The majority of the transects are located in the Owens River corridor. Some of the transects along the river are in habitats that are not currently grass-dominated, but are expected to support plant communities similar to other transect locations along the river following implementation of the LORP.

Sixty-five of the range trend transects are on the LORP leases of Twin Lakes, Blackrock, Thibaut, Islands, Lone Pine and Delta leases. Transects were also established on non-LORP leases including ST Ranch, Aberdeen, Colosseum, Independence, Tuttle and Lubkin; these will not be discussed further. Figure 4.23 shows all range trend transects established to date.

Six of the LORP lease transects were placed at former LADWP long-term photographic

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[27] U.S. BLM 1996b

[28] Inyo County and LADWP 1990

range-trend monitoring locations.[29] The photographic monitoring was conducted from 1975 – 1996 and monitored changes in vegetation composition, density, vigor or growth form (as influenced by climate), grazing and water management practices. While these locations are generally in more xeric habitats than the recently established monitoring sites, the retention of the long-term photographic history available for these sites was considered potentially valuable in interpreting future range trend data.

The starting point and orientation of each 100 meter transect was randomly selected within the LADWP GIS system using ArcView GIS 8.1 and digital aerial photos from 2000. A field crew was provided the UTM coordinates for each randomly-selected transect; they were also given the randomly selected compass direction for orientation of the transect. In some cases, slight adjustments were made in the field to the randomly-generated starting point or direction in order to avoid a road, ditch or other drastic changes in vegetation composition.

The starting and ending locations for each transect were marked with a white-tipped green fence post. The fence posts were placed three meters fore and aft of the actual start and end point of each transect, respectively, in the event that livestock concentration around the post resulted in excessive vegetation disturbance. Each post was marked with an aluminum tag identifying the project (“TREND”) and a unique transect identifier which includes the lease name and transect number and whether or not the post marked the beginning (0 meter) or end (100 meter) of the transect (e.g., “TREND THIBAUT_4 BEG”).

Frequency
Range trend will be monitored in years 1, 2, 3, 5, 10 and 15 post-implementation, with year 1 being 2009. Monitoring will be more frequent during the initial post-implementation period and then occur on a less frequent basis. This will allow for more responsive adaptive management approach during initial phases of the project.

Data Management
There are no data management protocols exclusive to range trend monitoring. See Section 4.1.1 for general data management direction. It is the responsibility of the TL to ensure that all data management direction is followed. If problems are encountered, TL is to solicit the Scientific Team for further direction.

Data Analysis and Reporting

Technical staff will enter the data into spreadsheets such as Microsoft Excel. The name of the staff entering the data will be recorded on the original field form. The technical staff entering the data will be responsible for reviewing and correcting any data transcription errors. The project leader will do a final proofing of data entry prior to analysis. Data compilation will proceed as follows:

1) Nested Frequency: The frequency values for each nested plot in the frequency frame will be tallied and the percent frequency of each species in each will be determined by dividing the number of occurrences in each subquadrat by the number of samples.
2) Cover estimates: For each transect, the average cover of each species will be calculated.
3) Line intercept: For each transect, the percent cover for each species will be determined by totaling the intercept measurements and converting the value to percent cover for the transect.
4) Shrub age classification: For each transect and each species, the total number of shrubs in each age class will be totaled.

Statistical Applications
Statistical tests appropriate to data type will be applied to all components of the monitoring program. Data will be analyzed by each individual monitoring component as well as from a multivariate approach. Trend will be evaluated in terms of changes to cover and frequency of forage species, invasive or other undesirable species, cover of bare ground, shrub cover and the dynamics of the shrub community. Soil type, utilization history, site constraints and comparisons to grazing

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[29] LADWP 1981

exclosure sites will all be taken into consideration during the evaluation of trend.

GIS Applications

The beginning and end of each range trend transect has been identified and transferred to aerial photos in order to provide visual representation of sampling activities. Range trend data may be useful in modeling the impacts and effects of various land management activities through time, however this potential aspect of the project has not been explored to date.

Reporting

Task Leader is to report monitoring results annually by the end of September, where applicable. MOU Consultant makes adaptive management recommendations to LADWP and ICWD management by the first of November.

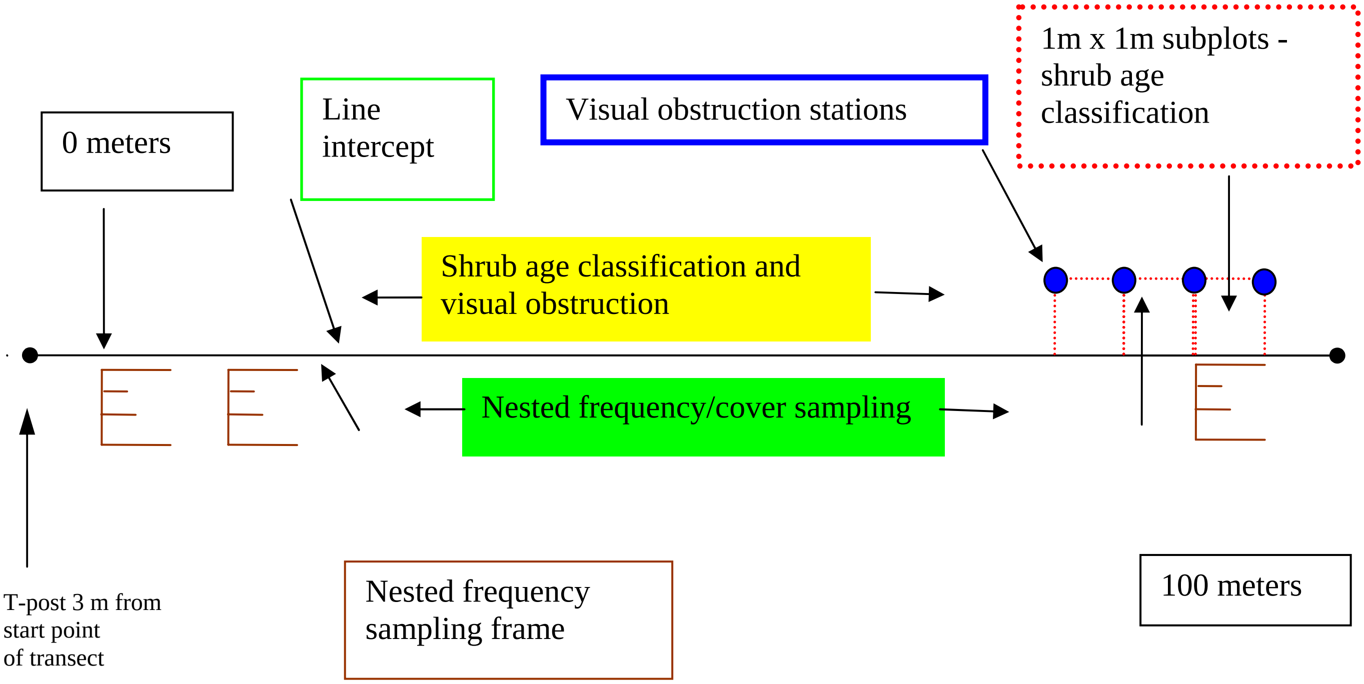

Figure 4.9. Layout of range trend vegetation monitoring components.

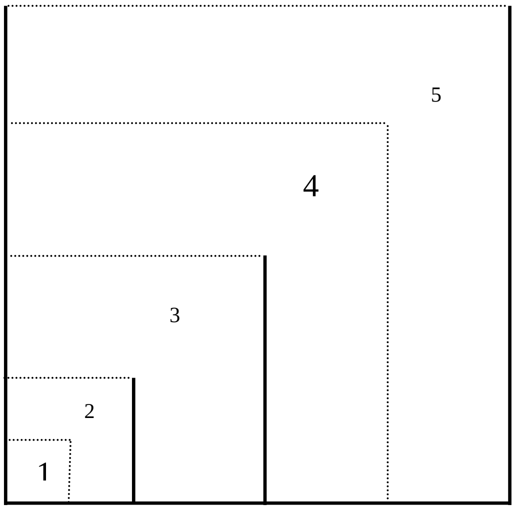

Figure 4.10. Plant species nested frequency sampling frame with sub-quadrat designations.

Figure 4.11. Example of a close-up view photo showing placement of the nested frequency frame.

Figure 4.12. Example of a general view photo of a range trend monitoring site.

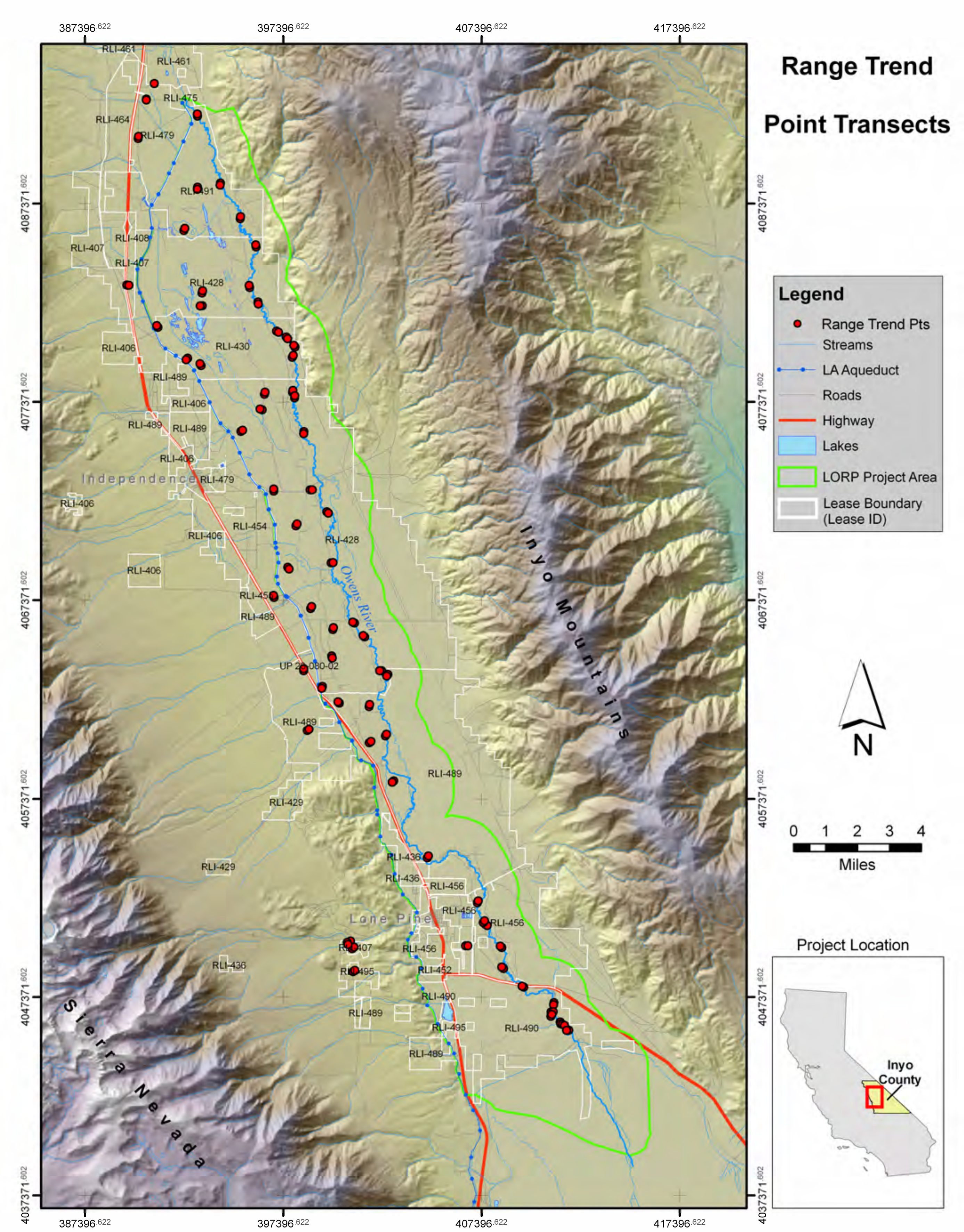

Figure 4.13. Range Trend Monitoring Points

Appendices

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Lower Owens River Project

Monitoring, Adaptive Management and Reporting Plan

April 28, 2008

A.1 References

APPENDICES
A.1

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A.2 Monitoring Tables

APPENDICES

A.2

Table A.1 Riverine-Riparian System Monitoring

MOU Management Objectives (as stated verbatim in the MOU)	Monitoring Component	Project Actions	Monitoring Actions	Monitoring, Data Analysis, and Reporting	Duration and Frequency
Base flow Monitoring					
Achieve MOU-required base flows of approximately 40 cfs from the Intake to the pump station, with seasonal habitat flows up to 200 cfs in general proportion to the forecasted runoff in the watershed. A continuous flow in the river channel will be maintained to sustain fish during periods of temporary flow modifications. LORP management should be consistent with applicable water quality laws, standards, and regulations.	Base Flow	Achieve approximately 40 cfs base flows throughout the river. And as specified in the Stipulation and Order, Appendix A.9.	Detect significant losses or gains in the river flow; document compliance with MOU and Stipulation and Order base flow requirements.	Collect data from continuous recorders at gaging stations. Until a stable flow of approximately 40 cfs has been achieved throughout the river, flow rates will be monitored and reported as specified in the Stipulation and Order, Appendix A.9. Once flows have stabilized, continuous flow data will be reported as specified in the Stipulation and Order, Appendix A.9.	Continuous data will be collected and reported as specified in the Stipulation and Order, Appendix A.9, and thereafter for the life of the monitoring effort (15 years).
	Base Flow Water Quality	Avoid, minimize, and manage water quality degradation during the establishment of base flows, within the constraints of the flow requirements of the MOU.	Measure water quality parameters related to RWQCB designated beneficial uses and track trends in water quality over time.	Measure water quality conditions at 7 locations and other locations along the river channel, including DO, pH, EC, temperature, turbidity, ammonia, hydrogen sulfide and tannins and lignin.	During the month prior to the commencement of Phase I water quality monitoring will occur once to establish baseline conditions. During Phase I releases, monitoring will be performed weekly or bi-weekly as needed. During Phase II releases, monitoring will be performed weekly or bi-weekly for 6 months, as necessary, then 1 day per week for 6 months. Thereafter, water quality monitoring will occur monthly (except during seasonal habitat flow releases-see below).

MOU Management Objectives (as stated verbatim in the MOU)	Monitoring Component	Project Actions	Monitoring Actions	Monitoring, Data Analysis, and Reporting	Duration and Frequency
	Base Flow Fish Condition	Same as above.	Assess fish conditions (evidence of stress such as excessive jumping, lying motionless near the surface, rapid gill movement and poor coloring or body appearance) and mortality.	Visual observations of river to detect fish conditions or fish kills at 4 water quality monitoring locations.	Same duration & frequency as water quality monitoring.
Seasonal Habitat Flows					
Achieve seasonal habitat flows up to 200 cfs in general proportion to the forecasted runoff in the watershed. The purpose of the habitat flow is the creation of a dynamic equilibrium for riparian habitat, the fishery, water storage, water quality, animal migration and biodiversity, which results in resilient productive ecological systems. To achieve and maintain riparian habitats in a healthy ecological condition, and establish a healthy warm water recreational fishery with habitat for native species, the plan will recommend habitat flows of sufficient frequency, duration and amount that will: (1) minimize the quantity of muck and other river bottom material that is transported out of the riverine-riparian system, but will cause this material to be redistributed on floodplains and terraces within the riverine-riparian system and the Owens	Seasonal Habitat Flow Compliance	Release up to 200 cfs seasonal habitat flows in accordance with the schedule and nomograph contained in the LORP Ecosystem Management Plan.	Document compliance with MOU seasonal habitat flow requirements, detect significant losses or gains, and determine travel time for seasonal habitat flows.	During the first release of habitat flows, collect data from continuous recorders at gaging stations. During subsequent releases of habitat flows, collect data from only the permanent monitoring stations. Report flow data daily during flow releases.	Frequency is annually and duration is the life of the monitoring effort (15 years).
	Seasonal Habitat Flow Flooding Extent	Achieve the purposes identified in the MOU for the seasonal habitat flows.	Assess extent and duration of flooding during seasonal habitat flows.	Aerial video survey – From helicopter, or other means, survey and video/photograph seasonal habitat flows at peak flows (at least 8 days into habitat flow). Immediately report any observed problems. By August 1, prepare flooding extent report.	Monitoring is during peak of seasonal habitat flows, and to be done annually for the first 5 years; after those 5 years, monitoring frequency may be reduced to every 3 years.
	Seasonal Habitat Flow Water Quality	Avoid and minimize water quality degradation during seasonal habitat flows, within the constraints of the flow requirements of the MOU.	Measure water quality parameters related to RWQCB-designated beneficial uses, track trends in water quality over time, and identify options to protect water quality.	Measure water quality conditions at 3 locations, and other locations as needed, along the river channel, including DO, pH, EC, temperature, turbidity, ammonia, hydrogen sulfide, and tannins and lignin. Compile data and submit to LADWP & Inyo County at least weekly during seasonal habitat flows.	During the first three releases of flows, data from the 3 locations will be collected five times per week during the flow and one to five times (as needed) for up to two weeks following the flow release. After the first 3 flow releases, water quality monitoring will be discontinued.

MOU Management Objectives (as stated verbatim in the MOU)	Monitoring Component	Project Actions	Monitoring Actions	Monitoring, Data Analysis, and Reporting	Duration and Frequency
River delta for the benefit of the vegetation; (2) fulfill the wetting, seeding, and germination needs of riparian vegetation, particularly willow and cottonwood; (3) recharge the groundwater in the streambanks and the floodplain for the benefit of wetlands and the biotic community; (4) control tules and cattails to the extent possible; (5) enhance the fishery; (6) maintain water quality standards and Actions; and (7) enhance the river channel.	Seasonal Habitat Flow Fish Condition	Same as above.	Assess fish conditions (evidence of stress such as excessive jumping, lying motionless near the surface, rapid gill movement and poor coloring or body appearance) and mortality.	Observations of river to detect fish conditions or fish kills at 3 water quality monitoring locations	Same duration and frequency as water quality monitoring.
	River Channel Rapid Assessment Survey	Develop corridor of native riparian and wetland habitats dominated by willow, cottonwood, and wet meadow vegetation, consistent with 1993 model predictions (WHA 1993), that exhibits healthy age structure.	Track trends in habitat development, observe woody plant recruitment, assess beaver activity and beaver dam conditions, assess presence of exotic plants, and assess recreational impacts.	Walk the river along designated route from the intake to the pump station, with stops at permanent monitoring points. Take photos. GPS locations of noteworthy observations for future monitoring or evaluation. Enter data in GIS and spreadsheet. Report compiled data, annually, before October of each survey year.	Once per year in July or August for first 10 years of monitoring effort. Survey may be discontinued after the first 10 years.
Habitat Monitoring					
Create and maintain healthy and diverse riverine, riparian, and wetland habitats through flow and land management, to the extent feasible, consistent with the needs of the “habitat indicator species” for the river. These habitats will be as self-sustaining as possible. Create and sustain a healthy	Indicator Species’ Habitat	Develop native riparian and wetland habitats consistent with the suitability curves for habitat characteristics important to the “habitat indicator species” and special status species.	Measure trends in habitat characteristics that relate to the “habitat indicator species” and special status wildlife species; changes in habitat will be analyzed using CWHR system.	Assess habitat elements (outlined by CWHR) including vegetation type, structural elements, cover classes, and special elements. Evaluate LORP-specific habitats to derive suitability values for each indicator species and guild.	During growing season (June - September) in years 2, 5, 7, 10, and 15.

MOU Management Objectives (as stated verbatim in the MOU)	Monitoring Component	Project Actions	Monitoring Actions	Monitoring, Data Analysis, and Reporting	Duration and Frequency
warm water recreational fishery with healthy habitat suitable for native fish. Comply with state and federal laws that protect Threatened and Endangered species. Control deleterious species whose presence within the LORP area interferes with the achievement of the Management Objectives of the LORP. These control measures will be implemented jointly with other responsible agency programs. Manage livestock grazing and recreational use consistent with the other Management Objectives of the LORP.	Fish Habitat	Develop riverine habitats consistent with the needs of native and sport fishes.	Measure habitat characteristics important to native and sport fishes; characteristics include: substrate, bank undercut, organic debris, channel width, depths, wetted perimeter width, and canopy cover.	Measure 8 habitat characteristics at approximately 105 transects. Before October of each monitoring year, prepare report summarizing results and making recommendations for adaptive management.	To be conducted in September of years 3, 6, and 9.
Vegetation Assessments					
	Landscape Vegetation Mapping	Develop corridor of native riparian and wetland habitats dominated by willow, cottonwood, and wet meadow vegetation, consistent with 1993 model predictions (WHA 1993), that exhibits healthy age structure.	Measure large-scale vegetation trends and habitat extent, document tule development, beaver dams, and open water areas.	Acquire and interpret satellite imagery of the river and map vegetation. Prepare report summarizing interpretation, presenting mapping results (including CD with digital copies of imagery and attributed GIS maps) and making recommendations for adaptive management.	During growing season in years 2, 5, 7, 10 and 15.

MOU Management Objectives (as stated verbatim in the MOU)	Monitoring Component	Project Actions	Monitoring Actions	Monitoring, Data Analysis, and Reporting	Duration and Frequency
	Site Scale Vegetation Assessment & Landform Elevation Modeling	Provides site specific, scale appropriate data that quantitatively explains the changes in the vegetation communities adjacent to the Lower Owens River. Develop knowledge base of relationship between riparian vegetation, riparian landforms, and water surface elevations.	Components include: vegetation transect data, subplot data, landform and elevation data, and community type mapping, which all occur at five 2 km study plots established along the Lower Owens riverine-riparian corridor.	Data are analyzed spatially and geographically to track vegetation trends between monitoring efforts. Reporting will occur in each monitoring year following data collection and analysis.	During years 2, 5, 7, 10 and 15; unless new aerial imagery is acquired in which case monitoring should be performed concurrently.
Population Monitoring					
	Avian Census		Conduct avian point counts and note vegetation community descriptions.	Census all points by recording birds detected within a 50m radius; conduct habitat and vegetation assessments at same locations.	During years 2, 5, 7, 10 and 15; census 3 times during peak breeding season.
	Creel Census		Collect information about the abundance and distribution of game fish throughout LORP area.	Utilize volunteers to conduct systematic census of game fish; collect fish population and distribution data as well as fish size, sex, species, length and health.	During years 2, 5, 7, 10 and 15.
Other					
Adaptive Management	Contingency Monitoring		Rapid assessment surveys and other monitoring could indicate a need for additional monitoring focused on areas or resources of particular interest (e.g. recruitment, rare species).	Additional monitoring may be incorporated into the monitoring program during the first 15 years of project operation.	To be determined by Scientific Team as needed.
Compliance	Data Analysis and Reporting			Staffs report monitoring data and certain analyses to Scientific Team; Scientific Team analyzes, synthesizes and reports results as well as makes adaptive management and monitoring prescriptions in LORP Annual Report.	LORP Annual Report is to be presented by Scientific Team to LADWP and ICWD in a transparent, publicly accessible manner in February following each monitoring year.

Table A.2 Blackrock Waterfowl Management Area Monitoring

MOU Management Objectives	Monitoring Component	Project Actions	Monitoring Actions	Monitoring, Data Analysis, and Reporting	Duration and Frequency
Approximately 500 acres of the area will be flooded at any given time when runoff is forecasted to be average or above average. In years of less than average runoff, the water supply to the area will be reduced in general proportion to the forecasted runoff in the watershed. Even in the driest years, available water will be used in the most efficient manner to maintain the habitat. Provide the opportunity for the establishment of resident and migratory waterfowl populations and provide habitat for other native species. Create and maintain healthy and diverse natural habitats through flow and land management, to the extent feasible, consistent with the needs of the "habitat indicator species" for this element of the LORP. These habitats will be as self-sustaining as possible. Comply with state and federal laws that protect Threatened and Endangered species. Control deleterious species whose presence within the LORP area interferes with the achievement of the Management Objectives of the LORP. These control measures will be implemented jointly with other responsible agency programs. Manage livestock grazing and recreational use consistent with the other Management Objectives of the LORP.	Blackrock Flow and Wetland Area	Flood approximately 500 acres at any given time.	Document compliance with MOU requirements and consistency with LORP Plan.	Determine staff gage – flooded extent relationship by aerial surveys and ground assessments during initial years of project, and as needed thereafter. Record spillgate discharge, flows at diversions, and staff gage elevations that serve as indicators of a real extent of flooding. Change datalogger modules weekly.	For duration of monitoring effort (15 years). Record all data weekly during the first year; may decrease frequency thereafter.
	Blackrock Rapid Assessment Survey	Create, enhance, and sustain a diverse and productive "managed wetland" community for the "habitat indicator species" and special status species.	Document compliance with MOU requirements and consistency with LORP Plan, assess trends in habitat development and wetland response to flows, observe aerial extent, depth, and duration of shallow flooding, rate of flood level changes, wetland vegetation, woody plant recruitment, assess the extent of the presence of tules and exotic plants, and assess recreational impacts.	Perform semi-quantitative assessment of wetland conditions along a pre-determined route, with photo documentation of wetland conditions due to flooding regime in different units.	Once per year in July or August for first 10 years of monitoring effort. Survey may be discontinued after the first 10 years.
	Indicator Species' Habitat Monitoring	Develop native riparian and wetland habitats consistent with the suitability curves for habitat characteristics important to the "habitat indicator species" and special status species.	Measure trends in habitat characteristics that relate to the "habitat indicator species" and special status wildlife species; changes in habitat will be analyzed using CWHR system.	Assess habitat elements (outlined by CWHR) including vegetation type, structural elements, cover classes and special elements. Evaluate LORP-specific habitats to derive suitability values for each indicator species and guild.	During growing season (June - September) in years 2, 5, 7, 10 and 15.
	Landscape Vegetation Mapping	Create, enhance, and sustain a diverse and productive "managed wetland" community for the "habitat indicator species" and special status species	Measure trends in habitat development and wetland response to flows; measure aerial extent of shallow flooding and wetland and riparian vegetation, including tules.	Acquire and interpret remote sensing imagery. Map vegetation communities and crosswalk as necessary to compare to previous monitoring results.	During growing season in years 2, 5, 7, 10 and 15.

MOU Management Objectives	Monitoring Component	Project Actions	Monitoring Actions	Monitoring, Data Analysis, and Reporting	Duration and Frequency
	Wetland Avian Census		Conduct avian point counts and note vegetation community descriptions.	Census all points by recording birds detected within a 50m radius; conduct habitat and vegetation assessments at same locations.	During years 2, 5, 7, 10 and 15; census 3 times during peak breeding season.
	Contingency Monitoring		Rapid assessment surveys and other monitoring could indicate a need for additional monitoring focused on areas or resources of particular interest (e.g. recruitment, rare species).	Additional monitoring may be incorporated into the monitoring program during the first 15 years of project operation.	To be determined by Scientific Team as needed.
	Data Analysis, Report Preparation, Recommendations		Staffs report monitoring data and certain analyses to MOU Consultant; MOU Consultant analyzes, synthesizes, and reports results as well as provides adaptive management and monitoring recommendations to ICWD and LADWP management.	LORP Annual Report is to be presented by LADWP and ICWD in a transparent, publicly accessible manner following each monitoring year.	Annual.

Table A.3 Delta Habitat Area Monitoring

MOU Management Objectives (as stated verbatim in the MOU)	**Monitoring Component**	Project Actions	Monitoring Actions	**Monitoring, Data Analysis, and Reporting**	**Duration and Frequency**
Release an annual average of 6 to 9 cfs below the LORP pump station, not including water that is not captured by the station during periods of seasonal habitat flows.	Delta Flow Monitoring	Release an annual average of 6 to 9 cfs below the LORP pump station, not including water that is not captured by the station during periods of seasonal habitat flows.	Document compliance with MOU flow requirements and wetland Management Objectives.	Flows released to the delta will be managed and documented as part of pump station management. Data, as to the amount of water released from the pump station, will be documented by a continuous recorder module. The data will be reported weekly. Data from stream gages established to continuously monitor outflow from the Delta will be reported every 14 days for one year after project implementation.	Monitoring of releases to the delta from the pump station will occur over the life of the monitoring effort (15 years). Data from the stream gages will be reported monthly.
Enhance and maintain existing habitat and establish and maintain new habitat consisting of riparian areas and ponds suitable for shorebirds, waterfowl, and other animals. Create and maintain diverse natural habitats through flow and land management, to the extent feasible, consistent with the needs of the “habitat indicator species” for this element of the LORP. These habitats will be as self-sustaining as possible. Comply with state and federal laws that protect Threatened and Endangered species.	Delta Flows During Establishment of Base flows (first year following project implementation)	Within the annual average of 6 to 9 cfs, establish the seasonal base flow to be released to the delta in the years after the first year following the implementation of the project.	Document that a continuous, combined flow of at least 0.5 cfs is passing the two gaging stations on the east and west branches of the delta.	Flows released to the delta will be managed and documented as part of pump station management. Data, as to the amount of water released from the pump station, will be documented by a continuous recorder module, and is transmitted hourly to LADWP Bishop Office. Stream gages will be established to continuously monitor outflow from the delta from the east and west branches for a one year period after project implementation. Stream gage data will be reported every 14 days.	Record inflows and outflows continuously and transmit hourly to LADWP Bishop Office.
	Delta Flows After Base flow Establishment (first year following project implementation)	Adjust the seasonal base flow and/or the pulse flows to be released to the delta after the first year following the implementation of the project (within the annual average of 6 to 9 cfs required by the MOU)	Achievement of the Management Objectives for the delta.	Adjust base flow releases within the 6-9 cfs annual average range. Review flow data weekly. During the four pulse flow periods, flow data are recorded continuously.	These monitoring activities will occur through the life of the monitoring effort (15 years following implementation of project). Review flow data weekly.

MOU Management Objectives (as stated verbatim in the MOU)	**Monitoring Component**	Project Actions	Monitoring Actions	**Monitoring, Data Analysis, and Reporting**	**Duration and Frequency**
Control deleterious species whose presence within the LORP area interferes with the achievement of the Management Objectives of the LORP. These control measures will be implemented jointly with other responsible agency programs. Create and maintain diverse natural habitats through flow and land management, to the extent feasible, consistent with the needs of the "habitat indicator species" for this element of the LORP. These habitats will be as self-sustaining as possible. Comply with state and federal laws that protect Threatened and Endangered species. Control deleterious species whose presence within the LORP area interferes with the achievement of the Management Objectives of the LORP. These control measures will be implemented jointly with other responsible agency programs.	Delta Rapid Assessment Surveys	Create, enhance, and sustain a diverse complex of wetland riparian areas and ponds suitable for shorebirds, waterfowl, and other animals. LADWP's Management Objective for the delta habitat will be to enhance and maintain the wetland resource (on its lands) that exists at the time the project is implemented and within this area, to establish and maintain habitat consisting of riparian areas and ponds suitable for shorebirds, waterfowl, and other animals.	Document trends in habitat development and wetland response to flows; observe aerial extent of shallow flooding, wetland vegetation, including plants of concern to Native Americans, and woody plant recruitment; make incidental observations of birds (semi-quantitative inventory); assess tule and beaver dam conditions; assess presence of exotic plants; assess recreational impacts.	Semi-quantitative assessment of wetland conditions and woody riparian recruitment along a pre-determined route, with photo documentation of wetland response to flows. Enter data in GIS and spreadsheet.	Once per year in July or August for first 10 years of monitoring effort. Survey may be discontinued after the first 10 years.
	Indicator Species' Habitat Monitoring	Develop native riparian, wetland and open water habitats consistent with the suitability index curves for the habitat characteristics important to the "habitat indicator species" and special status species.	Measure trends in habitat characteristics that relate to the "habitat indicator species" and special status wildlife species; changes in habitat will be analyzed using CWHR system.	Assess habitat elements (outlined by CWHR) including vegetation type, structural elements, cover classes, and special elements. Evaluate LORP-specific habitats to derive suitability values for each indicator species and guild.	During growing season (June - September) in years 2, 5, 7, 10 and 15.

MOU Management Objectives (as stated verbatim in the MOU)	**Monitoring Component**	Project Actions	Monitoring Actions	**Monitoring, Data Analysis, and Reporting**	**Duration and Frequency**
Manage livestock grazing and recreational use consistent with the other Management Objectives of the LORP.	Landscape Vegetation Mapping	Create, enhance, and sustain a diverse complex of wetland riparian areas and ponds suitable for shorebirds, waterfowl, and other animals.	Measure aerial extent of shallow flooding and wetland and riparian vegetation, including tules; identify beaver dams; measure open water areas.	Acquire and interpret remote sensing imagery as with other LORP features in primary years. Prepare attributed GIS map of habitat types at delta area.	Years 3, 4, 6, 8, 9 and 11-14.
	Wetland Avian Census		Conduct avian point counts and note vegetation community descriptions.	Census all points by recording birds detected within a 50m radius; conduct habitat and vegetation assessments at same locations.	During years 2, 5, 7, 10 and 15; census 3 times during peak breeding season.
	Contingency Monitoring		Rapid assessment surveys and other monitoring could indicate a need for additional monitoring focused on areas or resources of particular interest (e.g. recruitment, rare species).	Additional monitoring may be incorporated into the monitoring program during the first 15 years of project operation.	To be determined by Scientific Team as needed.
	Data Analysis, Report Preparation, Recommendations		Staffs report monitoring data and certain analyses to MOU Consultant; MOU Consultant analyzes, synthesizes and reports results as well as provides adaptive management and monitoring recommendations to ICWD and LADWP management.	LORP Annual Report is to be presented by LADWP and ICWD in a transparent, publicly accessible manner following each monitoring year.	Annual.

Table A.4 Off-River Lakes and Ponds Monitoring

MOU Management Objectives	Monitoring Component	Project Actions	Monitoring Actions	Monitoring, Data Analysis, and Reporting	Duration and Frequency
Maintain and/or establish these lakes and ponds to sustain diverse habitat for fisheries, waterfowl, shorebirds, and other animals. Create and maintain healthy and diverse natural habitats through flow and land management, to the extent feasible, consistent with the needs of the “habitat indicator species” for this element of the LORP. These habitats will be as self-sustaining as possible. Comply with state and federal laws that protect Threatened and Endangered species. Control deleterious species whose presence within the LORP area interferes with the achievement of the Management Objectives of the LORP. These control measures will be implemented jointly with other responsible agency programs. Manage livestock grazing and recreational use consistent with the other Management Objectives of the LORP.	Flow and Wetland Area Monitoring	Maintain the existing lakes and ponds identified in the MOU	Document compliance with MOU requirements.	Record staff gage levels weekly for first year of project; frequency may decrease thereafter. Calculate average weekly water surface elevation, as well as the monthly and annual mean, median, maximum and minimum.	Duration of monitoring effort (15 years).
	Rapid Assessment Survey	Maintain the off-river lakes and ponds to sustain diverse habitat for fisheries, waterfowl, shorebirds, and other animals.	Document trends in habitat development and wetland response to flows, observe aerial extent of ponded areas, wetland vegetation, and woody plant recruitment, make incidental observations of birds, assess presence of tules and exotic plants, and assess recreational impacts.	Semi-quantitative assessment of wetland conditions and woody riparian recruitment along a pre-determined route, with photo documentation of wetland response to flows. Enter data in GIS and spreadsheet.	Once per year in July or August for first 10 years of monitoring effort. Survey may be discontinued after the first 10 years.
	Creel Census		Collect information about the abundance and distribution of game fish throughout LORP area.	Utilize volunteers to conduct systematic census of game fish; collect fish population and distribution data as well as fish size, sex, species, length and health.	During years 2, 5, 7, 10 and 15.
	Contingency Monitoring		Rapid assessment surveys and other monitoring could indicate a need for additional monitoring focused on areas or resources of particular interest (e.g. recruitment, rare species).	Additional monitoring may be incorporated into the monitoring program during the first 15 years of project operation.	To be determined by Scientific Team as needed.
	Data Analysis, Report Preparation, and Recommendations		Staffs report monitoring data and certain analyses to MOU Consultant; MOU Consultant analyzes, synthesizes, and reports results as well as provides adaptive management and monitoring recommendations to ICWD and LADWP management.	LORP Annual Report is to be presented by LADWP and ICWD in a transparent, publicly accessible manner following each monitoring year.	Annually, for duration of monitoring effort (15 years).

Table A.5 Range Trend Monitoring

MOU Management Objectives	Monitoring Component	Project Actions	Monitoring Actions	Monitoring, Data Analysis, and Reporting	Duration and Frequency
The MOU (1997) states, *"the LORP will be augmented to include the development and implementation of an ecosystem management plan for the Lower Owens River area as described below that incorporates multiple resource values and provides for management based upon holistic management principles"* (Section II). It goes on to describe the goal of the LORP as, *"the establishment of a healthy, functioning, Lower Owens River riverine-riparian ecosystem, and the establishment of healthy, functioning ecosystems in the other physical feathers of the LORP, for the benefit of biodiversity and Threatened and Endangered Species, while providing for the continuation of sustainable uses including recreation, livestock grazing, agriculture and other activities (Section II B)."* Lastly, the MOU (1997) mandates the, *"Management of livestock grazing and recreational use consistent with the other goals of LORP"* (Section II B 5).	Utilization	Utilization data collected on a seasonal basis will determine compliance with grazing utilization standards, while long-term utilization data will aid in the interpretation of range trend data and will help guide future grazing management decisions.	Permanent utilization transects will be established during the 2006/2007 grazing season. At least twice during the grazing period, measure 20 ungrazed and grazed plant heights while walking transects in all pastures. The locations of each utilization transect will be transferred to aerial photos in order to provide visual representation of sampling activities.	Grazing utilization data are collected by walking along transects, stopping every 6-8 steps and recording the height of plants that are closest to the toe of your shoe. The distance between measurements (in terms of number of steps) is selected by the observer, based on the size of the field and the spacing of the plants. Information about transect, field or livestock use of the field is noted on the utilization datasheet. Monitoring results will be prepared annually where applicable and included in the LORP Annual Monitoring Report.	During November and May, for the duration of the monitoring effort (15 years).
	Irrigated Pasture Condition Scoring	Evaluate pasture health and the effectiveness of management in terms of optimizing plant and livestock productivity while minimizing detrimental effects to soil or water resources.	Each pasture on a lease is evaluated in its entirety. Crews walk random transects throughout the entire irrigated pasture or through the entire area of a pasture that is irrigated. Throughout the transect, crews perform visual evaluation of 10 indicators, each having five environmental conditions. Each indicator is rated separately and the scores are combined into an overall score for the pasture and percent rating is calculated.	Monitoring occurs annually for pastures below the minimum 80 percent score. Pastures between 80 and 90 percent will be monitored bi-annually. Pastures scoring over 90 percent will be evaluated every 5 years. Data will be compiled in the Irrigated Pasture Condition Database. Results will be reported annually where appropriate and included in the LORP Annual Monitoring Report.	Annually, bi-annually, and/or every five years, depending upon prior condition scoring.

	Range Trend	Assess the trend in key indices of range condition and health and provide data necessary to determine whether grazing management activities are supporting the goals of the LORP.	On 65 transects (or more, if added), perform nested frequency sampling, cover estimates for vegetation and surface substrates, line intercept sampling for shrub cover, shrub age classification, vertical obstruction readings, and photo documentation.	Data will be analyzed by each individual monitoring component as well as from a multivariate approach. Trend will be evaluated in terms of changes to cover and frequency of forage species, invasive or other undesirable species, cover of bare ground, shrub cover, and the dynamics of the shrub community. Monitoring results will be prepared annually where applicable and included in the LORP Annual Monitoring Report.	Performed on monitoring years 1, 2, 3, 5, 10 and 15.
	Contingency Monitoring		Rapid assessment surveys and other monitoring could indicate a need for additional monitoring focused on areas or resources of particular interest (e.g. recruitment, rare species).	Additional monitoring may be incorporated into the monitoring program during the first 15 years of project operation.	To be determined by Scientific Team as needed.
	Analysis and Reporting		Staffs report monitoring data and certain analyses to MOU Consultant; MOU Consultant analyzes, synthesizes, and reports results as well as provides adaptive management and monitoring recommendations to ICWD and LADWP management.	LORP Annual Report is to be presented by LADWP and ICWD in a transparent, publicly accessible manner following each monitoring year.	Annual.

Table A.6 Monitoring Summary Table

TERM	MANAGEMENT AREA		**OUTPUT** See the LORP Monitoring Methodologies Section 3.0 for details on each task.		TIMING
	RIVER MONITORING				
Short-term Output	Base Flow Flow Compliance		Collect data from continuous recorders at 15 gaging stations (to be no fewer than 4 once it has been determined that a stable flow of approximately 40 cfs has been achieved throughout the river). Until a stable flow of approximately 40 cfs has been achieved throughout the river, flow rates are monitored and reported weekly or bi-weekly as needed. Once flows have stabilized, continuous flow data is reported monthly.		Year-round
	Base Flow Water Quality		Measure water quality conditions at 7 locations and other locations along the river channel, including DO, pH, EC, temperature, turbidity, ammonia, hydrogen sulfide, and tannins and lignins. During the month prior to the commencement of Phase I flows, monitoring data are reported once. During Phase I releases, monitoring is reported weekly or bi-weekly. During Phase II releases, monitoring is reported weekly or bi-weekly at first and then weekly.		December 06 or January 07
	Base Flow Fish Condition		Visual observations of river to detect fish conditions or fish kills at 7 water quality monitoring locations. Same duration & frequency as water quality monitoring.		Concurrent with WQ Sample
	Seasonal Habitat Flow Compliance		During the release of flows, data are collected five times per week during the flow and for up to two weeks following the flow release. Monitoring data is reported weekly.		May-June
	Seasonal Habitat Flow Flooding Extent		Aerial survey – From LADWP helicopter, survey and video/photograph seasonal habitat flows at peak flows.		May-June
	Seasonal Habitat Flow Water Quality		During the first three releases of flows, data from the 7 locations are collected five times per week during the flow and for up to two weeks following the flow release. After the first 3 flow releases, water quality monitoring is discontinued.		May-June
	Seasonal Habitat Flow Fish Condition		Visual observations of river to detect fish conditions or fish kills at 7 water quality monitoring locations. Same duration & frequency as water quality monitoring.		May-June
	Rapid Assessment Survey		Walk the river along designated route from the intake to the pump station, with stops at permanent monitoring points. Take photos. GPS locations of noteworthy observations for future monitoring or evaluation. Enter data in GIS and spreadsheet. Once per year.		July or August
	Contingency Monitoring		Additional monitoring may be incorporated into the monitoring program during the first 15 years of project operation.		unknown
Long-term Output	Riparian Habitat Development		Measure 25 habitat characteristics at approximately 242 sample sites to assess habitat development along the river.		September
	Landscape Vegetation Mapping		Acquire and interpret satellite imagery of the river and map habitats. Measure large-scale vegetation trends and habitat extent, document tule development, beaver dams, and open water areas.		May-June
	Site Scale Vegetation Assessment		GIS files of vegetation community patterns and trends.		June-September
	Fish Habitat Survey		Measure 8 habitat characteristics at approximately 105 transects located in 5 representative plots.		July-August
	Analysis and Reporting		Analyze, synthesize, and report on data collected during riverine-riparian field efforts, report on observed trends, problems, and successes, document compliance with MOU requirements, recommend adaptive management measures or changes to monitoring. By October 1 of each year submit report to LADWP and the County.		October

	BLACKROCK MONITORING				
Short-term Output	Rapid Assessment Survey		Walk the wetlands along designated route from the intake to the pump station, with stops at permanent monitoring points. Take photos and GPS locations of noteworthy observations for future monitoring or evaluation. Enter data in GIS and spreadsheet.		July-August
	Contingency Monitoring		Additional monitoring may be incorporated into the monitoring program during the first 15 years of project operation.		unknown
Long-term Output	Wetland Compliance		Record spillgate discharge, flows at diversions, and staff gage elevations that serve as indicators of a real extent of flooding. Change datalogger modules weekly.		Year-round
			Field measure the flooding extent of active units using aerial surveys and/or circumnavigating flooded areas. Map the flooding extent to determine the amount of acreage flooded and compliance.		May-June
	Habitat Development		Measure 25 habitat characteristics at 58 permanent plots per unit to assess habitat development at representative sampling sites.		July-August
	Landscape Vegetation Mapping		Acquire and interpret remote sensing imagery. Measure trends in habitat development and wetland response to flows; measure aerial extent of shallow flooding and wetland and riparian vegetation, including tules. Mapping may be discontinued after year 5, if it is determined to not be needed.		July-August
	Analysis and Reporting		Analyze, synthesize, and report on data collected during delta efforts, report on observed trends, problems, and successes, document compliance with MOU requirements, recommend adaptive management measures or changes to monitoring. By October 1 of each year submit report to LADWP and the County.		October
	DELTA MONITORING				
Short-term Output	Rapid Assessment Survey		Semi-quantitative assessment of wetland conditions and woody riparian recruitment along a pre-determined route, with photo documentation of wetland response to flows. Enter data in GIS and spreadsheet.		July-August
	Contingency Monitoring		Additional monitoring may be incorporated into the monitoring program during the first 15 years of project operation.		unknown
Long-term Output	Flow Compliance		Monitoring of releases to the delta from the pump station occurs over the life of the project. Data from the stream gages is reported monthly. Document that a continuous, combined flow of at least 0.5 cfs is passing the two gaging stations on the east and west branches of the delta.		Year Round
	Habitat Development		Measure 10 habitat characteristics at 29 transects to assess habitat development at the delta.		July-August
	Landscape Vegetation Mapping		Acquire and interpret remote sensing imagery as with other LORP features in primary years. Annual mapping may be discontinued after year 5, if it is determined to not be needed. Measure aerial extent of shallow flooding and wetland and riparian vegetation, including tules; identify beaver dams; measure open water areas.		July-August
	Analysis and Reporting		Analyze, synthesize, and report on data collected during delta efforts, report on observed trends, problems, and successes, document compliance with MOU requirements, recommend adaptive management measures or changes to monitoring. By October 1 of each year submit report to LADWP and the County.		October

	OFF-RIVER LAKES AND PONDS MONITORING				
Short-term Output	Rapid Assessment Survey		Semi-quantitative assessment of wetland conditions and woody riparian recruitment along a pre-determined route, with photo documentation of wetland response to flows. Enter data in GIS and spreadsheet.		July-August
Long-term Output	Water Level Compliance		Record staff gage elevations. Average weekly water surface elevation will be calculated, as well as the monthly and annual mean, median, maximum, and minimum. Staff gage data will be reported weekly in the initial year of restoration. If water surface elevations remain stable over time, monitoring and reporting frequency will be reduced.		Year Round
	Analysis and Reporting		Analyze, synthesize, and report on data collected during delta efforts, report on observed trends, problems, and successes, document compliance with MOU requirements, recommend adaptive management measures or changes to monitoring. By October 1 of each year submit report to LADWP and the County.		October
	RANGE MONITORING				
Short-term Output	Utilization		Measure 20 ungrazed and grazed plant heights on walking transects in all pastures to determine percent utilization. Results will be reported annually where appropriate and included in the LORP Annual Monitoring Report.		Nov May
	Irrigated Pasture Condition		Rate all irrigated pastures using 10 indicators, rated separately; the scores are combined into an overall score for the pasture and percent rating is calculated. Results will be reported annually where appropriate and included in the LORP Annual Monitoring Report.		May-Jun
Long-term Output	Range Trend		Measure 34 samples on 65 transects for nested frequency analysis.		July-August
	Analysis and Reporting		Analyze, synthesize, and report on data collected during delta efforts, report on observed trends, problems, and successes, document compliance with MOU requirements, recommend adaptive management measures or changes to monitoring. By October 1 of each year submit report to LADWP and the County.		October
	MEETINGS/COORDINATION				
	Management		Annual meetings to coordinate work efforts, analyze data and make adaptive management recommendations		Year Round

A.3 Monitoring Costs Estimate

APPENDICES
A.3

The following tables are an estimate of labor time, cost and sampling schedule for the monitoring and reporting of the LORP. This schedule is only an estimate. As the monitoring details and field requirements are better understood the proposed schedule and sampling years may change if it is deemed more efficient.

Table A.7 Monitoring Labor Estimates and Costs Table

	Labor Estimate (days/level)		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Total
RIVER MONITORING																		
Base Flow Flow Compliance	8 /Tech		25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	375
Base Flow Water Quality	60/Tech		30															30
Base Flow Fish Condition	0 (with above)		0															0
Seasonal Habitat Flow Compliance	6/Tech		14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	210
Seasonal Habitat Flow Flooding Extent	5/Professional		5	5	5	5	5			5			5			5		40
Seasonal Habitat Flow Water Quality	20/Tech		20	20	20													60
Seasonal Habitat Flow Fish Condition	0 (with above)		0	0	0	0												0
Rapid Assessment Survey	35/Professional		35	35	35	35	35	35	35	35	35	35						350
	15/Professional		15	15	15	15	15	15	15	15	15	15						150
Riparian Habitat Development	120/Tech			120			120		120			120					120	600
	30 Professional			30			30		30			30					30	150
Landscape Vegetation Mapping	45/Professional			45			45		45			45					45	225
Site Scale Vegetation Assessment	65/Tech			105			105		105			105					105	525
	40/Professional																	
Fish Habitat Survey	70/Tech				70			70			70							210
	20 Professional				20			20			20							60
Contingency Monitoring	unknown																	unknown
Analysis and Reporting	30/Professional		30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	450
	30/Professional		30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	450
	30/Professional		30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	450
BLACKROCK MONITORING																		
Wetland Compliance	8/Tech		8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	120
	3/Tech		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	45
	1/Professional		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Rapid Assessment Survey	12/Professional		12	12	12	12	12	12	12	12	12	12						120
	6/Professional		6	6	6	6	6	6	6	6	6	6						60
Habitat	24/Tech			24			24		24			24					24	120

Development	12 Professional			12			12		12			12					12	60
Landscape Vegetation Mapping	25/ Professional				25	25		25		25	25		25	25	25	25		225
Contingency Monitoring	unknown																	unknown
Analysis and Reporting	10/Professional		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	150
	10/Professional		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	150
	10/Professional		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	150
DELTA MONITORING																		
Flow Compliance	4/Tech		4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	60
Rapid Assessment Survey	9/Professional		9	9	9	9	9	9	9	9	9	9						90
	3/Professional		3	3	3	3	3	3	3	3	3	3						30
Habitat Development	18/Tech			18			18		18			18					18	90
	3 Professional			3			3		3			3					3	15
Landscape Vegetation Mapping	15/Professional				15	15		15		15	15		15	15	15	15		135
Contingency Monitoring	unknown																	unknown
Analysis and Reporting	10/Professional		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	150
	10/Professional		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	150
	10/Professional		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	150
OFF-RIVER LAKES AND PONDS																		
Water Level Compliance	4/Tech		4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	60
Rapid Assessment Survey	3/Professional		3	3	3	3	3	3	3	3	3	3						30
	3/Professional		3	3	3	3	3	3	3	3	3	3						30
Analysis and Reporting	2 Professional		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	30
	2 Professional		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	30
RANGE MONITORING																		
Utilization	72/Tech		72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	1080
Irrigated Pasture Condition	10/Tech		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	150
Range Trend	132/Tech			132	132		132					132					132	660
Analysis and Reporting	60/Professional		60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	900
MEETINGS/COORDINATION																		
Management	20/Professional		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	300
	20/Professional		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	300
	15/Professional		15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	225
ANNUAL LABOR			**551**	**1050**	**783**	**541**	**1030**	**626**	**853**	**541**	**626**	**985**	**487**	**482**	**482**	**487**	**931**	

EXPENSES			**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**	**Year 11**	**Year 12**	**Year 13**	**Year 14**	**Year 15**	
Field Equipment			$10,000	$10,000	$12,000	$12,000	$12,000	$14,000	$14,000	$14,000	$16,000	$16,000	$16,000	$18,000	$18,000	$18,000	$18,000	$218,000
Materials and Fuel			$3,500	$3,500	$4,000	$4,000	$4,000	$4,500	$4,500	$5,000	$5,500	$5,500	$6,000	$6,500	$6,500	$7,000	$7,500	$77,500
Fence Maintenance			0	$30,000	0	0	$33,000	0	0	$35,000	0	0	0	$45,000	0	0	$55,000	$198,000
Road Maintenance			0	$27,000	0	0	$29,000	0	0	$32,000	0	0	$36,000	0	0	$40,000	0	$164,000
Remote Imagery			0	$65,000	$65,000	$68,000	$68,000	$70,000	$70,000	$75,000	$75,000	$80,000	$80,000	$82,000	$84,000	$90,000	$90,000	$1,062,000
Water Quality			$22,000	$22,000	$22,000	$12,000	$12,000	$14,000	$14,000	$16,000	$16,000	$16,000	$18,000	$18,000	$18,000	$20,000	0	$240,000
Total Expenses			**$35,500**	**$157,500**	**$103,000**	**$96,000**	**$158,000**	**$102,500**	**$102,500**	**$177,000**	**$112,500**	**$117,500**	**$156,000**	**$169,500**	**$126,500**	**$175,000**	**$170,500**	**$1,959,500**

A.4 LORP Grazing Lease Maps

APPENDICES
A.4

PROLOGUE

Owens Valley Management Plans are one of the components required in the Memorandum of Understanding (MOU) between the City of Los Angeles Department of Water and Power (LADWP), the County of Inyo, the California Department of Fish and Game, the California State Lands Commission, the Sierra Club, and the Owens Valley Committee (1997). The goal of the Owens Valley Management Plan is to support the achievement of LADWP's watershed management goals, which are to improve water quality, improve water-use efficiency, maintain compatibility with water gathering activities, and support LADWP's goal of continuing a cost-effective aqueduct operation. Additional goals are to establish a healthy, functioning ecosystem for the benefit of biodiversity and special status species while providing for the continuation of sustainable uses, including recreation, livestock grazing, agriculture, and other activities (MOU 1997). LADWP plans to achieve these goals through the implementation of "Best Management Practices" (BMPs), and apply adaptive management to build and maintain a healthy watershed. BMPs are methods, measures, or land-management practices designed to improve watershed health.

One of the items to be addressed in the Owens Valley Management Plans was livestock grazing. In an effort to meet the goals of protecting valuable water resources while providing for the continuation of sustainable uses, LADWP, in consultation with Ecosystem Sciences, the MOU consultants, and the ranch lessees, developed Grazing Management Plans for each of the then 49 ranch leases in Inyo County. These grazing management plans are designed to meet regional water quality regulations by implementing BMPs that address water quality issues and enhance existing conditions. During the development of these plans, staffs from Ecosystem Sciences and the Watershed Resources section of LADWP coordinated closely with the lessees in an attempt to develop plans that are compatible with the lessees' operations yet ensure that watershed health goals are met.

Several issues were raised during the development of the final drafts of plans for ranch leases that lie within the boundaries of the Lower Owens River Project (LORP). These issues included forage utilization rates on upland areas, assessing the condition of irrigated pastures, and critical operational management areas for the leases. In an effort to address these issues, a focus group of ranch lessees met with staff from LADWP in December 2003. The intent was to arrive at solutions that were acceptable to both LADWP and the lessees on these critical issues. In attendance representing LADWP were Gene Coufal, Clarence Martin, Brian Tillemans, Paula Hubbard, Debbie House, David Martin, and Dale Schmidt. Lessees in attendance were Scott Kemp, Mark Johns, Mark Lacey, Ron Yribarren, and Gary Giacomini.

In early drafts of the Grazing Management Plans, irrigated pasture conditions were to be determined ocularly and pastures qualitatively rated as being in poor, fair, good, or excellent condition. Pastures rated as either poor or fair would have utilization standards established in an effort to improve their condition rating. In an effort to establish a more quantitative system of rating that would be less susceptible to bias, LADWP staff tested the Natural Resource Conservation Service Guide to Pasture Condition Scoring and determined that the method was quantitative, easy to implement, repeatable, and yielded consistent results among various users. Members of the lessee focus group indicated that the method was acceptable. Beginning in 2004, LADWP and the lessees jointly would start assessing irrigated pastures on all leases. Due to the number of irrigated pastures, it was determined that it would not be possible to assess the condition of all irrigated pastures on all leases every year, but a subset of all irrigated pastures will be jointly (LADWP and lessee) evaluated annually. During years of below-normal precipitation and when water allotments for irrigation are reduced, there will be no downgrading of pasture condition. If irrigation reduction lasts for more than one season, however, adjustments in livestock numbers may be necessary to ensure there are no long-term detrimental impacts to irrigated pastures.

Early Grazing Management Plan drafts established upland forage utilization rates at 65 percent as long as there were 31 days of rest for the pasture at some time during the growing season. LADWP staff were concerned that this level of utilization and short rest period would prohibit native grasses from completing seed set and, consequently, result in a decline in the trend of the upland area. More restrictive language setting utilization rates at 50 percent if plants were grazed at anytime during the period from April 2 to September 30 was not acceptable to the rancher focus group because of the restrictions concerning being able to move livestock to other private lands or federal permit areas prior to April 2. As a compromise, 65 percent utilization was established for all upland areas as long as there was a minimum of 60 continuous days of rest for the area during the plant "active growth stage" to allow seed set between June and September. If the pasture does not receive 60 continuous days of rest between June and September, utilization rates will be set at 50 percent. This was acceptable to the lessees and should not prohibit the achievement of LADWP's goal if adaptive management guidelines are followed.

The final concern that the rancher focus group expressed was that there are portions of their leases that are critical to their ability to operate. These areas include livestock gathering areas, holding areas, and shipping areas. LADWP recognized these needs and agreed that establishment of utilization standards for these areas would not be appropriate.

GRAZING MANAGEMENT PLAN SUMMARIES

Below are summaries of grazing management plans for the seven major leases that occur in the LORP planning area. These plans were completed in June 2006 by LADWP in cooperation with Ecosystem Sciences and the leaseholders.

Twin Lakes Grazing Management Plan (RLI-485)

Twin Lakes Lease is located south of the Los Angeles Aqueduct Intake and named for Twin Lakes, located at the southern end. The 4-J Cattle Company, Inc. grazes livestock on the Twin Lakes Lease. The lease is 4,971 acres and is presently managed as a single pasture. The reach of the Owens River passing through this lease is 6.1 miles. No permanent flow occurs in the river channel; however, some areas are wetted from sub-surface sources.

Upper and Lower Twin Lakes are a 24-acre Enhancement/Mitigation area on the Twin Lakes Lease. Riparian/wetland lands are associated with the Owens River Channel, Upper and Lower Twin Lakes, and one spring (BLK 133) in the Twin Lakes Lease. The upper 4 miles of the Owens River in the lease receives leakage from the Los Angeles Aqueduct diversion. Ponded water and marsh vegetation are present within the historic river channel; wet meadow is present on low floodplains; alkali meadow is prominent on higher floodplains and low terraces; and alkali shrubs occur on higher river terraces.

The Owens River Channel in the lease is primarily dry or seasonally moist. Riparian/wetland habitat in the channel is limited to patches of emergent vegetation and scattered willows. Additional herbaceous wetlands are present near Drew Slough, around Twin Lakes, and near a spring north of Upper Twin Lake. The isolated spring (BLK 133) occurs along the Owens Valley Fault, just north of Upper Twin Lake. Open water, tule marsh, riparian shrub, wet meadow, and alkali meadow vegetation comprises 96 acres in the vicinity of the spring. Water from the spring does not reach the river.

No known threatened or endangered species issues occur on the lease, but other special status species may be present. Habitat improvements from the addition of future river flows and changes in livestock management should enhance habitats for all species.

Once the new grazing plan is adopted, the lessee will have a period of one to three years to phase its present grazing operation into the changes and requirements of this plan. By the fourth year, and from that time on, the lessee must meet all standards, criteria, and directions outlined in this plan.

Present grazing management is for winter-spring grazing only. The lessee manages the herd depending upon forage condition, which varies based on precipitation in any given year. Cattle presently enter the south end of the lease in late October or early November. A second batch of cattle enters the lease in late December or early January. All cattle are usually off the lease by May 15. The current grazing practice is to release cattle into the lease and then let forage conditions and drinking water determine their grazing patterns. Most of the drinking water and available forage occur on the south end of the lease, along Blackrock Ditch. Livestock also use areas surrounding existing water holes in the river channel. The area along the river receives use, particularly the middle river reach, from December through May 15. The terraces and fans east of the river are utilized during March through May, depending upon when green-up occurs.

Major management changes include the establishment of a large riparian pasture (1,700 acres). This pasture will be managed under a grazing prescription that protects young willows and other LORP goals. Grazing management changes for the riparian pasture were designed to minimally affect the lessee's upland grazing practices. Four miles of new fence and two new cattle guards will be required to create the new pasture. An existing rare plant exclosure for Nevada oryctes (*Oryctes nevadensis*) will also be reconstructed, requiring 0.25 mile of new fence.

The new riparian pasture will be grazed in the spring. The earliest grazing will be allowed is April 1. Livestock will be removed from the pasture by mid-May. The riparian pasture may be grazed until 40 percent of the herbaceous forage is utilized in the riparian area, or the end of the specified grazing period for the pasture, whichever comes first. This prescribed utilization should ensure the survival of riparian shrubs and trees during their first three years of growth. Grazing "on-and-off" dates can vary each year in response to varied climatic conditions, forage development, and livestock management practices, contingent upon attainment of upland and riparian objectives.

Under the Blackrock Waterfowl Habitat Management Plan, the Drew Slough Unit will occasionally be flooded and managed as waterfowl and shorebird habitat. A temporary loss of acreage available for grazing will occur due to the flooding. This forage loss may be offset by increased forage production due to increased water availability.

Long-term monitoring will compare vegetation response and condition in the riparian pasture with response in a nongrazed riparian pasture in the Thibaut Lease. If long-term monitoring determines that livestock management is precluding development of desired riparian conditions along the Owens River, grazing prescriptions will be modified to attain desired conditions. Riparian pastures may also contain upland habitat. If significant amounts of upland vegetation occur within a riparian pasture or field, upland grazing utilization standards, as outlined in this lease plan, will also apply to these upland habitat types. Livestock will be removed from a riparian pasture when either the riparian or the upland grazing utilization standard is met.

Upland management objectives are to sustain livestock grazing, provide productive wildlife and fish habitat, maintain desired healthy range conditions, and maintain or increase range condition trend. Maximum annual average herbaceous utilization allowed in upland areas is 65 percent if grazing occurs only during the plant dormancy period. Utilization allowed in upland areas is 50 percent if livestock grazing occurs during the active plant growing period; however, if no livestock grazing occurs during the active plant growing period (that period when plants are "active" in putting on green growth) or the pasture or field is completely unused for a minimum of 60 continuous days during the later part of this "active stage", allowable forage utilization can be increased from 50 to 60 percent.

LADWP and the lessee will jointly determine irrigated field or pasture condition. The method utilized will be the *Natural Resource Conservation Service Condition Assessment*. Irrigated fields or pastures scoring 80 percent or greater will be considered in good to excellent condition. These fields or pastures will not be subject to any changes in grazing management. Any irrigated field or pasture scoring less than 80 percent will require management prescription changes (i.e., changes in utilization, livestock numbers, season of use, or duration of use).

Ecological or range sites within the lease will be monitored using condition and trend evaluations, documented annual range inspections, and periodic photos of established points. Utilization cages will be used to monitor forage use. Management directions specified in this plan may be modified through adaptive management based on analysis of monitoring information. The adaptive management approach provides flexibility to account for unforeseen benefits or impacts.

Blackrock Lease Grazing Management Plan (RLI-428)

The Blackrock Lease is the largest lease in the LORP area. Livestock grazing on the lease is managed by Lacey Livestock.

Goose Lake, in the White Meadow Pasture, and Billy Lake, in the Reservation Field, are the two Enhancement/Mitigation Projects on the Blackrock Lease. Five hundred eighty-eight (588) acres of Type E vegetation occur on the lease. Alkali shrubs, complimented with scattered riparian shrubs and alkali meadow, are prevalent along dry portions of the Owens River in the White Meadow and Reservation Fields. Riparian shrubs, marsh, and alkali meadow are prevalent along wetted portions of the Owens River channel below Billy Lake. Riparian/wetland vegetation also occurs on the historic floodplain of the Owens River, around Goose Lake in the White Meadow Pasture, and Billy Lake in the Reservation Field. Riparian/wetland vegetation also occurs in the vicinities of four springs associated with the Owens Valley Fault and around another spring in Robinson Pasture. Riparian pastures may also contain upland habitat. If significant amounts of upland vegetation occur within a riparian pasture or field, upland grazing utilization standards, as outlined in this lease plan, will also apply to these upland habitat types. Livestock will be removed from a riparian pasture when either the riparian or the upland grazing utilization standard is met.

The lessee will have one to three years from the date this new grazing plan is implemented to phase in requirements described in this plan. At the beginning of the fourth year, the lessee must meet all standards, criteria, and other management direction outlined in this plan.

Numerous rare plant sites were identified on the lease. Five of these sites will be excluded from livestock grazing during the flowering periods for the Inyo County star-tulip (*Calochortus excavatus*) and the Owens Valley checkerbloom (*Sidalcea covillei).* Five new riparian pastures will be established to protect riverine/riparian habitat. Riparian grazing is designed to minimally affect the lessee's livestock management in the uplands. Creation of the five riparian pastures will require 20 miles of new fence. Livestock will graze riparian pastures for only a short period in the spring. Spring grazing will also allow livestock to use spring forbs during "green-up" on alluvial fans east of the Owens River.

Grazing riparian pasture can begin in late March in selected pastures. Livestock will be removed from these pastures by mid-May. Grazing "on and off" dates can vary from year to year in response to changing climatic conditions, forage development, and livestock management practices. Cattle will be removed from riparian pastures at the end of the grazing period or when the average utilization of herbaceous forage (includes elk use) has reached 40 percent, whichever comes first. This prescribed utilization and duration will ensure survival of riparian shrubs and trees during their first three years of growth, when they are most susceptible to grazing.

Two new stockwater sources will be developed in uplands east of the river and a third in the Reservation Field to encourage less livestock use in riparian areas. Water sources will be developed prior to livestock grazing riparian pastures. One new water source converts a former windmill site in the North River Riparian Field. An abandoned artesian well in the southwest part of Reservation Field and one in the western portion of White Meadow Field will be developed.

Upland management grazing objectives are to sustain livestock grazing, provide productive wildlife and fish habitat, maintain desired healthy rangeland conditions, and maintain or increase range condition trend. Maximum annual average herbaceous livestock grazing utilization allowed in upland areas is 65 percent if grazing occurs only during the plant dormancy period. Maximum average herbaceous forage utilization allowed in upland areas is 50 percent if livestock grazing occurs during the active plant growing period; however, if no livestock grazing occurs during the active plant growing period (that period when plants are "active" in putting on green growth) or the pasture or field is completely unused for a minimum of 60 continuous days during the later part of this "active stage," allowable forage utilization can be increased from 50 to 65 percent.

Forage use in selected upland and riparian pastures will be monitored annually using utilization cages. Cattle will be removed from pastures when comparisons inside and outside the cages indicate that utilization standards have been met. Cattle will then be moved to the previously used pasture in the grazing rotation provided utilization standards have not already been exceeded, or to the next pasture in the grazing sequence. Other monitoring tools will include annual range inspections, condition and trend evaluations, photo points, and the lessee's monitoring information. Grazed riparian pasture conditions will be compared with nongrazed riparian pasture conditions. This information will identify changes needed to attain desired riparian ecosystems along the re-watered Owens River. Ecological and/or range sites will be monitored using vegetation condition and trend evaluations, documented annual range inspections, and periodic photos of established points. Utilization cages will be used for monitoring forage use.

Thibaut Lease Grazing Management Plan (RLI-430)

The Thibaut Lease (RLI-430) is leased to Herbert London, Robert C. Tanner, and Mammoth Lakes Pack Outfit for livestock grazing. These three lessees operate horseback riding and packing services in the Sierras. When the summer recreation season closes in mid-September, they bring their horses and mules to graze the Thibaut Lease until their packing services resume the following June.

Designated irrigated pasture comprises 80 acres of the Thibaut Lease. Type E vegetation lands occur in the northwest corner of the lease, in an area where the Blackrock Waterfowl Habitat Area will be established.

Riparian/wetland vegetation is present on some areas of the historic floodplain of the Owens River. Saltgrass, scattered tamarisk, and a few willows are dominant where the floodplain is moist. Shallow groundwater tables and subirrigation from the Los Angeles Aqueduct sustain extensive saltgrass/sacaton meadows along the west side of the lease. The spring (IND56) located on the Owens Valley Fault, near the center of the lease, also sustains riparian/wetland vegetation.

The Owens Valley checkerbloom (*Sidalcea covillei*), a state-listed endangered species, is found on parts of the lease. Other special status species may be present on the lease; however, improvements from future water flow and livestock management are expected to enhance habitats for species of concern.

Management changes within the Thibaut Lease include a reduction in herd size, establishing grazing utilization standards, creating two additional pastures through fencing, and constructing a large riparian/river exclosure. Livestock will be excluded from the large riparian exclosure to ensure that future riverine/riparian values are protected. A 247-acre pasture will be created for waterfowl management in the northwest corner of the lease. A second 211-acre area along the western border of the lease will be fenced to protect rare plants. Livestock management in these two special management areas will be managed to achieve waterfowl habitat and rare plant goals.

> The lessees will have one to three years from the date this new grazing plan is implemented to phase in requirements described in this plan. At the beginning of the fourth year, the lessees must meet all standards, criteria, and other management direction outlined in this plan.

The entire Owens River riparian area within the lease will be fenced and not grazed for a minimum of 10 years. At the end of 10 years, LADWP will evaluate whether the vegetation goals have been met and decide future management for the area. Packer livestock herd size will be reduced; a large, nongrazed riparian pasture (846 acres) will be developed; and two new pastures will be fenced to allow restricted and controlled livestock use. Regardless of the scheduled "off-dates," stock will be removed when monitoring determines that average utilization of herbaceous forage on riparian sites has reached 40 percent. Long-term monitoring will compare vegetation response on the riparian pastures with nongrazed areas established as controls. If long-term monitoring determines that livestock management is precluding the development of desired riparian communities on the Thibaut Lease, grazing prescriptions will be modified to attain desired conditions.

Riparian pastures may also contain upland habitat. If significant amounts of upland vegetation occur within a riparian pasture or field, upland grazing utilization standards, as outlined in this lease plan, will also apply to these upland habitat types. Livestock will be removed from a riparian pasture when either the riparian or the upland grazing utilization standard is met.

Upland management objectives are to sustain livestock grazing, provide productive wildlife and fish habitat, maintain desired healthy range conditions, and maintain or increase range condition trend. Maximum annual average herbaceous livestock grazing utilization allowed in upland areas is 65 percent if grazing occurs only during the plant dormancy period. Maximum average herbaceous forage utilization allowed in upland areas is 50 percent if livestock grazing occurs during the plant active growing period; however, if no livestock grazing occurs during the active plant growing period (that period when plants are "active" in putting on green growth) or the pasture or field is completely unused for a minimum of 60 continuous days during the later part of this "active stage," allowable forage utilization can be increased from 50 to 65 percent.

LADWP and the lessees will jointly determine irrigated field or pasture condition. The method utilized will be the *Natural Resource Conservation Service (NRCS) Pasture Condition Assessment*. Irrigated fields or pastures scoring 80 percent or greater will be considered in good to excellent condition. These fields or pastures will not be subject to any changes in grazing management. Any irrigated field or pasture scoring less than 80 percent will require management prescription changes (i.e., changes in utilization as needed, livestock numbers, and season, or duration of use).

LADWP will 1) construct 2.4 miles of new barbed wire fence along the western boundary of the Thibaut Riparian Exclosure; 2) reconstruct 6 miles of fence along the northern and southern boundaries of the lease, including the Thibaut Riparian Exclosure; and 3) construct 3.5 miles of fence to create the Waterfowl Management Area and the Rare Plant Management Area. After construction, the lessees will maintain all interior fences annually to LADWP standards. Sections of this fence will be designed to allow easy access during designated grazing periods.

Ecological or range sites within the pastures will be monitored through condition and trend evaluations, documented annual range inspections, and periodic photos of established points. Utilization cages will be used to monitor forage use. Management directions specified in this plan may be modified through adaptive management based on review of monitoring information. The adaptive management approach provides flexibility to account for unforeseen benefits or impacts.

Islands and Delta Leases Grazing Management Plan (RLI-489 and RLI-490)

The Islands and Delta Leases are both within the LORP planning area and operated by the Kemp family and, therefore, are considered together as one plan. The Kemp family also operates the Archie Adjunct Lease, the Fort Independence Lease, the Georges Creek Lease, and the Lubkin Adjunct Lease; all of which are outside of the LORP planning area. These leases are only briefly considered in this plan so that movement of animals between leases can be better understood.

Type E lands are supplied with water sufficient to avoid decreases and changes from vegetation conditions that existed on such lands during the 1981-1982 runoff year (Inyo County and City of Los Angeles, 1990). Type E vegetation comprises 388 acres on the Islands Lease and 72 acres on the Delta Lease, for a total of 460 acres.

Riparian/wetland vegetation is present on the historic floodplain of the Owens River in the vicinity of two springs on the Islands Lease (Reinhackle [DWP7] and DWP9), and near one spring on the Delta Lease (IPT11). Riparian trees, shrubs, marsh, and saltgrass meadow are prominent on the Owens River floodplain. Marsh and alkali meadow occur around the Reinhackle Spring (DWP7). Riparian shrub, meadow, and marsh are prominent around spring DWP9. Meadows surround spring IPT11.

Reinhackle, DWP9, and IPT11 are springs within the lease boundaries. All known springs on the ranch lease were visited prior to plan development. There were no adverse affects to any of the springs under current livestock management; therefore, no fencing will be constructed to protect the springs. Water from Reinhackle will continue to be used to irrigate pastures north and east of the spring.

No known threatened or endangered species issues occur on the leases, but other special status species may be present. Improvements from future river flows and changes in livestock management are expected to enhance habitats for these species.

The lessee will have one to three years from the date this new grazing plan is implemented to phase in requirements described in this plan. At the beginning of the fourth year, the lessee must meet all standards, criteria, and other management direction outlined in this plan.

Management changes within the Islands and Delta Leases include establishing two new riparian pastures, new grazing prescriptions for managing an existing riparian pasture, and creating a riparian exclosure. The two new riparian pastures will be grazed only in the spring. Grazing will not begin before February 1 for the Depot Riparian Pasture or before February 1 for the Carasco Riparian Pasture. Livestock will be removed from both pastures by the end of March. Regardless of the scheduled "off dates," cattle will be removed when monitoring determines that average utilization of herbaceous forage on riparian sites has reached 40 percent.

Long-term monitoring will compare vegetation response on the riparian pastures with nongrazed areas established as controls. If long-term monitoring determines that livestock management is precluding the development of desired riparian communities along the Owens River on the Islands and Delta Leases, grazing prescriptions will be modified to attain desired conditions. Riparian pastures may also contain upland habitat. If significant amounts of upland vegetation occur within a riparian pasture or field, upland grazing utilization standards, as outlined in this lease plan, will also apply to these upland habitat types. Livestock will be removed from a riparian pasture when either the riparian or the upland grazing utilization standard is met.

Upland management objectives are to sustain livestock grazing, provide productive wildlife and fish habitat, maintain desired healthy range conditions, and maintain or increase range condition trend. Maximum annual average herbaceous livestock grazing utilization allowed in upland areas is 65 percent if grazing occurs only during the plant dormancy period. Maximum average herbaceous forage utilization allowed on upland areas is 50 percent if livestock grazing occurs during the plant active growing period; however, if no livestock grazing occurs during the active plant growing period (that period when plants are "active" in putting on green growth) or the pasture or field is completely unused for a minimum of 60 continuous days during the later part of this "active stage," allowable forage utilization can be increased from 50 to 65 percent.

LADWP and the lessees will jointly determine irrigated field or pasture condition. The method utilized will be the Natural Resource Conservation Service (NRCS) Pasture Condition Assessment. Irrigated fields or pastures scoring 80 percent or greater will be considered in good to excellent condition. These fields or pastures will not be subject to any changes in grazing management. Any irrigated field or pasture scoring less than 80 percent will require management prescription changes (i.e., changes in utilization as needed, livestock numbers, and season, or duration of use).

Ecological or range sites within the pastures will be monitored through condition and trend evaluations, documented annual range inspections, and periodic photos of established points. Utilization cages will be used to monitor forage use. Management directions specified in this plan may be modified through adaptive management based on review of monitoring information. The adaptive management approach provides flexibility to account for unforeseen benefits or impacts.

Lone Pine Lease Grazing Management Plan (RLI-456)

Three pastures within the lease contain enhancement/mitigation (E/M) projects. An additional 11-acre project is located in the Adolofo Field, west of the Richards field and east of U.S. Highway 395. In addition to the E/M projects, designated Type E lands totaling 252 acres are present in the Miller, Smith, Old Place, and Edwards Pastures. There are 550 acres of riparian/wetland vegetation along the historic floodplain of the Owens River within the lease.

The lessee will have one to three years from the date this new grazing plan is implemented to phase in changes and requirements described in this plan. At the beginning of the fourth year, the lessee must meet all standards, criteria, and other management direction outlined in this plan.

Management changes include the improvement of an existing riparian pasture, new grazing prescriptions, and additional fencing to promote enhancement of riparian vegetation. The creation of the riparian pastures, exclosures, and other improvements will require one mile of new fence and 4.5 miles of reconstructed fence. The size of the lease will be increased by including LADWP lands to the east of the Owens River.

Livestock can be in the River Riparian Pasture from January 1 through March 30. Grazing "on-and-off" dates can vary each year to respond to climatic conditions, forage development, and livestock management practices, contingent upon attainment of upland and riparian objectives. All changes, however, must first have LADWP approval. Regardless of the scheduled "off date," all livestock will be removed when the average utilization of herbaceous forage on riparian sites reaches 40 percent. This prescribed use should ensure survival of riparian shrubs and trees during their first three years of growth. Livestock will not return to the riparian pasture after March 30. The only change to the lessee’s current grazing duration periods is that livestock will not be allowed back on the River Pasture to graze from May 28 through June 12.

Long-term monitoring will compare vegetation condition in pastures containing riparian vegetation with a nongrazed riparian exclosure established as a control. If monitoring determines that livestock management is precluding development of desired riparian communities, grazing prescriptions will be modified to attain desired conditions. Further monitoring information can be found in the LORP Ecosystem Management Plan.

Upland management objectives are to sustain livestock grazing, provide productive wildlife and fish habitat, maintain desired healthy rangeland conditions, and maintain or increase range condition trend. Maximum annual average herbaceous utilization allowed in upland areas is 65 percent if grazing occurs only during the plant dormancy period. The utilization allowed in upland areas is 50 percent if livestock grazing occurs during the plant active growing period; however, if no livestock grazing occurs during the latter part of the active plant growing period (that period when plants are "active" in putting on green growth) or the pasture or field is completely unused for a minimum of 60 continuous days during the later part of this "active stage," allowable forage utilization can be increased from 50 to 65 percent.

Utilization cages will be placed on the lease to monitor forage use by livestock. These cages will be positioned in selected pastures prior to the arrival of livestock. These utilization cages will be moved on an annual or seasonal basis, depending on the specific livestock operations of the lease. The percent utilization of key forage species will be monitored and documented using locally developed height-weight curves.

Cattle will be removed from pastures when comparisons inside and outside the cages indicate that utilization standards have been met. Cattle can be moved to the previously used pasture in the grazing rotation, provided utilization standards have not already been exceeded, or to the next pasture in the grazing sequence. Other monitoring tools will include annual range inspections, condition and trend evaluations, photo point evaluations, and the lessee's monitoring information. Ecological and/or range sites will be monitored using vegetation condition and trend evaluations, documented annual range inspections, and periodic photo interpretation of established points.

Irrigated pastures will be rated according to the Natural Resource Conservation Service (NRCS) Pasture Condition Assessment (NRCS, 1991). This rating system is designed to evaluate pasture productivity and the stability of the plant community, soil, and water resources. The rating also aids in the identification of management options to improve pasture condition and productivity, if needed.

Management directions specified in this plan may be modified through adaptive management based on review of monitoring information. The adaptive management approach provides flexibility to account for unforeseen benefits or impacts. Future grazing management may be amended based on upland baseline assessments and trend monitoring. Evolving conditions in the riparian areas will also be monitored and may serve as a basis for amending future riparian management. Fencing, livestock numbers, forage utilization, water sources, and timing of grazing may be adjusted to achieve LADWP, LORP, and lease goals.

Intake Lease Grazing Management Plan (RLI-475)

Mr. Murton Stewart manages the Intake Lease. The lease is managed in conjunction with the lessees of other LADWP ranch leases in the Big Pine area. The lease is used to graze 40 horses and mules employed in a commercial packer operation. The Intake Lease (289) is comprised of two pastures. The 185-acre Intake Pasture lies to the west of the Owens River and the Los Angeles Aqueduct (LAA) at the LAA Intake. The 104-acre Big Meadow Pasture lies to the east of the Owens River, north of the LAA Intake and east of the LAA below the Intake.

Riparian/wetland vegetation is present on the historic floodplain of the Owens River. Marsh, wet meadow, alkali meadow, and riparian shrub vegetation are prominent. Rewatering of the Owens River and future livestock management in the Intake Lease will enhance riparian/wetland vegetation.

A seep that parallels the Owens Valley Fault creates approximately two acres of marginal wetland habitat consisting of alkali meadow, playa, and upland shrub vegetation types.

No known threatened or endangered species occur on the lease, but other special status species may be present. Improvements from future river flows and changes in livestock management are expected to enhance habitats for these species.

The lessee will have one to three years from the date this new grazing plan is implemented to phase in requirements described in this plan. At the beginning of the fourth year, the lessee must meet all standards, criteria, and other management directions outlined in this plan.

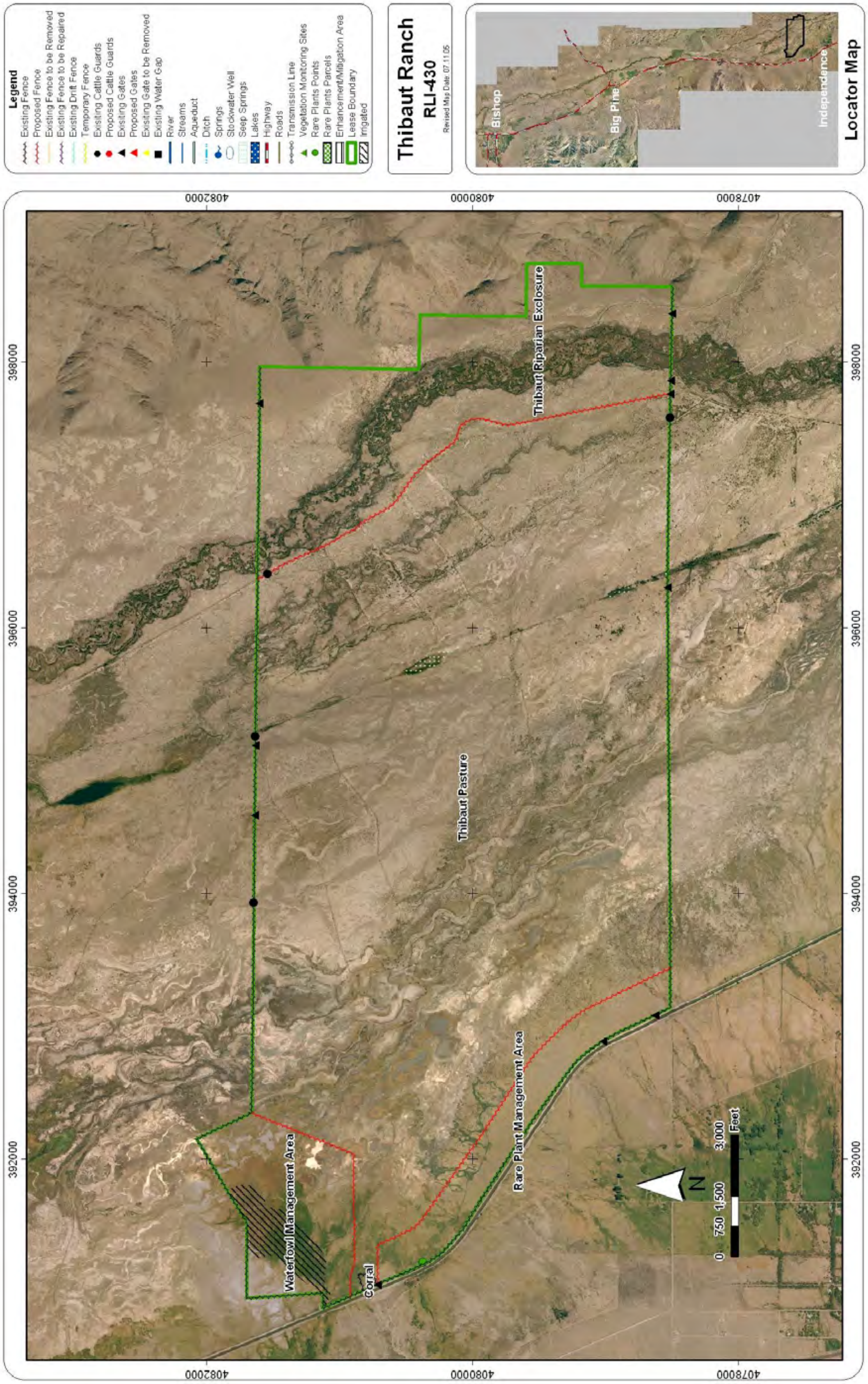
The Big Meadow Pasture will be managed as a riparian pasture. Riparian vegetation along the Owens River, within the Intake Grazing Lease, will be managed in accordance with the LORP goals. The Intake Pasture will continue to be managed as an upland pasture.

Regardless of the scheduled “off-dates”, stock will be removed when monitoring determines that average utilization of herbaceous forage on riparian sites has reached 40 percent. Long-term monitoring will compare vegetation response on the riparian pastures with non-grazed areas established as controls. If long-term monitoring determines that livestock management is precluding the development of desired riparian communities on the Intake Lease, grazing prescriptions will be modified to attain desired conditions. Riparian pastures may also contain upland habitat. If significant amounts of upland vegetation occur within a riparian pasture or field, upland grazing utilization standards, as outlined in this lease plan, will also apply to these upland habitat types. Livestock will be removed from a riparian pasture when either the riparian or the upland grazing utilization standards are met.

Upland management objectives are to sustain livestock grazing, provide productive wildlife and fish habitat, maintain desired healthy range conditions, and maintain or increase range condition trend. Maximum annual average herbaceous livestock grazing utilization allowed in upland areas is 65 percent if grazing occurs only during the plant dormancy period.

Maximum average herbaceous forage utilization allowed in upland areas is 50 percent if livestock grazing occurs during the active plant growing period; however, if no livestock grazing occurs during the active plant growing period (that period when plants are “active” in putting on green growth) or the pasture or field is completely unused for a minimum of 60 continuous days during the latter part of this “active stage”, allowable utilization can be increased from 50 to 65 percent.

Ecological or range sites within the pastures will be monitored through condition and trend evaluations, documented annual range inspections, and periodic photos of established points. Utilization cages will be used to monitor forage use. Management directions specified in this plan may be modified through adaptive management based on review of monitoring information.


Thibaut Ranch
RLI-430
Revised Map Date 07.11.05
Legend
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Proposed Fence
Existing Fence to be Removed
Existing Fence to be Repaired
Existing Drift Fence
Temporary Fence
Existing Cattle Guards
Proposed Cattle Guards
Existing Gates
Proposed Gates
Existing Gate to be Removed
Existing Water Gap
River
Streams
Aqueduct
Ditch
Springs
Stockwater Well
Seep Springs
Lakes
Highway
Roads
Transmission Line
Vegetation Monitoring Sites
Rare Plants Points
Rare Plants Parcels
Enhancement/Mitigation Area
Lease Boundary
Irrigated
Bishop
Big Pine
Independence
Locator Map
Thibaut Riparian Exclosure
Thibaut Pasture
Rare Plant Management Area
Waterfowl Management Area
Corral
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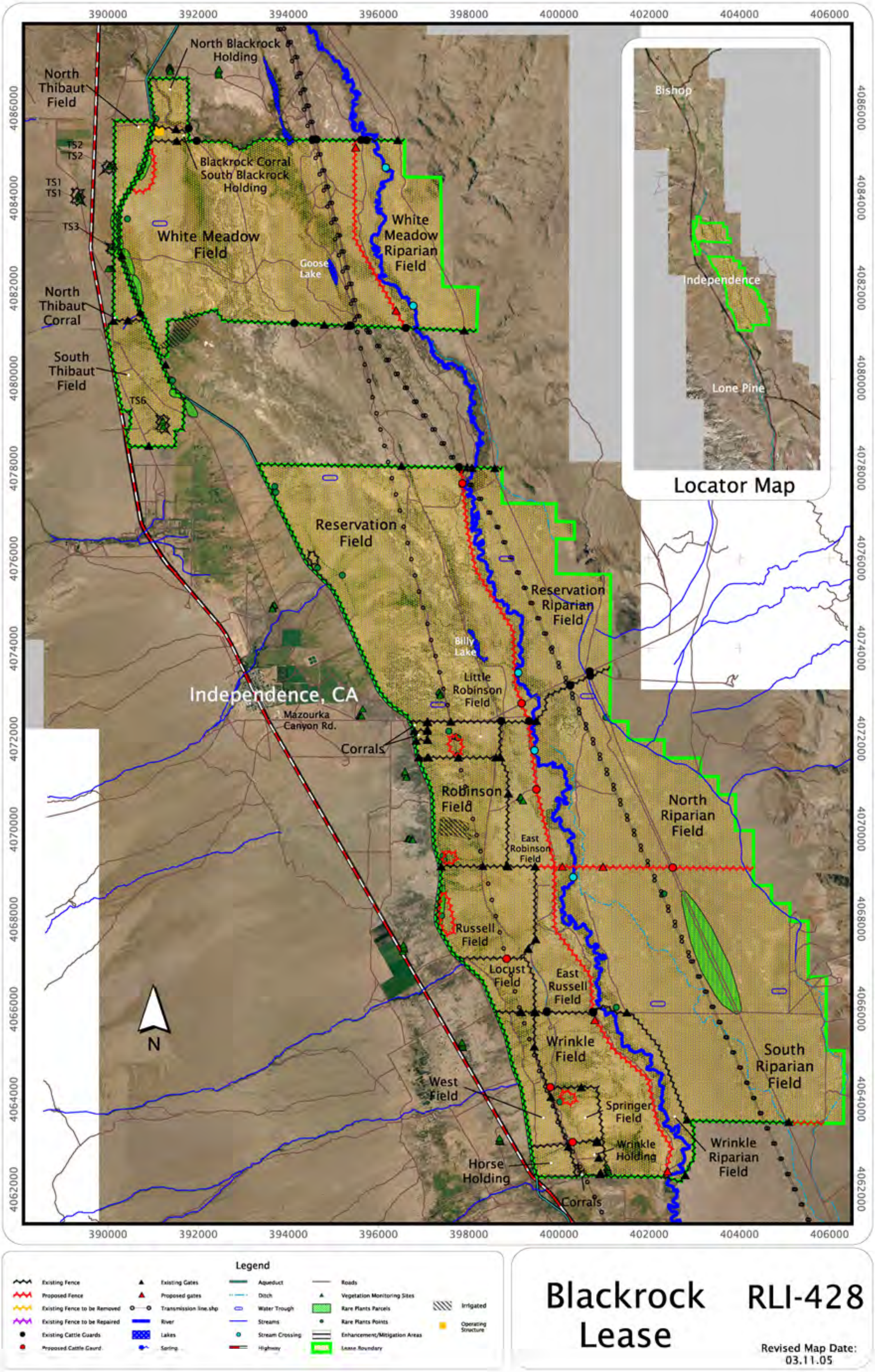
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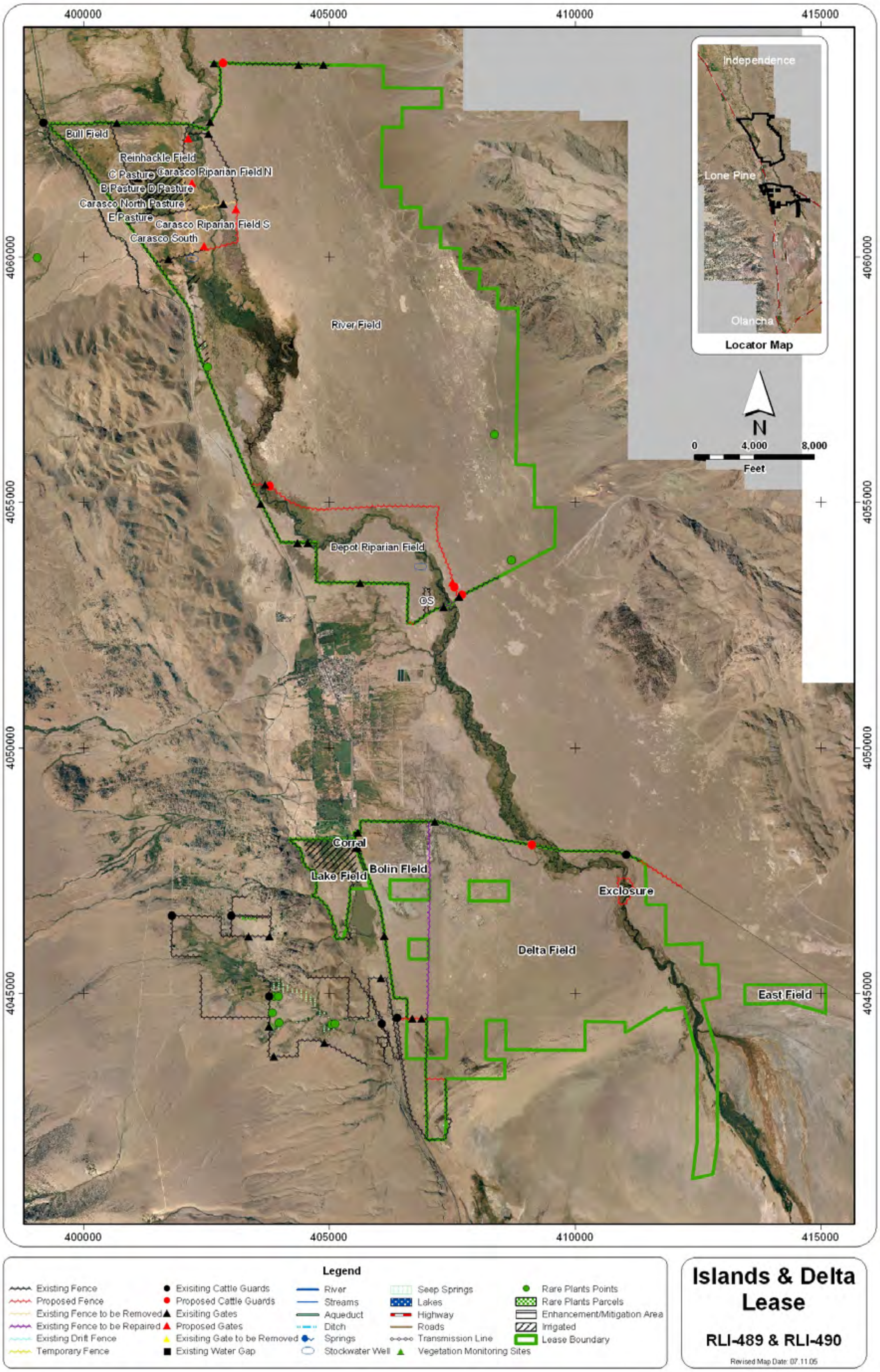
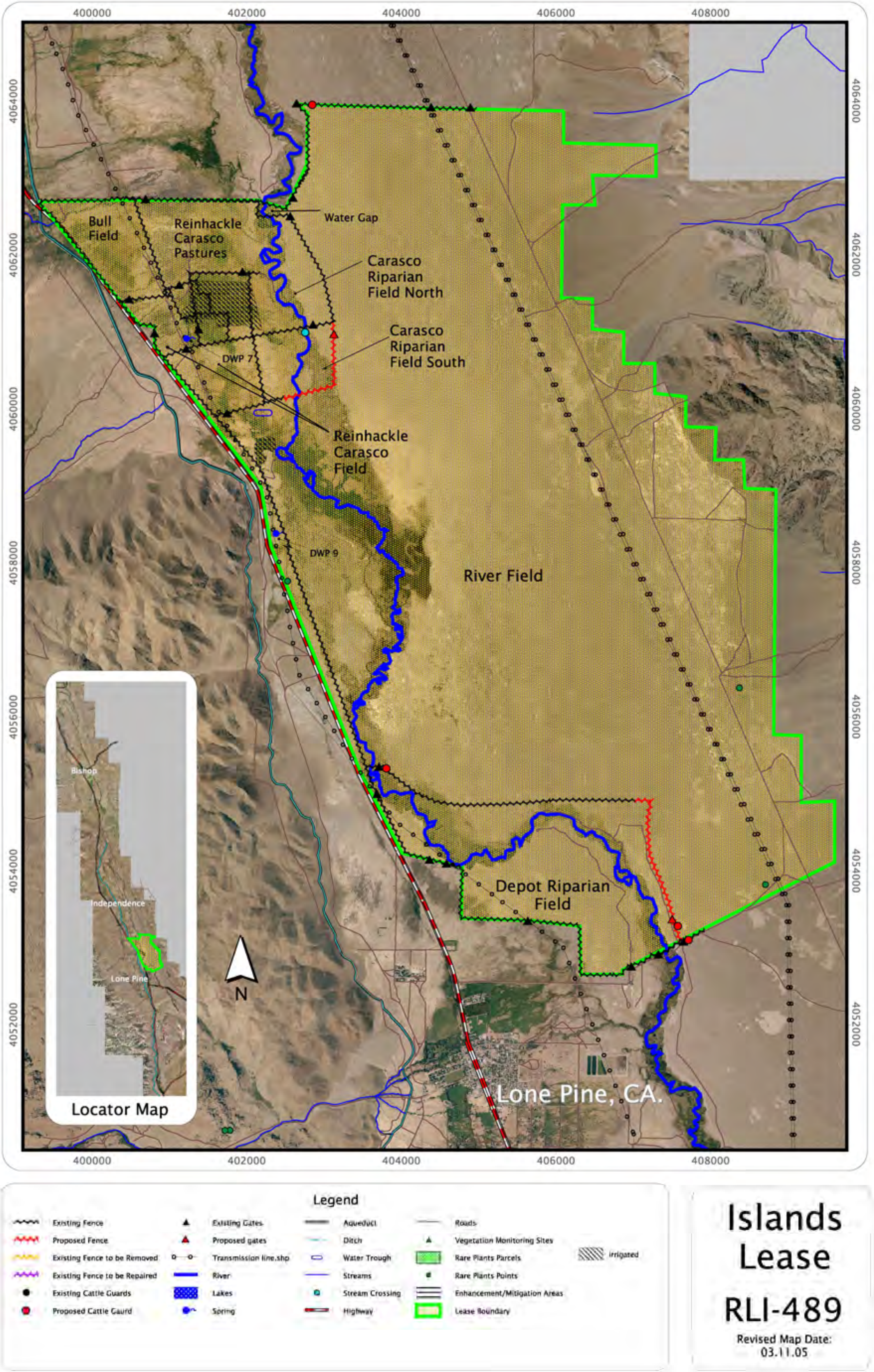
North Blackrock Holding
North Thibaut Field
TS2
TS2
TS1
TS1
TS3
Blackrock Corral South Blackrock Holding
White Meadow Field
Goose Lake
White Meadow Riparian Field
North Thibaut Corral
South Thibaut Field
TS6
Reservation Field
Reservation Riparian Field
Billy Lake
Little Robinson Field
Independence, CA
Mazourka Canyon Rd.
Corrals
Robinson Field
East Robinson Field
North Riparian Field
Russell Field
Locust Field
East Russell Field
Wrinkle Field
South Riparian Field
West Field
Springer Field
Wrinkle Holding
Wrinkle Riparian Field
Horse Holding
Corrals
N
Bishop
Independence
Lone Pine
Locator Map
Legend
Existing Fence
Proposed Fence
Existing Fence to be Removed
Existing Fence to be Repaired
Existing Cattle Guards
Proposed Cattle Gaurd
Existing Gates
Proposed gates
Transmission line.shp
River
Lakes
Spring
Aqueduct
Ditch
Water Trough
Streams
Stream Crossing
Highway
Roads
Vegetation Monitoring Sites
Rare Plants Parcels
Rare Plants Points
Enhancement/Mitigation Areas
Lease Boundary
Irrigated
Operating Structure
Blackrock Lease
RLI-428
Revised Map Date: 03.11.05



Islands & Delta Lease

RLI-489 & RLI-490

Revised Map Date: 07.11.05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Bull Field
Reinhackle Carasco Pastures
Water Gap
Carasco Riparian Field North
Carasco Riparian Field South
DWP 7
Reinhackle Carasco Field
DWP 9
River Field
Depot Riparian Field
Lone Pine, CA.
Locator Map
Bishop
Independence
Lone Pine
N
Legend
Existing Fence
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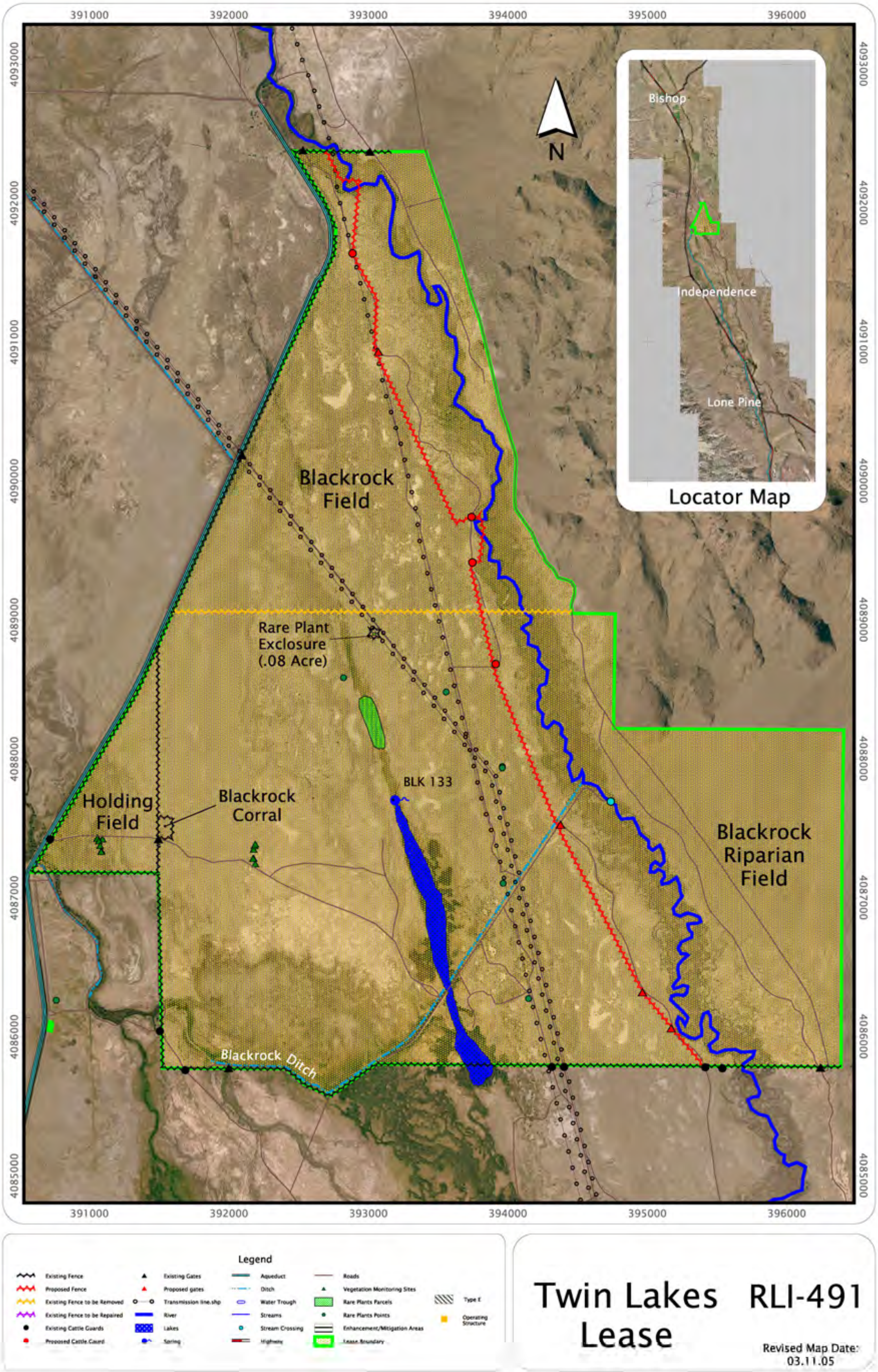
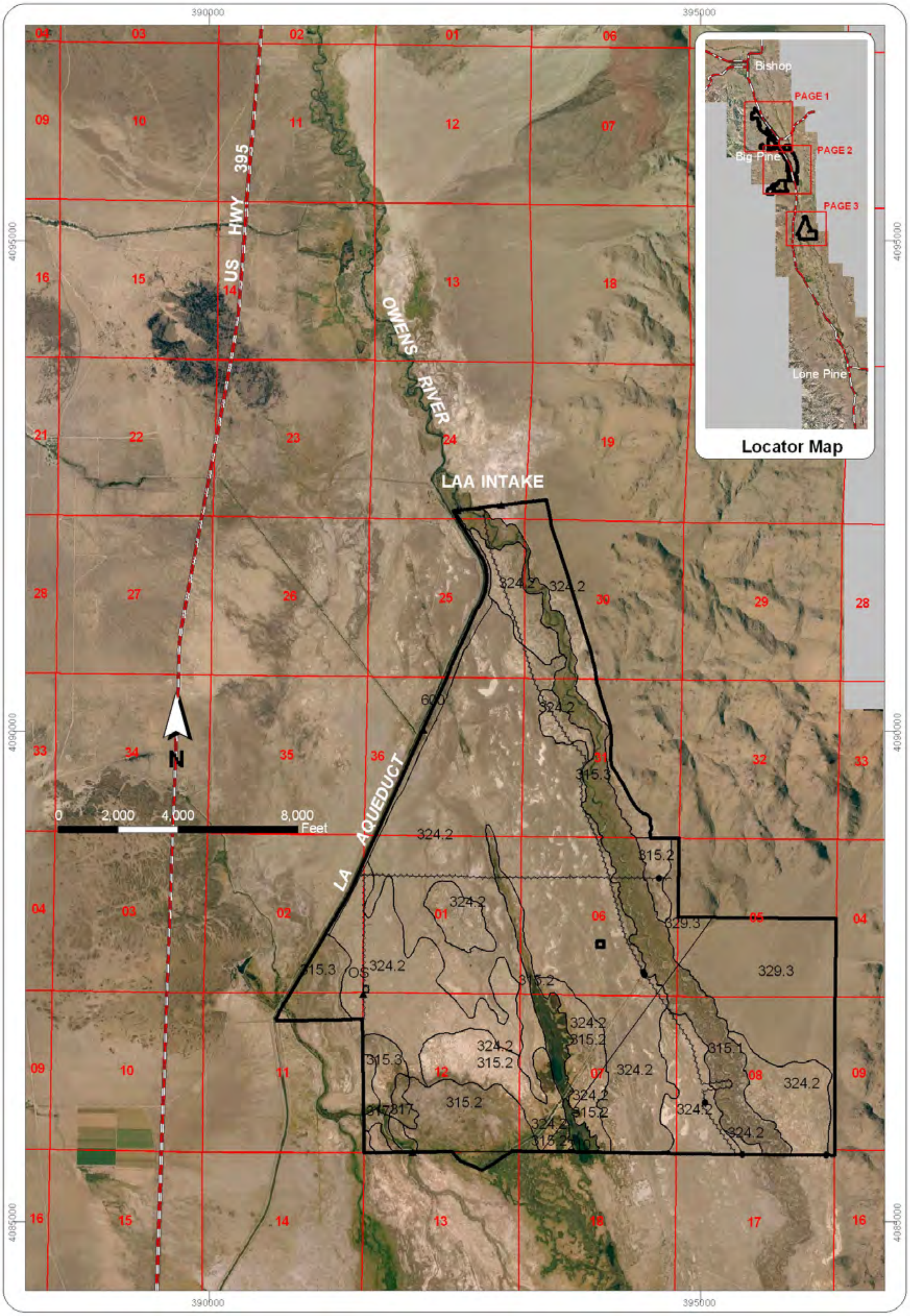
Existing Fence to be Removed
Existing Fence to be Repaired
Existing Cattle Guards
Proposed Cattle Gaurd
Existing Gates
Proposed gates
Transmission line.shp
River
Lakes
Spring
Aqueduct
Ditch
Water Trough
Streams
Stream Crossing
Highway
Roads
Vegetation Monitoring Sites
Rare Plants Parcels
Rare Plants Points
Enhancement/Mitigation Areas
Lease Boundary
irrigated
Islands Lease
RLI-489
Revised Map Date: 03.11.05



Twin Lakes Lease RLI-491

Revised Map Date: 03.11.05



Land Description

	Dry Grazing Cover Type	314.2	Rabbit/Nev. Saltbush/Saltgrass/Medium	330.2	Sage/-Grass/Rabbitbrush	OS	Operating Structures
320	Riparian Vegetation	314.3	Rabbit/Nev. Saltbush/Saltgrass/High	330.3	Sage/Rabbitbrush		Irrigated Pasture
340	Riparian Vegetation	324.1	Greasewood/Saltbush/Low	560	Abandoned Land	511	Alfalfa "A"
316	Rush/Saltgrass Meadow	324.2	Greasewood/Saltbush/High	111	Dry Lakes	512	Alfalfa "B"
317	Tule Marsh Complex	329.1	Semi-Desert Shrublands/+Atriplex	112	Barren Ponds	513	Alfalfa "C"
315.1	Saltgrass/Sacaton Meadow/Low	329.2	Semi-Desert Shrublands/+Grass	160	Slicks	521	Pasture "A"
315.2	Saltgrass/Sacaton Meadow/Medium	329.3	Semi-Desert Shrublands/-Grass	210	Lakes, Ponds, Reservoirs	522	Pasture "B"
315.3	Saltgrass/Sacaton Meadow/High	329.4	Semi-Desert Shrublands	600	Urban And Industrial Areas	523	Pasture "C"
314.1	Rabbit/Nev. Saltbush/Saltgrass/Low	330.1	Sage/+Grass/Mtn Shrub		Non-Use	524	Pasture "D"

Fences
● Cattle Guards
▲ Gates
● Measuring Stations
Ditch
River
Stream
Aqueduct

Section Line
Highway
Transmission Line
☐ Irrigated Veg Parcels
☐ Dry Veg Parcels
☐ Lease Boundary

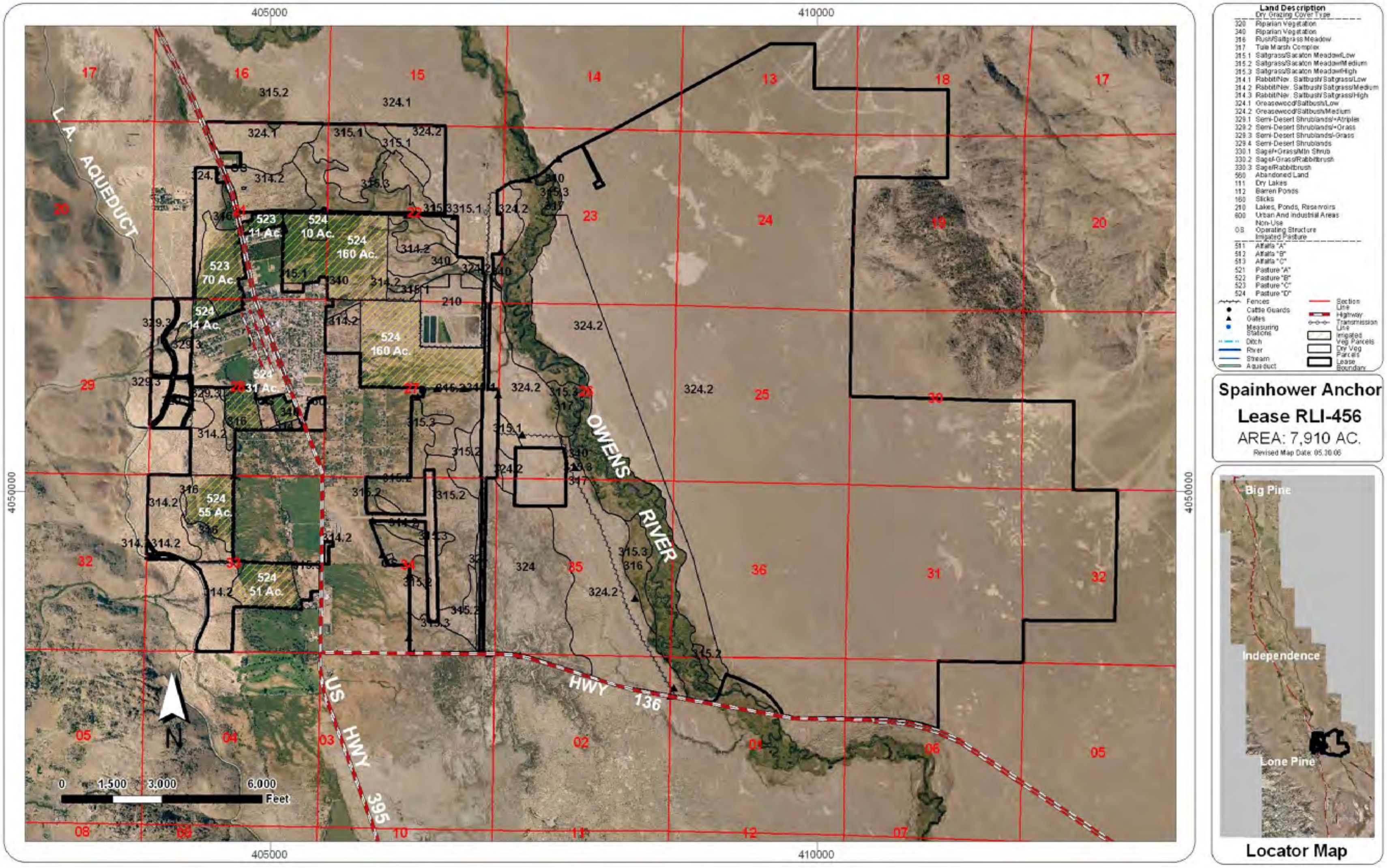
Four-J Cattle Corp.

Lease RLI-491

Page 3 of 3

AREA: 20,829 AC.

Revised Map Date: 06.27.06



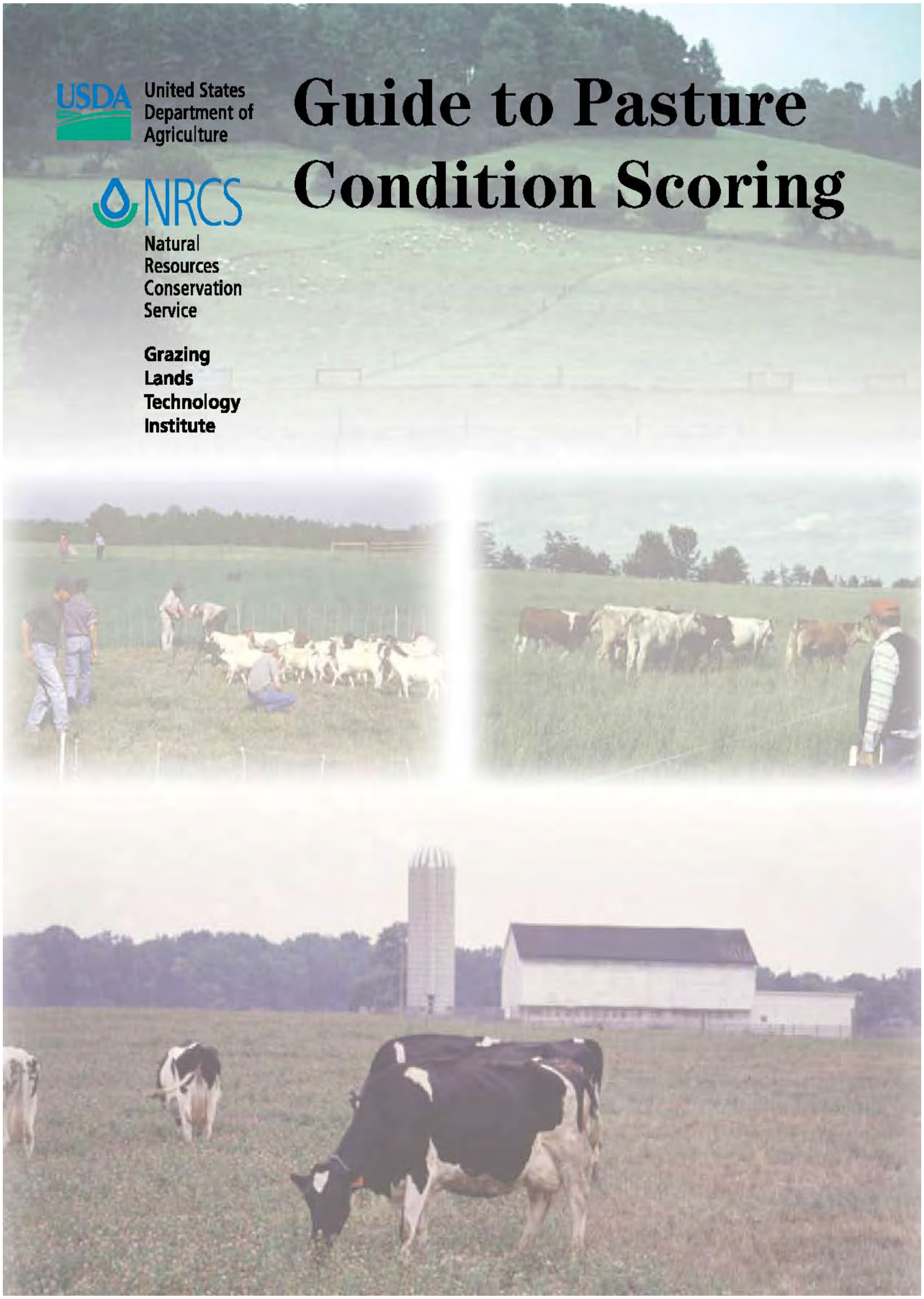
Spainhower Anchor

Lease RLI-456

AREA: 7,910 AC.

Revised Map Date: 05.30.06

A.5 Pasture Condition Scoring Document



USDA United States Department of Agriculture

NRCS Natural Resources Conservation Service

Grazing Lands Technology Institute

Guide to Pasture Condition Scoring

Introduction

A well-managed pasture is one whose productivity (plant and animal) is optimized while it does no harm to soil, water, and air quality. Pasture condition scoring is a systematic way to check how well a pasture is managed. If the pasture is located on the proper site and well managed, it will have a good to excellent overall pasture condition score. By rating key indicators and causative factors common to all pastures, pasture condition can be evaluated and the primary reasons for a low condition score identified. A condition that can lead to one or more pasture resource concerns such as poor plant growth, weedy species invasion, poor animal performance, visible soil loss, increased runoff, and impaired water quality.

Pasture condition scoring, to be most useful, should occur several times a year during key critical management periods throughout the grazing season. Scoring should be performed:

- At the start before placing livestock on pasture
- At peak forage supply periods
- At low forage supply periods
- As plant stress appears
- Near the end to help decide when to remove livestock

In addition, pastures used for year-round grazing benefit from pasture condition scoring:

- Going into the winter season
- Late in winter
- During thaws or wet periods

Pasture condition scoring can be useful in deciding when to move livestock or planning other management actions. It sorts out which improvements are most likely to improve pasture condition or livestock performance.

Pasture condition scoring involves the visual evaluation of 10 indicators, listed and described below, which rate pasture condition. In the *Pasture Condition Score Sheet*, each indicator or factor has five conditions described for it, ranging from lowest (1) to highest (5). This objectively ranks the extent of any problem(s) and helps sort out the likely cause(s). Evaluate each indicator separately. They may be combined into an overall score for the pasture unit or left as an individual score and compared with the other nine indicators. Indicators receiving the lowest scores can be targeted for corrective action as warranted. The plant vigor indicator can be analyzed further by rating six factors that cause plant vigor to be what it is. As one or more erosion indicators may exist on a site, they are split into four types: sheet and rill, gully, streambank or shoreline, and wind.

Indicator Descriptions

Percent desirable plants

This indicator determines if the pasture has the kind of plants that the livestock on it will graze readily. A desirable species is readily consumed, persistent, and provides high tonnage and quality for a significant part of the growing season. Undesirable species, such as woody invaders, noxious weeds, and toxic plants, are those that typically are not eaten (rejected) by most livestock or cause undesirable side effects when eaten, and that crowd out more desirable species. A few forages for a time are undesirables during a specific growth stage when they produce toxins. Intermediate species are those which, while eaten, provide low tonnage or lose quality fast, and often have a short-lived grazing use period. Some examples are dandelions, wild plantains, and annual grasses, such as crabgrass. Estimate visually the proportion of desirable species present in the entire sward by weight, and score accordingly.

(Guide to Pasture Condition Scoring, May 2001)

Plant cover

The percentage of the soil surface covered by plants is important for pasture production and soil and water protection. A dense stand (high stem count) ensures, when properly grazed, high animal intake and high sunlight interception for best forage growth. Bare, open spots allow for weed encroachment, increased water runoff during intense rains, and soil erosion. Visually estimate the total cover of all desirable and intermediate species. Assign a value based on either green leaf canopy or live vegetative basal area cover percentage. Use the most familiar method that provides a consistent, reliable estimate of plant cover for the pasture being rated.

Canopy cover works best on sod-forming pastures. It can be determined at any time on continuously grazed pastures provided stubble heights greater than 1 inch are present. On rotational pastures, estimate canopy cover of a paddock the day prior to livestock entry. This will represent the best possible condition. If it rates fair or lower at this growth stage, management changes are definitely in order.

Basal area works best on bunch grass pastures. It is hard to use on pastures where sod-forming grasses and broadleaf plants dominate. Estimate by eye or use either the step-point or the point-intercept methods. Basal area is measured by both methods by counting pin hits on live stems and plant crowns at ground level (within 1 inch above). Where it is most useful, basal area is more constant than canopy cover and thus is more reliable.

Plant residue

Plant residue, in various states of decay, provides additional surface cover and organic matter to the soil. However, too much standing dead material in the grass stand reduces the feed value of the forage consumed and animal intake, and inhibits new plant shoot growth. Excessive amounts of standing dead material may cause the forage to be rejected by the grazing animal. Less than 25 percent of the standing forage mass should be dead or dying leaves and stems. Buildup of thatch (mat of undecomposed residue) at the soil surface indicates retarded residue decay. Thatch promotes fungal diseases and retards or prevents shoot and seedling emergence. This results in forage stand decline.

Plant diversity

Plant diversity is the number of different forage plants that are well represented (20% or more of plant cover) in a pasture. Low species diversity causes season-long pastures, or a set of pastures grazed as a unit, to be less reliable suppliers of forage to livestock during the grazing season. Forage production varies more widely through the grazing season because of changing weather and light conditions and insect and disease pressure. Pastures that have high species diversity tend to be older, moderately grazed permanent pastures. Here planted and volunteer forages have adjusted to the management and the prevailing environmental stresses. No single forage species is so dominant as to crowd out others.

Having more than one functional plant group growing either in a pasture or in different, complementary pastures is highly important. This maintains the most consistent forage supply during the grazing season. Functional groups of forages are plant groupings that have similar growth habits and management needs. The four basic functional groups for improved pastures are cool-season grasses, warm-season grasses, legumes, and other grazable broadleaf plants (e.g., *Brassicas* and forage chicory). These basic functional groups can be split into more specific groups, such as upright versus prostrate and sod-formers versus bunch grasses. However, this extra detail is unwarranted in improved pasture condition evaluations.

Plants from different functional groups are most compatible when they can compete successfully together as managed. Mixed species pastures with at least two functional groups and three to four well-

Standing dead residue of mature plants reduce forage quality and cause livestock to selectively graze around them.

(Guide to Pasture Condition Scoring, May 2001)

represented forage species are generally the most productive. Higher diversity (over six species) does not assure higher productivity. It may actually spur animals to avoid some species and graze others hard, as species differences in palatability and maturity are more likely. Potential forage is wasted. Less desirable species gain in area by outcompeting overgrazed desirable species. However, trying to prevent this selectivity by reducing forage on-offer and forcing animals to eat everything, reduces intake and gains. This also decreases productivity.

When plant diversity scores low, several courses of action are possible. The appropriate response depends on the region in which the pasture is located, its intended use period, and the species growing in it. Applying other treatment measures may be easier or more appropriate than trying to grow several plant species together within a single pasture. These measures include:

- Applying nitrogen fertilizer to a pasture with few or no legumes present
- Establishing a different forage functional group in a separate pasture
- Oversowing an annual forage crop into a perennial forage pasture going into dormancy

Always rate plant diversity even if you may ultimately not wish to change it in that pasture. Monocultures can be quite productive on seasonal and irrigated pastures. They can provide abundant production at times precisely when other pastures on the operating unit are unproductive. However, when plant diversity is rated low on an individual field, some alternative course of action must be in place or developed. Some, such as feeding hay or applying N fertilizer, are expensive alternatives.

Plant vigor

Desirable species should be healthy and growing at their potential for the season when rated. If not, they will be replaced by weeds and low quality forage plants. If plant growth conditions really suffer, bare soil will begin to appear. Some things to consider when rating plant vigor are color, size of plants, rate of regrowth following harvest, and productivity. Determine overall vigor of desirable and intermediate species, and record. If score is less than four, utilize the causative factors below to help determine what may be causing the lack of vigor. If scoring a pasture for the first time, review soil test results or get soil tests done for it regardless of plant vigor rating to determine the pasture's level of fertility and pH. It also pays to rate the other causative factors as well first time out; this provides initial facts vital to managing the pasture from here, on.

Soil fertility

Adequate, but not excessive, fertility is critical for good plant vigor. Test soil or plant tissue to determine nutrient status. Excessive amounts of nutrients, particularly N, P, and K, can also cause animal health and/or water quality problems. Rank, often lodged, dark green to blue-green forages are a warning sign of excessive soil fertility. Maintain adequate nutrient balance to not exceed maximum economic yield of desirable forage species. In some areas of the United States, excess salts and sodium are often present in the soil at levels that reduce plant vigor. Test those soils for electrical conductivity and exchangeable sodium. Reduce their levels, or plant forage species tolerant of the levels found.

When urine and dung patches are noticeably greener than the rest of the pasture, nutrients are limiting production.

Severity of use

Grazing management is critical in maintaining productive pastures. Close, frequent grazing (mown lawn appearance) often causes loss of vigor reducing yields and ground cover. Low stocking rates promote selective grazing that causes excessive residue buildup (presence of mature seed stalks and dead leaves). This standing residue blocks sunlight, reduces overall forage quality, and favors the spread of less palatable and/or taller, grazing intolerant forages. Assign a value based on the proportion of the pasture grazed closest and the height at which it is grazed. Compare that height to minimum stubble heights recommended for maintaining desired forages.

(Guide to Pasture Condition Scoring, May 2001)

Site adaptation of desired species

Climate and soil type play a major role in the vigor of a given species. Consider these items when evaluating adaptability:

- cold hardiness
- tolerance to aridness
- summer heat and humidity levels
- frost heave or soil cracking
- soil wetness
- flooding or ponding
- soil acidity or alkalinity
- toxic elements
- salinity
- sodicity
- low or high nutrient levels

Two other factors to consider are the desired species tolerance to existing grazing pressure and soil and water management. Plants that hold their growing point close to the ground can be grazed close provided they are allowed some time between grazing events to push out new leaf area. Others that elevate the growing point into the grazing zone need grazing events timed to release new shoot growth. The presence and balance of desired species are compared with those species present now and their balance. This verifies how well adapted the desired species were to the site, grazing pressure, and management.

Climatic stresses

Extremely wet, dry, hot, or cold weather may threaten plant vigor even when climatically adapted forage species are present. When rating the pasture, consider recent weather events and their role in the present health of a forage stand. Extremely cold and wet weather can cause temporary nitrogen deficiency symptoms (yellowish leaves). A hard winter may weaken the stand. A drought can cause the stand to go dormant. Check for frost or freeze damage to foliage.

Soil pH

Soil pH influences plant vigor primarily through its effect on nutrient availability. It also influences the amount of nitrogen-fixing nodules formed on legume roots. Determine the pH in the surface 3 to 4 inches through a soil test or reliable field methods. Adjust pH to provide optimum yield of desirable forage species.

Note: Reduced yields may continue if the pH in the subsoil is too low or high. Contact a soil fertility or forage management specialist for further management options.

Insect and disease pressure

Look for signs of leaf, stem, and root damage caused by insects and disease. Assess their impact on forage quality, quantity, and stand life. Some are chronic, occurring yearly, but with little consequence to the forage stand life. Others take the forage species under attack out of the stand. Corrective actions to take are numerous and specific to the insect or disease involved. Consult with a local, respected forage expert when unsure of proper course of action.

Livestock concentration areas

Concentration areas are places in pastures where livestock return frequently and linger to be near water, feed, mineral or salt, or shelter, or to be in shade. Typically, well-worn pathways lead to these preferred areas. Depending on the degree of usage, these areas are usually bare and receive extra animal waste. Depending on where they are on the landscape and flow paths, they can direct sediment, nutrients, and bacteria to nearby waterbodies.

Heavy use areas, such as around this feed bunk, often wash during heavy rains. Note missing hay residue at the bare spots in foreground.

These areas can direct contaminated runoff to surface waters unless there is an intervening grass buffer between them and open channels. Note reed canarygrass riparian area buffer below feed bunk.

(Guide to Pasture Condition Scoring, May 2001)

Uniformity of use

Spot grazing often occurs where forage growth exceeds livestock intake at least seasonally. Once established, it stays in place unless pattern is destroyed seasonally.

Check uniformity of use by observing animal grazing patterns. Uniform grazing results in all desirable and intermediate species being grazed to a similar height. Spotty or patterned grazing appears uneven throughout a pasture with some plants or parts of paddocks grazed heavily and others lightly. Individual forage species are being selected for or against by the livestock based on their palatability and nutritional value. Selectivity is also affected by forage species stage of maturity differences, amount of forage offered to livestock, and their length of stay in the paddock. Zone grazing occurs when one end of the pasture is heavily grazed and the other end is ungrazed or lightly grazed. It occurs on long and narrow pastures and ones that run lengthwise up and down steep slopes. Other pastures that have shady areas, windbreaks, or hay feeding, creep feeding, and watering sites whose location and duration of use at that location skew foraging to one end of a pasture are often zone grazed as well. Physical barriers, such as streams, cliffs, and obstructing fencelines, can confine livestock to one area of a pasture causing zone grazing. When rating this factor keep in mind that while overgrazing may result in a uniform height (mown lawn appearance), it is to a height lower than that needed to maintain all desirable forage species.

Areas that are grazed close contrasted with areas largely avoided. Several causes exist. The one shown is a deep, entrenched stream barrier and entry choice to pasture.

Erosion

Sheet and rill

This erosion is soil loss caused by rain drop impact, drip splash from rainwater dropping off plant leaves and stems onto bare soil, and a thin sheet of runoff water flowing across the soil surface. Sheet and rill erosion increases as ground cover decreases. Evidence of sheet erosion in a pasture appears as small debris dams of plant residue that build up at obstructions or span between obstructions. Some soil aggregates or worm castings may also be washed into these debris dams. Rills are small, incised channels in the soil that run parallel to each other downslope. They join whenever the ground surface warps and deflects the direction of their flow. When rills appear, serious soil loss is occurring. This erosion type also includes most irrigation-induced erosion.

Streambank, shoreline, and gully

This erosion occurs in large, open drainage channels or around shorelines. When in pastures, these channels or shorelines can have heightened erosion problems and losses of vegetative cover that typically grows on them. These heightened damages result from grazing animal traffic in or on them. Open channels may be intermittent or perennial flowing streams or dry washes. The factors that affect the extent of disturbance livestock cause to gullies, streambanks, shorelines, and their associated vegetation are:

- Livestock traffic patterns
- Frequency of use
- Attractiveness of these channels or banks as sunning, dusting, travel lanes, watering, grazing, or rubbing areas
- Channel shape (depth, width, presence and frequency of meanders, and bank stability)
- Flow characteristics (frequency, depth, sediment carried, swiftness, and turbulence)

Wind

Erosion occurs when heavier, windblown soil particles abrade exposed soil and cause dust to become airborne. Deposition of the heavier soil particles occurs downwind of obstructions, such as fencelines, buildings, and vegetation. Often vegetative debris is windrowed against obstructions.

(Guide to Pasture Condition Scoring, May 2001)

Percent legume

Legumes are important sources of nitrogen for pastures and improve the forage quality of a pasture mix when they comprise at least 20 percent of total air-dry weight of forage. Deep-rooted legumes also provide grazing during hot, dry periods in mid-summer. Visually estimate the percentage of legume present in the total forage mass. Rate this indicator even if site or grass species preclude successful legume establishment and reliable survival to have an effective legume component to fix nitrogen. Most pastures are nitrogen-limited since much of the nitrogen excreted by animals eludes plant uptake. Pastures with few or no legumes present need alternative means of supplying nitrogen for optimum forage production. When bloating legume content is greater than 60 percent of total forage dry weight; bloat incidence in livestock is likely without preventative steps.

Cool-season grass pastures should have 30 percent legume by weight.

Avoid grazing pastures too close that causes spreading, bloat-inducing legumes to become dominant (over 60 percent of stand by weight).

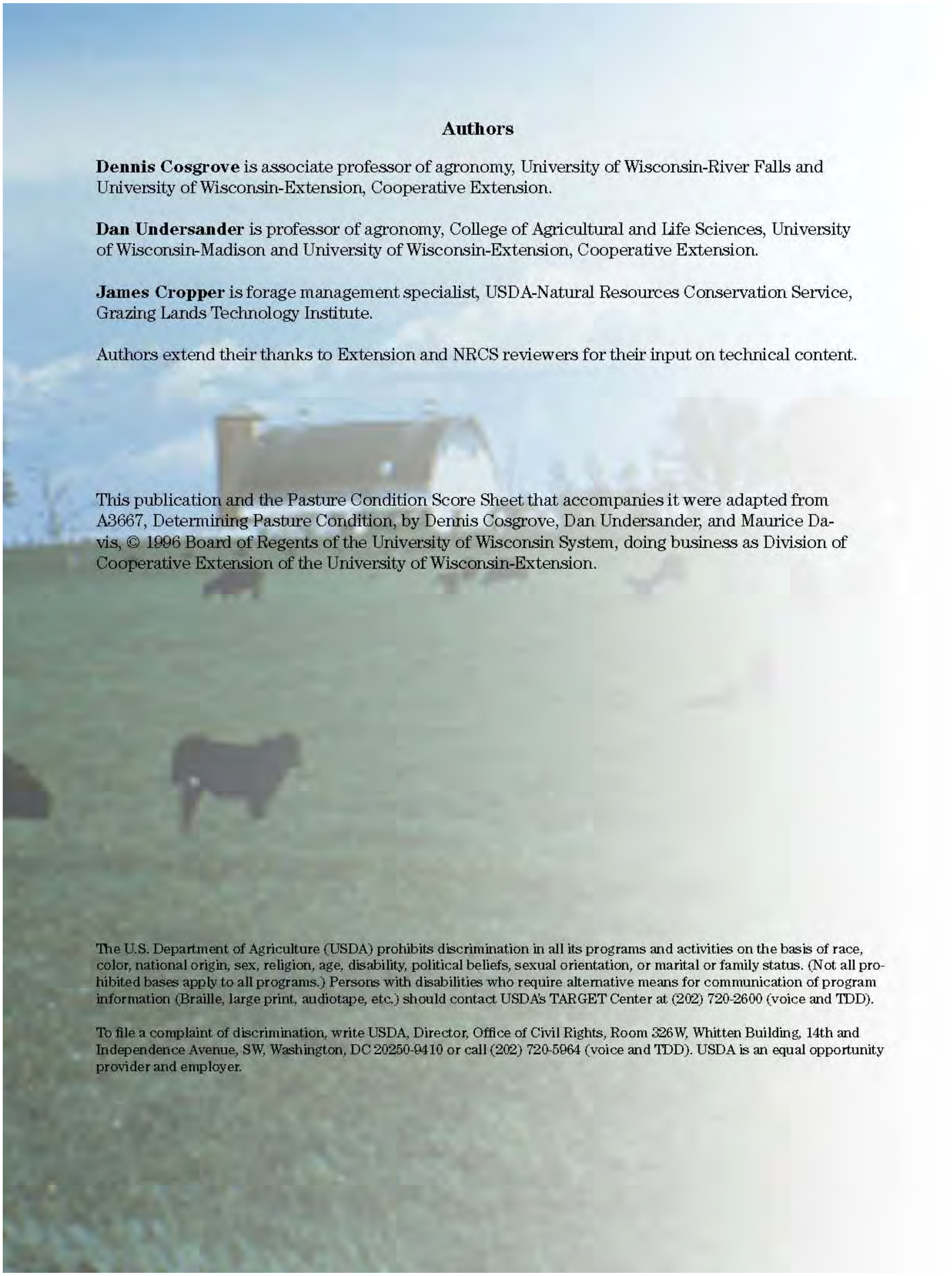
Warm-season grass pastures, like this rotationally grazed bermudagrass-white clover, should have 20 percent legume for good livestock performance and nitrogen self-sufficiency.

Soil compaction

Soil compaction impacts water infiltration rates and runoff. Lack of infiltration decreases water available in the soil for plant growth. Instead, water runs off, increasing channel erosion downstream, and conveys contaminants, such as nutrients, from the site, reducing water quality. Soil compaction is best determined by measuring the bulk density (weight per volume of soil) at 1-inch increments to plow depth. However, compaction can be detected in the field using a soil probe, metal rod, or knife. As these tools are pushed into the soil, compacted soil layers interrupt their ease of penetration. Compare in-field resistance to penetration with resistance found at a grazed fenceline where the livestock cannot stand or walk on the soil surface. The more noticeable the difference in resistance between the two areas is, the worse the compaction is in the pasture.

Wet soils are easily compressed and deformed by livestock hooves.

(Guide to Pasture Condition Scoring, May 2001)



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Authors extend their thanks to Extension and NRCS reviewers for their input on technical content.

This publication and the Pasture Condition Score Sheet that accompanies it were adapted from A3667, Determining Pasture Condition, by Dennis Cosgrove, Dan Undersander, and Maurice Davis, © 1996 Board of Regents of the University of Wisconsin System, doing business as Division of Cooperative Extension of the University of Wisconsin-Extension.

Grazing Lands Technology Institute

May 2001

Pasture Condition Score Sheet

Purposes

- Evaluate current pasture productivity and the stability of its plant community, soil, and water resources.
- Identify what treatment needs, if any, are required to improve a pasture's productivity and protect soil, water, and air quality.

Suggested uses

This score sheet may be used to rate different pastures in a single growing season or the same pasture over a period of years. Rating a pasture yearly can track trends, either improvement or decline, in its condition. Some indicators change slowly in response to stresses caused by management or climate. Also, some indicators may change as each season progresses. An indicator or causative factor may rank high at one time and low another. Uniformity of use, plant residue, percent legume, severity of use, weather, and insect or disease pressure can vary widely on the same pasture depending on when they are scored during the year and the degree of management the pasture receives. Therefore, it is often wise to score a pasture at different, key times during the year before deciding to make changes in management. Indicate on the form the date the scoring occurred.

Procedure

Step 1—Rate each pasture one by one that is occupied all at the same time by a herd or flock and separated from other pasture areas by portable or fixed fencing. Paddocks in rotational pastures may be rated separately or as a combined unit. It depends on how alike they are. If any indicator looks markedly different from paddock to paddock, it may pay to rate each one separately.

Step 2—Score all 10 indicators regardless of your feelings of their relative worth. To learn or recall how each indicator reflects on how well a pasture is being managed, see *Guide to Pasture Condition Scoring*.

Step 3—Using the attached score sheet and indicator criteria, read the scoring criteria for each of the 10 pasture condition indicators one at a time and rate before moving onto the next. Use the 1 to 5 scale provided. Estimate by eye or measure as precisely as you feel is needed to rate the indicator reliably.

Step 4—When scoring plant vigor, enter a score based on the general criteria given on page 2 using the most limiting trait listed. Use this number to determine the overall pasture score. If the plant vigor score is less than 4, refer to the plant vigor causative factors' criteria on page 6 to identify the plant stress(es) causing reduced vigor. Rate each causative factor independently on the score sheet provided on page 5. Do not average to adjust the original vigor score.

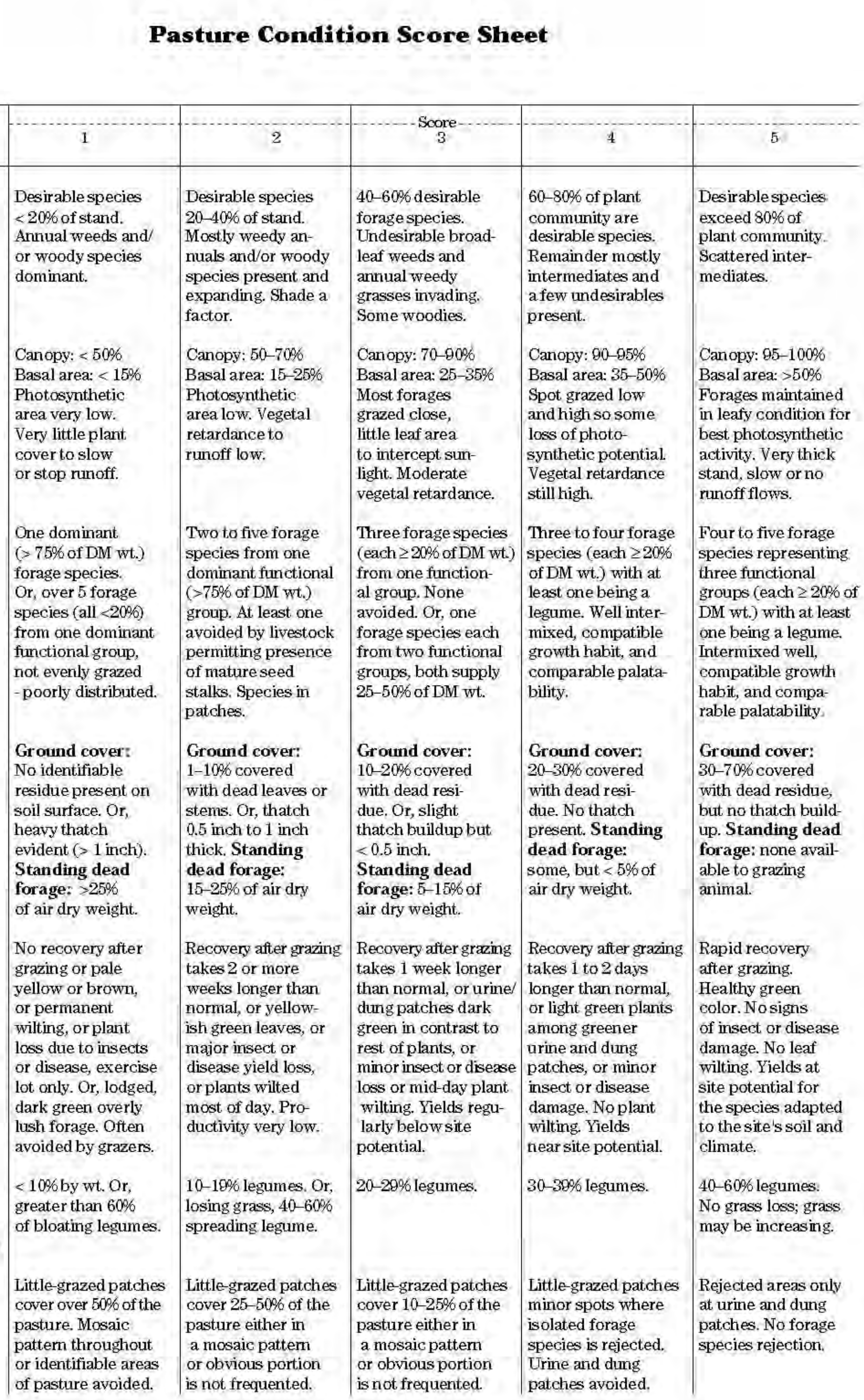
Step 5—When scoring erosion, rate sheet and rill erosion every time. Rate other types of erosion only if present. When present, indicate which one(s) by identifying the erosion type with a unique symbol next to its score. Divide the box as needed to score them separately. Erosion is rated by averaging the individual scores. A need remains to prioritize which erosion problem is controlled first and how.

Step 6—Total the score for each pasture and compare to the following chart. Also, focus on any low scoring individual indicators or causative factors.

Pasture condition score Overall	 Individual	Management change suggested
45–50	5	No changes in management needed at this time.
35–45	4	Minor changes would enhance, do most beneficial first.
25–35	3	Improvements benefit productivity and/or environment.
15–25	2	Needs immediate management changes, high return likely.
10–15	1	Major effort required in time, management, and expense.

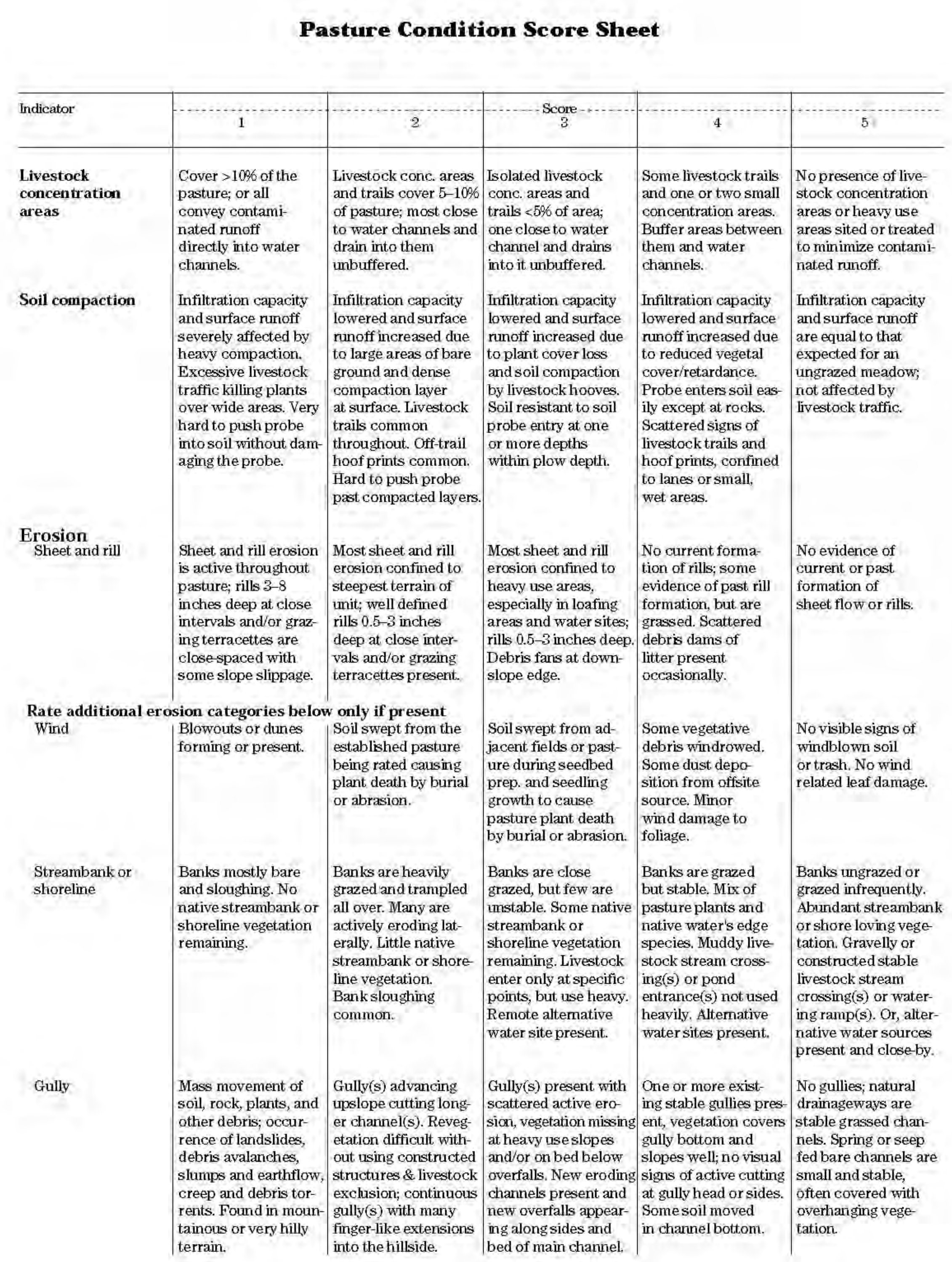
Step 7—When an individual indicator's score falls below a 5, determine its worth to your operation. Then, decide whether to correct the cause or causes for the low rating. If you choose to correct, apply the most suitable management options for your area and operation.

Authors: **Dennis Cosgrove** is associate professor of agronomy, University of Wisconsin-River Falls and University of Wisconsin-Extension, Cooperative Extension. **Dan Undersander** is professor of agronomy, College of Agricultural and Life Sciences, University of Wisconsin-Madison and University of Wisconsin-Extension, Cooperative Extension. **James Cropper** is forage management specialist, USDA-Natural Resources Conservation Service, Grazing Lands Technology Institute. Authors extend their thanks to Extension and NRCS reviewers for their input on technical content.



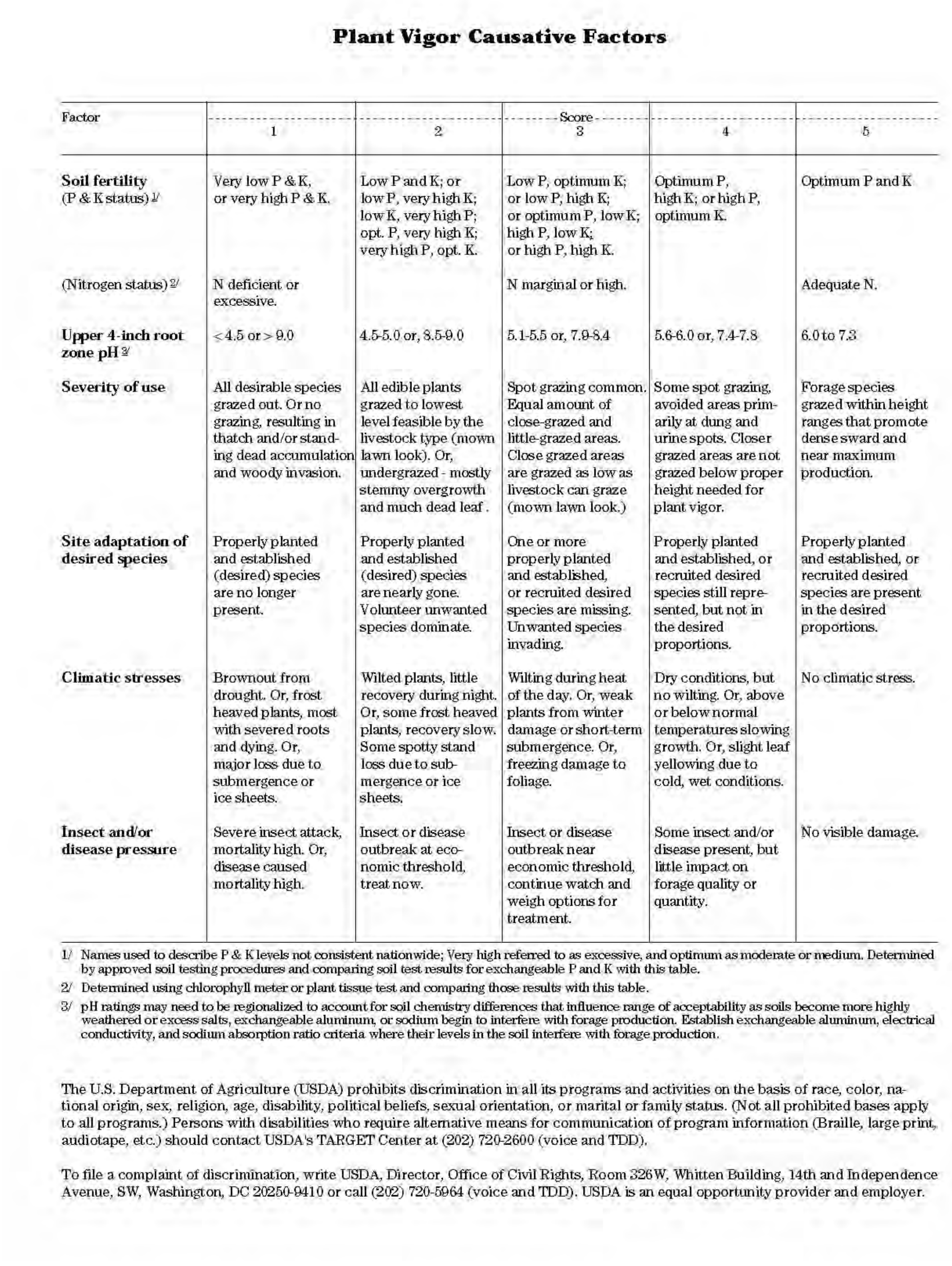
Pasture Condition Score Sheet

Indicator			Score		
	1	2	3	4	5
Percent desirable plants	Desirable species < 20% of stand. Annual weeds and/ or woody species dominant.	Desirable species 20–40% of stand. Mostly weedy annuals and/or woody species present and expanding. Shade a factor.	40–60% desirable forage species. Undesirable broadleaf weeds and annual weedy grasses invading. Some woodies.	60–80% of plant community are desirable species. Remainder mostly intermediates and a few undesirables present.	Desirable species exceed 80% of plant community. Scattered intermediates.
Plant cover (Live stems and green leaf cover of all desirable and intermediate species.)	Canopy: < 50% Basal area: < 15% Photosynthetic area very low. Very little plant cover to slow or stop runoff.	Canopy: 50–70% Basal area: 15–25% Photosynthetic area low. Vegetal retardance to runoff low.	Canopy: 70–90% Basal area: 25–35% Most forages grazed close, little leaf area to intercept sunlight. Moderate vegetal retardance.	Canopy: 90–95% Basal area: 35–50% Spot grazed low and high so some loss of photosynthetic potential. Vegetal retardance still high.	Canopy: 95–100% Basal area: >50% Forages maintained in leafy condition for best photosynthetic activity. Very thick stand, slow or no runoff flows.
Plant diversity	One dominant (> 75% of DM wt.) forage species. Or, over 5 forage species (all <20%) from one dominant functional group, not evenly grazed - poorly distributed.	Two to five forage species from one dominant functional (>75% of DM wt.) group. At least one avoided by livestock permitting presence of mature seed stalks. Species in patches.	Three forage species (each ≥ 20% of DM wt.) from one functional group. None avoided. Or, one forage species each from two functional groups, both supply 25–50% of DM wt.	Three to four forage species (each ≥ 20% of DM wt.) with at least one being a legume. Well intermixed, compatible growth habit, and comparable palatability.	Four to five forage species representing three functional groups (each ≥ 20% of DM wt.) with at least one being a legume. Intermixed well, compatible growth habit, and comparable palatability.
Plant residue (Rate ground cover and standing dead forage separately and average score.)	**Ground cover:** No identifiable residue present on soil surface. Or, heavy thatch evident (> 1 inch). **Standing dead forage:** >25% of air dry weight.	**Ground cover:** 1–10% covered with dead leaves or stems. Or, thatch 0.5 inch to 1 inch thick. **Standing dead forage:** 15–25% of air dry weight.	**Ground cover:** 10–20% covered with dead residue. Or, slight thatch buildup but < 0.5 inch. **Standing dead forage:** 5–15% of air dry weight.	**Ground cover:** 20–30% covered with dead residue. No thatch present. **Standing dead forage:** some, but < 5% of air dry weight.	**Ground cover:** 30–70% covered with dead residue, but no thatch buildup. **Standing dead forage:** none available to grazing animal.
Plant vigor *If plant vigor rating is less than 4, determine cause by rating 6 possible causes listed on page 5.*	No recovery after grazing or pale yellow or brown, or permanent wilting, or plant loss due to insects or disease, exercise lot only. Or, lodged, dark green overly lush forage. Often avoided by grazers.	Recovery after grazing takes 2 or more weeks longer than normal, or yellowish green leaves, or major insect or disease yield loss, or plants wilted most of day. Productivity very low.	Recovery after grazing takes 1 week longer than normal, or urine/ dung patches dark green in contrast to rest of plants, or minor insect or disease loss or mid-day plant wilting. Yields regularly below site potential.	Recovery after grazing takes 1 to 2 days longer than normal, or light green plants among greener urine and dung patches, or minor insect or disease damage. No plant wilting. Yields near site potential.	Rapid recovery after grazing. Healthy green color. No signs of insect or disease damage. No leaf wilting. Yields at site potential for the species adapted to the site's soil and climate.
Percent legume (Cool season stands. See foonote 3 of score sheet for warm season)	< 10% by wt. Or, greater than 60% of bloating legumes.	10–19% legumes. Or, losing grass, 40–60% spreading legume.	20–29% legumes.	30–39% legumes.	40–60% legumes. No grass loss; grass may be increasing.
Uniformity of use	Little-grazed patches cover over 50% of the pasture. Mosaic pattern throughout or identifiable areas of pasture avoided.	Little-grazed patches cover 25–50% of the pasture either in a mosaic pattern or obvious portion is not frequented.	Little-grazed patches cover 10–25% of the pasture either in a mosaic pattern or obvious portion is not frequented.	Little-grazed patches minor spots where isolated forage species is rejected. Urine and dung patches avoided.	Rejected areas only at urine and dung patches. No forage species rejection.



Pasture Condition Score Sheet

Indicator	Score				
	1	2	3	4	5
Livestock concentration areas	Cover >10% of the pasture; or all convey contaminated runoff directly into water channels.	Livestock conc. areas and trails cover 5–10% of pasture; most close to water channels and drain into them unbuffered.	Isolated livestock conc. areas and trails <5% of area; one close to water channel and drains into it unbuffered.	Some livestock trails and one or two small concentration areas. Buffer areas between them and water channels.	No presence of livestock concentration areas or heavy use areas sited or treated to minimize contaminated runoff.
Soil compaction	Infiltration capacity and surface runoff severely affected by heavy compaction. Excessive livestock traffic killing plants over wide areas. Very hard to push probe into soil without damaging the probe.	Infiltration capacity lowered and surface runoff increased due to large areas of bare ground and dense compaction layer at surface. Livestock trails common throughout. Off-trail hoof prints common. Hard to push probe past compacted layers.	Infiltration capacity lowered and surface runoff increased due to plant cover loss and soil compaction by livestock hooves. Soil resistant to soil probe entry at one or more depths within plow depth.	Infiltration capacity lowered and surface runoff increased due to reduced vegetal cover/retardance. Probe enters soil easily except at rocks. Scattered signs of livestock trails and hoof prints, confined to lanes or small, wet areas.	Infiltration capacity and surface runoff are equal to that expected for an ungrazed meadow; not affected by livestock traffic.
Erosion Sheet and rill	Sheet and rill erosion is active throughout pasture; rills 3–8 inches deep at close intervals and/or grazing terracettes are close-spaced with some slope slippage.	Most sheet and rill erosion confined to steepest terrain of unit; well defined rills 0.5–3 inches deep at close intervals and/or grazing terracettes present.	Most sheet and rill erosion confined to heavy use areas, especially in loafing areas and water sites; rills 0.5–3 inches deep. Debris fans at downslope edge.	No current formation of rills; some evidence of past rill formation, but are grassed. Scattered debris dams of litter present occasionally.	No evidence of current or past formation of sheet flow or rills.
Rate additional erosion categories below only if present					
Wind	Blowouts or dunes forming or present.	Soil swept from the established pasture being rated causing plant death by burial or abrasion.	Soil swept from adjacent fields or pasture during seedbed prep. and seedling growth to cause pasture plant death by burial or abrasion.	Some vegetative debris windrowed. Some dust deposition from offsite source. Minor wind damage to foliage.	No visible signs of windblown soil or trash. No wind related leaf damage.
Streambank or shoreline	Banks mostly bare and sloughing. No native streambank or shoreline vegetation remaining.	Banks are heavily grazed and trampled all over. Many are actively eroding laterally. Little native streambank or shoreline vegetation. Bank sloughing common.	Banks are close grazed, but few are unstable. Some native streambank or shoreline vegetation remaining. Livestock enter only at specific points, but use heavy. Remote alternative water site present.	Banks are grazed but stable. Mix of pasture plants and native water's edge species. Muddy livestock stream crossing(s) or pond entrance(s) not used heavily. Alternative water sites present.	Banks ungrazed or grazed infrequently. Abundant streambank or shore loving vegetation. Gravelly or constructed stable livestock stream crossing(s) or watering ramp(s). Or, alternative water sources present and close-by.
Gully	Mass movement of soil, rock, plants, and other debris; occurrence of landslides, debris avalanches, slumps and earthflow, creep and debris torrents. Found in mountainous or very hilly terrain.	Gully(s) advancing upslope cutting longer channel(s). Revegetation difficult without using constructed structures & livestock exclusion; continuous gully(s) with many finger-like extensions into the hillside.	Gully(s) present with scattered active erosion, vegetation missing at heavy use slopes and/or on bed below overfalls. New eroding channels present and new overfalls appearing along sides and bed of main channel.	One or more existing stable gullies present, vegetation covers gully bottom and slopes well; no visual signs of active cutting at gully head or sides. Some soil moved in channel bottom.	No gullies; natural drainageways are stable grassed channels. Spring or seep fed bare channels are small and stable, often covered with overhanging vegetation.



Plant Vigor Causative Factors

Factor			Score		
	1	2	3	4	5
Soil fertility (P & K status)[1/]	Very low P & K, or very high P & K.	Low P and K; or low P, very high K; low K, very high P; opt. P, very high K; very high P, opt. K.	Low P, optimum K; or low P, high K; or optimum P, low K; high P, low K; or high P, high K.	Optimum P, high K; or high P, optimum K.	Optimum P and K
(Nitrogen status)[2/]	N deficient or excessive.		N marginal or high.		Adequate N.
Upper 4-inch root zone pH[3/]	< 4.5 or > 9.0	4.5-5.0 or, 8.5-9.0	5.1-5.5 or, 7.9-8.4	5.6-6.0 or, 7.4-7.8	6.0 to 7.3
Severity of use	All desirable species grazed out. Or no grazing, resulting in thatch and/or standing dead accumulation and woody invasion.	All edible plants grazed to lowest level feasible by the livestock type (mown lawn look). Or, undergrazed - mostly stemmy overgrowth and much dead leaf .	Spot grazing common. Equal amount of close-grazed and little-grazed areas. Close grazed areas are grazed as low as livestock can graze (mown lawn look.)	Some spot grazing, avoided areas primarily at dung and urine spots. Closer grazed areas are not grazed below proper height needed for plant vigor.	Forage species grazed within height ranges that promote dense sward and near maximum production.
Site adaptation of desired species	Properly planted and established (desired) species are no longer present.	Properly planted and established (desired) species are nearly gone. Volunteer unwanted species dominate.	One or more properly planted and established, or recruited desired species are missing. Unwanted species invading.	Properly planted and established, or recruited desired species still represented, but not in the desired proportions.	Properly planted and established, or recruited desired species are present in the desired proportions.
Climatic stresses	Brownout from drought. Or, frost heaved plants, most with severed roots and dying. Or, major loss due to submergence or ice sheets.	Wilted plants, little recovery during night. Or, some frost heaved plants, recovery slow. Some spotty stand loss due to submergence or ice sheets.	Wilting during heat of the day. Or, weak plants from winter damage or short-term submergence. Or, freezing damage to foliage.	Dry conditions, but no wilting. Or, above or below normal temperatures slowing growth. Or, slight leaf yellowing due to cold, wet conditions.	No climatic stress.
Insect and/or disease pressure	Severe insect attack, mortality high. Or, disease caused mortality high.	Insect or disease outbreak at economic threshold, treat now.	Insect or disease outbreak near economic threshold, continue watch and weigh options for treatment.	Some insect and/or disease present, but little impact on forage quality or quantity.	No visible damage.

[1/] Names used to describe P & K levels not consistent nationwide; Very high referred to as excessive, and optimum as moderate or medium. Determined by approved soil testing procedures and comparing soil test results for exchangeable P and K with this table.

[2/] Determined using chlorophyll meter or plant tissue test and comparing those results with this table.

[3/] pH ratings may need to be regionalized to account for soil chemistry differences that influence range of acceptability as soils become more highly weathered or excess salts, exchangeable aluminum, or sodium begin to interfere with forage production. Establish exchangeable aluminum, electrical conductivity, and sodium absorption ratio criteria where their levels in the soil interfere with forage production.

Pasture Condition Score Sheet

Farm or ranch site:____ Date__________________

	Pasture Unit Description									
Indicators										
Percent desirable plants[1/] Percent plant cover by weight that is desirable forage: 1 2 3 4 5 <20 20-40 40-60 60-80 >80										
Plant cover[1/] [2/] Percent live, leafy canopy cover of desirables and intermediates is: 1 2 3 4 5 <50 50-70 70-90 90-95 95-100 Percent live basal area cover of desirables and intermediates is: <15 15-25 25-35 35-50 >50										
Plant diversity[1/] The diversity of well-represented forage species is: 1 2 3 4 5 (Read criteria and select appropriate number)										
Plant residue[1/] Ground cover, standing dead forage, or thatch is: 1 2 3 4 5 (Read criteria and select appropriate number)										
Plant vigor (Read criteria and select appropriate number) Degree of stress of plant community is: 1 2 3 4 5 (If less than 4, see Causative factors table. Rate those factors)										
Percent legume[1/] [3/] Percentage of legume present as total air dry weight: 1 2 3 4 5 <10, or >60 bloating legume; 10-19, or 40-60 spreading legume; 20-29; 30-39; 40-60 no grass loss										
Uniformity of use Degree of spot grazing is: 1 2 3 4 5 >50% ungrazed; 25-50% ungrazed; 10-25% ungrazed; Minor species rejection; Urine and dung spots ungrazed										
Livestock concentration areas Presence of livestock conc. areas and proximity to surface water: 1 2 3 4 5 (Read criteria and select appropriate number)										
Soil compaction Degree of soil compaction is: 1 2 3 4 5 (Read criteria and select appropriate number)										
Erosion (Always rate sheet and rill; others only if present) Sheet and rill, and gully, streambank, shoreline, or wind erosion is: 1 2 3 4 5 Very severe Severe Moderate Slight No visible										
Pasture condition score										

[1/] Pastureland inventory worksheet helpful.
[2/] Choose one proper, practical cover type estimation procedure to rate plant cover. The two procedures are not directly comparable.
[3/] For warm season grass (C4)-legume stands, use the following criteria: 5, 30-40%; 4, 20-29%; 3, 10-19%; 2, 5-9%; and 1 <4%.

Pasture Condition Score Sheet

	Pasture Unit Description									
Causative Factors Affecting Plant Vigor										
Soil fertility (P & K status)* Phosphorus and potassium status of the soil are: **1 2 3 4 5** (Read criteria and select appropriate number)										
Soil fertility (N status)* Nitrogen status of the grasses is: **1 3 5** (Read criteria and select appropriate number)										
Soil pH* pH status of the soil for the upper 4-inch root zone best fits: **1** ≤ 4.5, or > 9.0 **2** 4.5-5.0, or 8.5-9.0 **3** 5.1-5.5, or 7.9-8.4 **4** 5.6-6.0, or 7.4-7.8 **5** 6.0-7.3										
Severity of use Degree of forage removal is: **1 2 3 4 5** (Read criteria and select appropriate number)										
Site adaptation of desired species Presence of planted or desired forage species is: **1 2 3 4 5** (Read criteria and select appropriate number)										
Climatic stresses Degree of plant stress due to recent weather events is: **1 2 3 4 5** (Read criteria and select appropriate number)										
Insects and disease pressure Degree of plant stress due to insect or disease pressure is: **1 2 3 4 5** (Read criteria and select appropriate number)										

* Rate electrical conductivity and sodium adsorption ratios in regions where appropriate. Where excess salts, exchangeable sodium, or exchangeable aluminum hinder plant growth they are the controlling factor rather than soil pH conditions. Use appropriate criteria for them as found in the National Range and Pasture Handbook under Evaluating and rating pastures, Pasture Condition Scoring. See pH criteria below for highly weathered soils.

Soil pH Criteria for Major Landuse Resource Areas with Oxisols and Ultisols

pH status of the soil for the upper 4" rooting zone best fits:

1	**2**	**3**	**4**	**5**
< 4.0, or > 9.0	4.0-4.5 or, 7.0-9.0	4.5-5.0 or, 6.5-7.0	5.1-5.5 or, 6.2-6.5	5.6-6.2

Authors: Dennis Cosgrove is associate professor of agronomy, University of Wisconsin-River Falls and University of Wisconsin-Extension, Cooperative Extension. Dan Undersander is professor of agronomy, College of Agricultural and Life Sciences, University of Wisconsin-Madison and University of Wisconsin-Extension, Cooperative Extension. James Cropper is forage management specialist, USDA-Natural Resources Conservation Service, Grazing Lands Technology Institute. Authors extend their thanks to Extension and NRCS reviewers for their input on technical content.

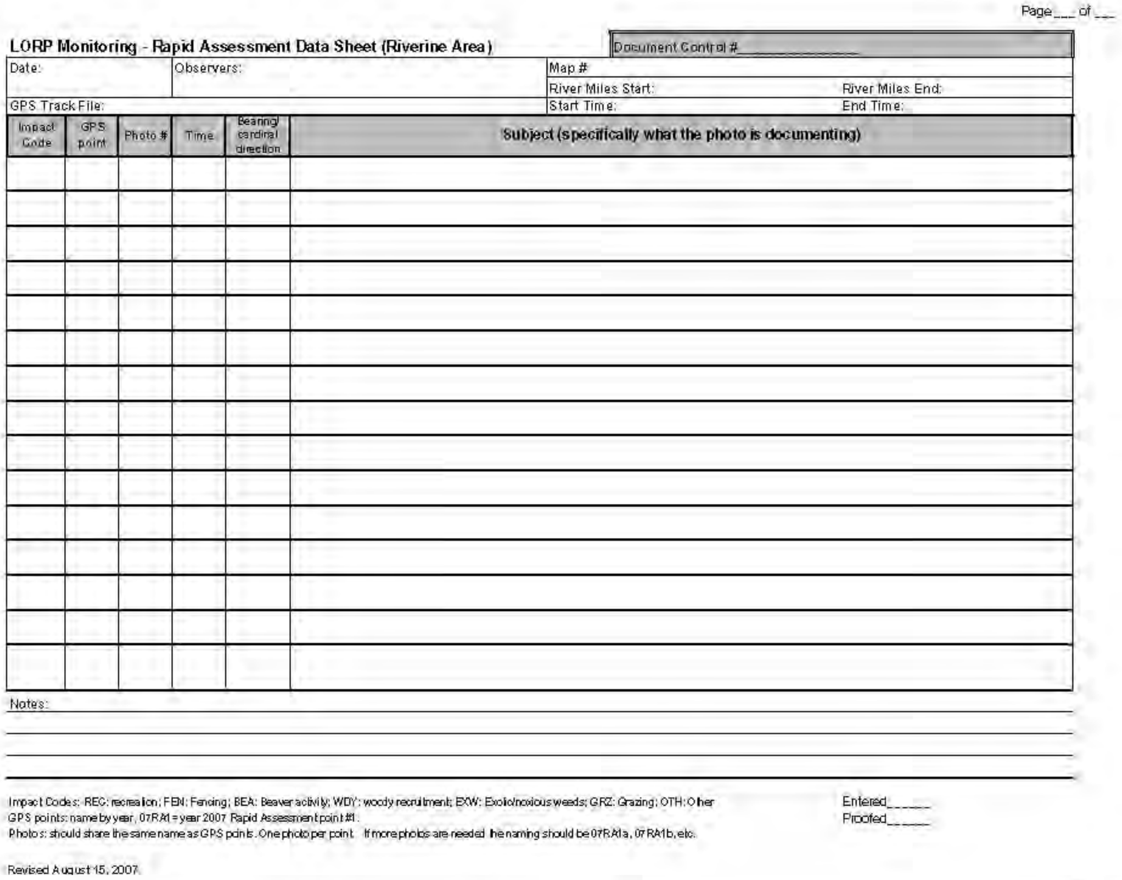
A.6 Sample Field Data Forms and Noxious Weed Table

APPENDICES
A.6

Data sheets and associate materials are listed in order of appearance:

1. Rapid Assessment Surveys
2. Pasture Utilization Data Sheet
3. Example Pasture Utilization Data Sheet
4. Utilization Data Form- Information
5. Example Utilization Data Form- Information
6. Instructions for Pasture Utilization Data Sheets
7. Range Trend Monitoring Datasheet
8. Shrub Line-Intercept Sampling
9. Vegetation Reference Plots Transect Line-Intercept
10. Vegetation Reference Plots Macroplots
11. Photo Record
12. Reference Plots Microhabitat/Fisheries Data
13. Habitat Characterization – Wildlife Protocols
14. Habitat Assessment Surveys – Vegetation
15. Noxious Weed Rating Table

* These Data Sheets are samples only and should be updated or revised prior to any fieldwork.



Page___ of ___

LORP Monitoring - Rapid Assessment Data Sheet (Riverine Area)

Document Control #_______________

Date:

Observers:

Map #

River Miles Start:

River Miles End:

GPS Track File:

Start Time:

End Time:

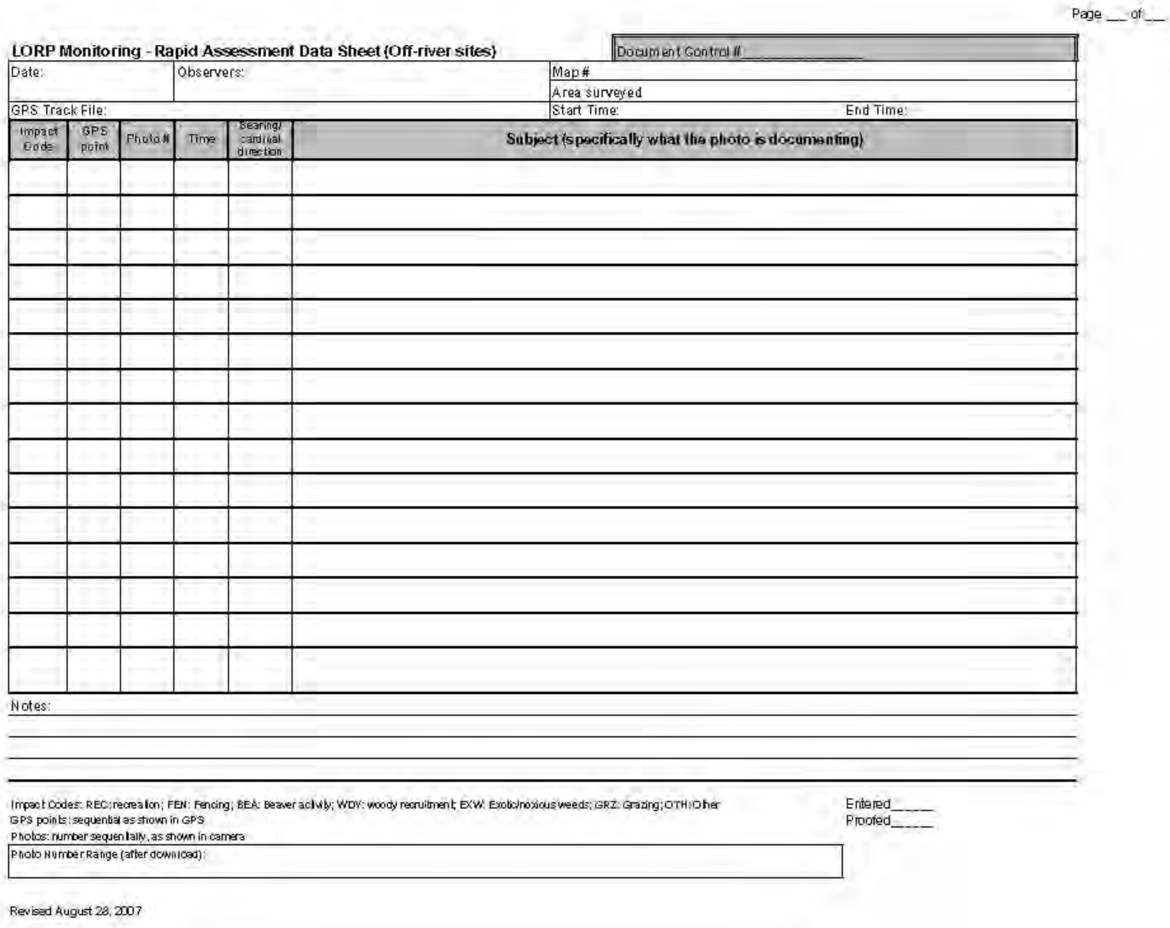
Impact Code	GPS point	Photo #	Time	Bearing/ cardinal direction	Subject (specifically what the photo is documenting)

Notes:

Impact Codes: REC: recreation; FEN: Fencing; BEA: Beaver activity; WDY: woody recruitment; EXW: Exotic/noxious weeds; GRZ: Grazing; OTH: Other
GPS points: name by year, 07RA1 = year 2007 Rapid Assessment point #1.
Photos: should share the same name as GPS points. One photo per point. If more photos are needed the naming should be 07RA1a, 07RA1b, etc.

Entered______
Proofed______

Revised August 15, 2007



Page ___ of ___

LORP Monitoring - Rapid Assessment Data Sheet (Off-river sites)

Document Control #_______________

Date:

Observers:

Map #

Area surveyed

GPS Track File:

Start Time:

End Time:

Impact Code	GPS point	Photo #	Time	Bearing/ cardinal direction	Subject (specifically what the photo is documenting)

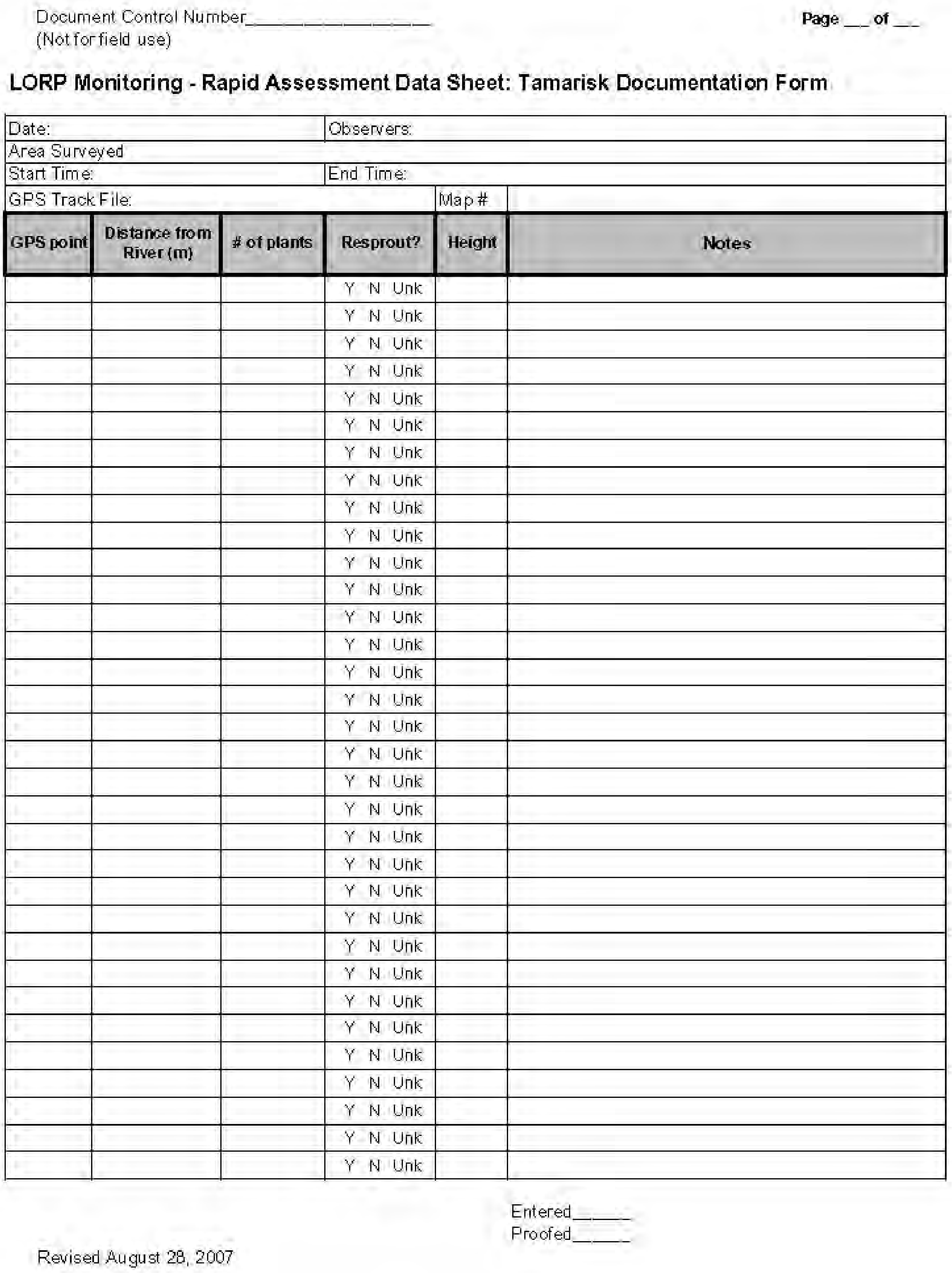
Notes:

Impact Codes: REC: recreation; FEN: Fencing; BEA: Beaver activity; WDY: woody recruitment; EXW: Exotic/noxious weeds; GRZ: Grazing; OTH: Other
GPS points: sequential as shown in GPS
Photos: number sequentially, as shown in camera

Entered_____
Proofed_____

Photo Number Range (after download):

Revised August 28, 2007



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(Not for field use)

Page ___ of ___

LORP Monitoring - Rapid Assessment Data Sheet: Tamarisk Documentation Form

Date:
Observers:
Area Surveyed
Start Time:
End Time:
GPS Track File:
Map #

GPS point	Distance from River (m)	# of plants	Resprout?	Height	Notes
			Y N Unk		
			Y N Unk		
			Y N Unk		
			Y N Unk		
			Y N Unk		
			Y N Unk		
			Y N Unk		
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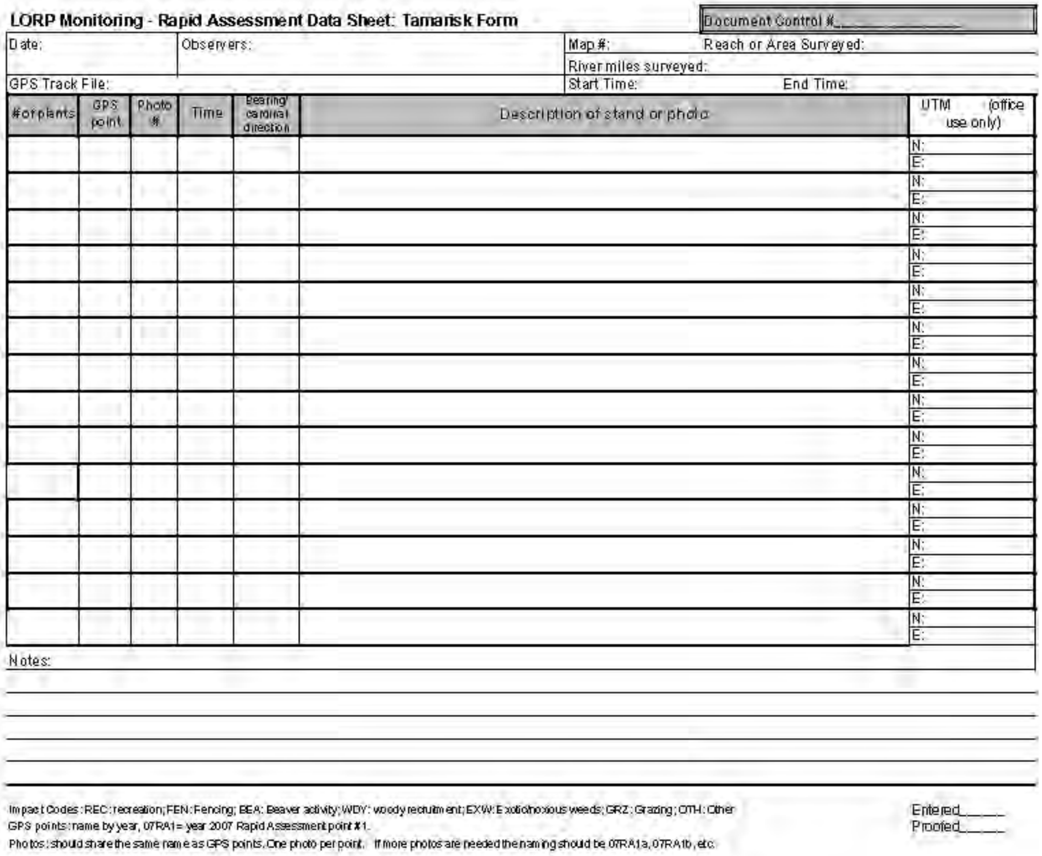
Entered_____
Proofed_____

Revised August 28, 2007



LORP Monitoring - Rapid Assessment Data Sheet: Tamarisk Form

Document Control #_____________

Date:

Observers:

Map #:

Reach or Area Surveyed:

River miles surveyed:

GPS Track File:

Start Time:

End Time:

#of plants	GPS point	Photo #	Time	Bearing/ cardinal direction	Description of stand or photo	UTM (office use only)
						N: E:
						N: E:
						N: E:
						N: E:
						N: E:
						N: E:
						N: E:
						N: E:
						N: E:
						N: E:
						N: E:
						N: E:
						N: E:
						N: E:

Notes:

Impact Codes: REC: recreation; FEN: Fencing; BEA: Beaver activity; WDY: woody recruitment; EXW: Exotic/noxious weeds; GRZ: Grazing; OTH: Other
GPS points: name by year, 07RA1= year 2007 Rapid Assessment point #1.
Photos: should share the same name as GPS points. One photo per point. If more photos are needed the naming should be 07RA1a, 07RA1b, etc.

Entered_____
Proofed_____

LORP Rapid Habitat Assessment **Noxious Weed Documentation and Reporting Form**

Date of Detection:

Observer:

GPS Point:

UTM (NAD27, CONUS)

Easting

Northing

Weed Common Name:

Weed Scientific Name:

Infestation Estimate (area or number of plants)

Was a comprehensive survey completed to locate all weeds in this area?
Yes No

Plant community type and associated plant species

Approximate distance to the river channel

Has this location been reported previously?
Yes No Unknown

Has this location been treated previously?
Yes No Unknown

If yes, has the number of noxious weed plants or extent of infestation increased/decreased or stayed the same?
Increased
Decreased
Same
Unknown

Where are the weeds? (Circle all that apply)
Along bank of river
In floodplain
In dry upland area
Other (please describe)

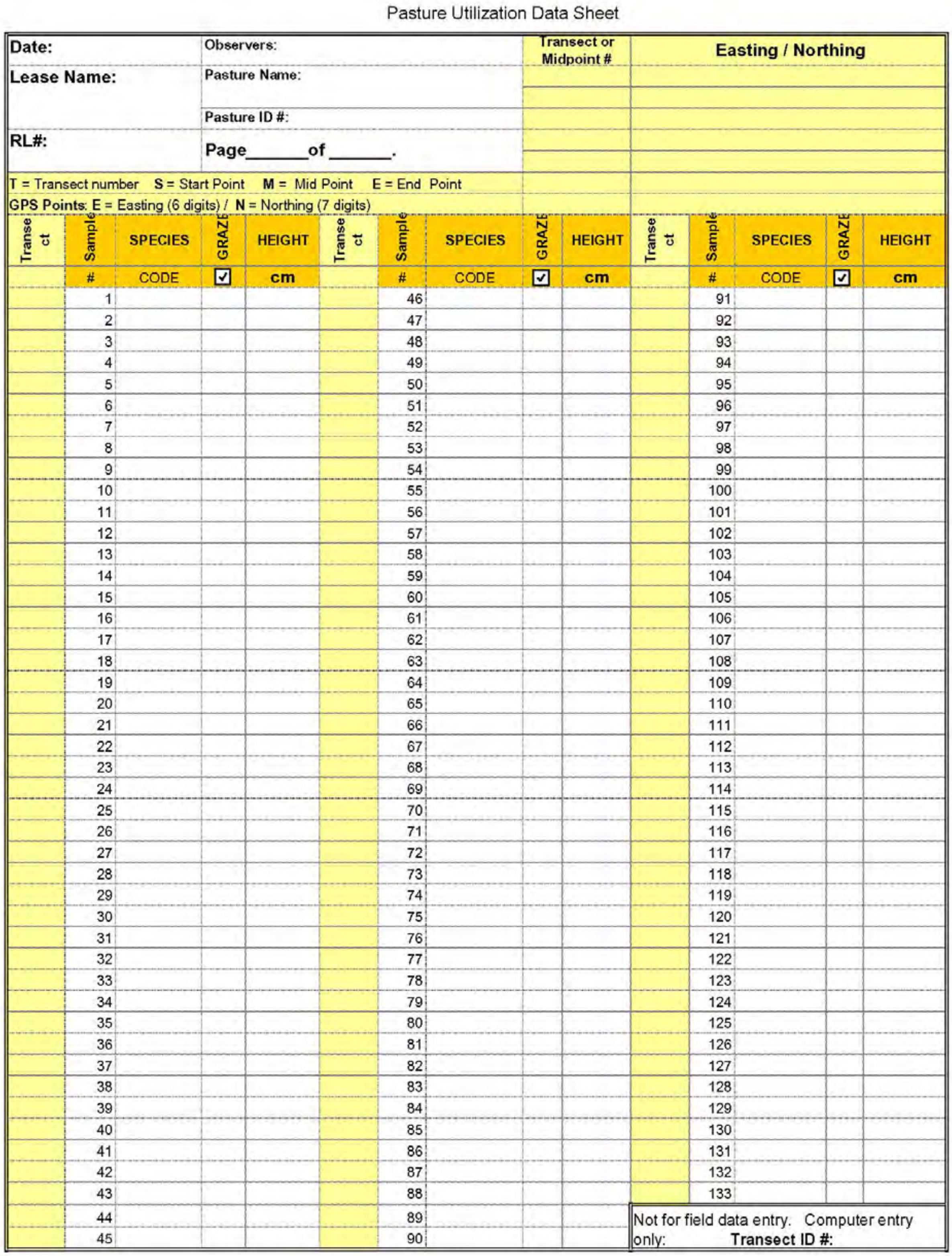
Nature of site (Circle all that apply)
Roadside
Livestock feeding or supplement area
Recreation site (parking area, campsite)
Other disturbed area
Area of intact native vegetation and no other obvious disturbance
Other (please describe)

Narrative (include additional notes on location or factors possibly contributing to presence, or that may affect treatment)

Send Copy to:
Inyo/Mono County Agricultural Commissioner's Office
207 West South Street
Bishop CA 93514

Copy Sent: ☐ Date Sent ______________ Copy Sent by _____________

Pasture Utilization Data Sheet, Example



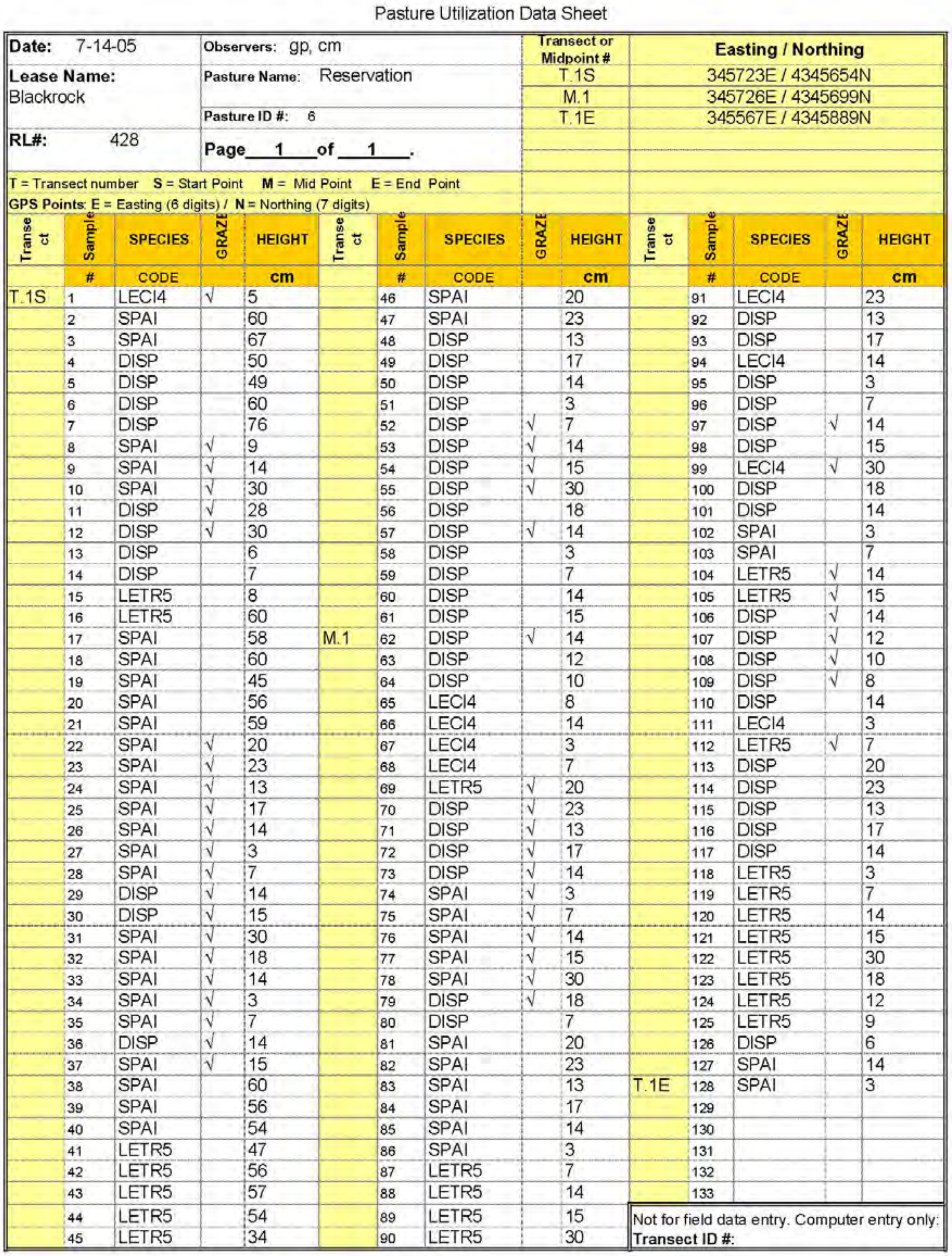
Pasture Utilization Data Sheet

Date:	Observers:	Transect or Midpoint #	**Easting / Northing**
Lease Name:	Pasture Name:		
	Pasture ID #:		
RL#:	**Page______of ______.**		

T = Transect number **S** = Start Point **M** = Mid Point E = End Point

GPS Points: E = Easting (6 digits) / **N** = Northing (7 digits)

Transect	Sample	SPECIES	GRAZE	HEIGHT	Transect	Sample	SPECIES	GRAZE	HEIGHT	Transect	Sample	SPECIES	GRAZE	HEIGHT
	#	CODE	☑	cm		#	CODE	☑	cm		#	CODE	☑	cm
	1					46					91			
	2					47					92			
	3					48					93			
	4					49					94			
	5					50					95			
	6					51					96			
	7					52					97			
	8					53					98			
	9					54					99			
	10					55					100			
	11					56					101			
	12					57					102			
	13					58					103			
	14					59					104			
	15					60					105			
	16					61					106			
	17					62					107			
	18					63					108			
	19					64					109			
	20					65					110			
	21					66					111			
	22					67					112			
	23					68					113			
	24					69					114			
	25					70					115			
	26					71					116			
	27					72					117			
	28					73					118			
	29					74					119			
	30					75					120			
	31					76					121			
	32					77					122			
	33					78					123			
	34					79					124			
	35					80					125			
	36					81					126			
	37					82					127			
	38					83					128			
	39					84					129			
	40					85					130			
	41					86					131			
	42					87					132			
	43					88					133			
	44					89					Not for field data entry. Computer entry only: **Transect ID #:**				
	45					90								



Pasture Utilization Data Sheet

Date: 7-14-05

Observers: gp, cm

Lease Name: Blackrock

Pasture Name: Reservation

Pasture ID #: 6

RL#: 428

Page 1 **of** 1 .

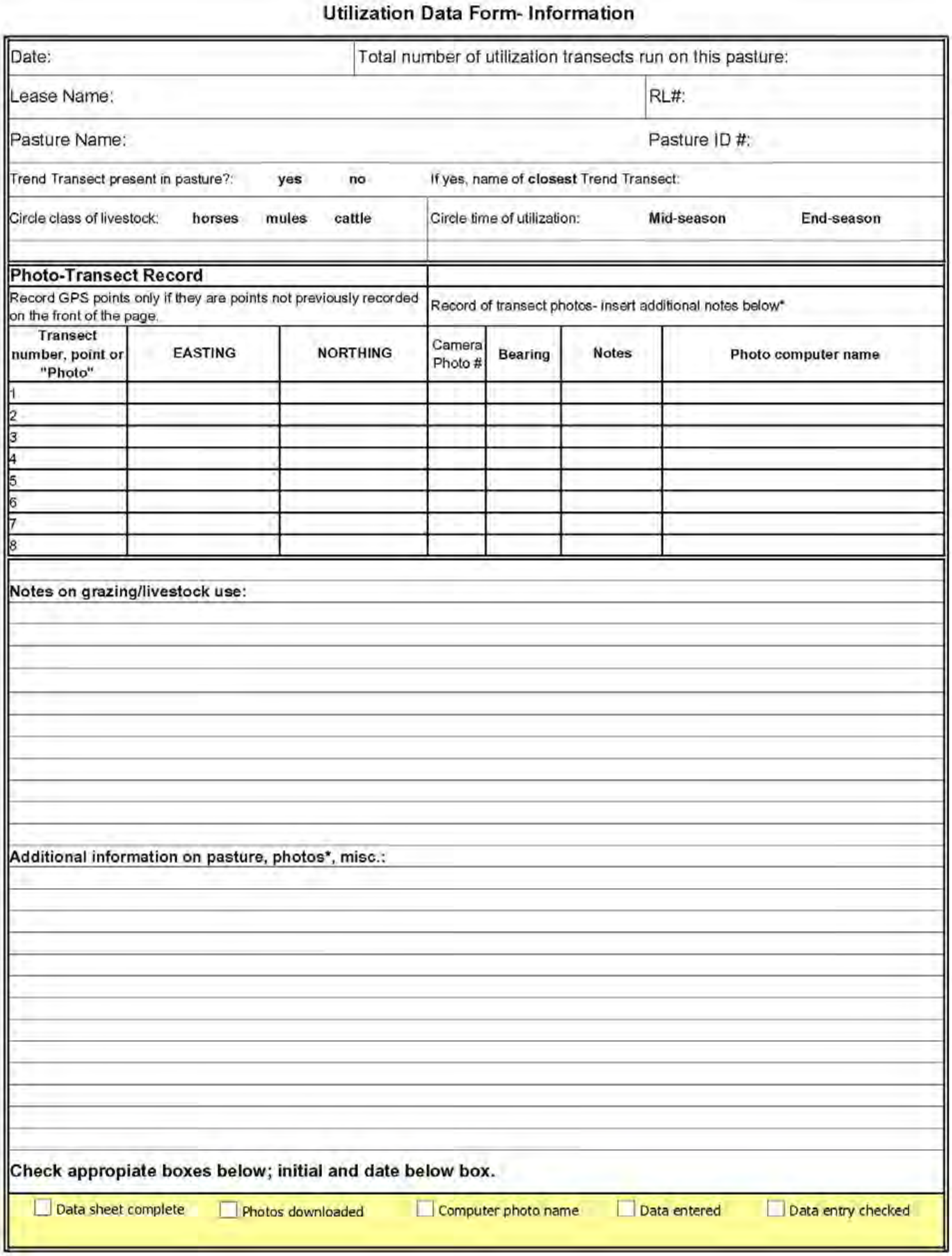
Transect or Midpoint #	Easting / Northing
T.1S	345723E / 4345654N
M.1	345726E / 4345699N
T.1E	345567E / 4345889N

T = Transect number **S** = Start Point **M** = Mid Point **E** = End Point

GPS Points: E = Easting (6 digits) / **N** = Northing (7 digits)

Transect	Sample #	SPECIES CODE	GRAZE	HEIGHT cm	Transect	Sample #	SPECIES CODE	GRAZE	HEIGHT cm	Transect	Sample #	SPECIES CODE	GRAZE	HEIGHT cm
T.1S	1	LECI4	√	5		46	SPAI		20		91	LECI4		23
	2	SPAI		60		47	SPAI		23		92	DISP		13
	3	SPAI		67		48	DISP		13		93	DISP		17
	4	DISP		50		49	DISP		17		94	LECI4		14
	5	DISP		49		50	DISP		14		95	DISP		3
	6	DISP		60		51	DISP		3		96	DISP		7
	7	DISP		76		52	DISP	√	7		97	DISP	√	14
	8	SPAI	√	9		53	DISP	√	14		98	DISP		15
	9	SPAI	√	14		54	DISP	√	15		99	LECI4	√	30
	10	SPAI	√	30		55	DISP	√	30		100	DISP		18
	11	DISP	√	28		56	DISP		18		101	DISP		14
	12	DISP	√	30		57	DISP	√	14		102	SPAI		3
	13	DISP		6		58	DISP		3		103	SPAI		7
	14	DISP		7		59	DISP		7		104	LETR5	√	14
	15	LETR5		8		60	DISP		14		105	LETR5	√	15
	16	LETR5		60		61	DISP		15		106	DISP	√	14
	17	SPAI		58	M.1	62	DISP	√	14		107	DISP	√	12
	18	SPAI		60		63	DISP		12		108	DISP	√	10
	19	SPAI		45		64	DISP		10		109	DISP	√	8
	20	SPAI		56		65	LECI4		8		110	DISP		14
	21	SPAI		59		66	LECI4		14		111	LECI4		3
	22	SPAI	√	20		67	LECI4		3		112	LETR5	√	7
	23	SPAI	√	23		68	LECI4		7		113	DISP		20
	24	SPAI	√	13		69	LETR5	√	20		114	DISP		23
	25	SPAI	√	17		70	DISP	√	23		115	DISP		13
	26	SPAI	√	14		71	DISP	√	13		116	DISP		17
	27	SPAI	√	3		72	DISP	√	17		117	DISP		14
	28	SPAI	√	7		73	DISP	√	14		118	LETR5		3
	29	DISP	√	14		74	SPAI	√	3		119	LETR5		7
	30	DISP	√	15		75	SPAI	√	7		120	LETR5		14
	31	SPAI	√	30		76	SPAI	√	14		121	LETR5		15
	32	SPAI	√	18		77	SPAI	√	15		122	LETR5		30
	33	SPAI	√	14		78	SPAI	√	30		123	LETR5		18
	34	SPAI	√	3		79	DISP	√	18		124	LETR5		12
	35	SPAI	√	7		80	DISP		7		125	LETR5		9
	36	DISP	√	14		81	SPAI		20		126	DISP		6
	37	SPAI	√	15		82	SPAI		23		127	SPAI		14
	38	SPAI		60		83	SPAI		13	T.1E	128	SPAI		3
	39	SPAI		56		84	SPAI		17		129			
	40	SPAI		54		85	SPAI		14		130			
	41	LETR5		47		86	SPAI		3		131			
	42	LETR5		56		87	LETR5		7		132			
	43	LETR5		57		88	LETR5		14		133			
	44	LETR5		54		89	LETR5		15					
	45	LETR5		34		90	LETR5		30					

Not for field data entry. Computer entry only:
Transect ID #:



Utilization Data Form- Information

Date:
Total number of utilization transects run on this pasture:

Lease Name:
RL#:

Pasture Name:
Pasture ID #:

Trend Transect present in pasture?: **yes** **no** If yes, name of **closest** Trend Transect:

Circle class of livestock: **horses** **mules** **cattle**
Circle time of utilization: **Mid-season** **End-season**

Photo-Transect Record

Record GPS points only if they are points not previously recorded on the front of the page.

Record of transect photos- insert additional notes below*

Transect number, point or "Photo"	**EASTING**	**NORTHING**	Camera Photo #	**Bearing**	**Notes**	**Photo computer name**
1						
2						
3						
4						
5						
6						
7						
8						

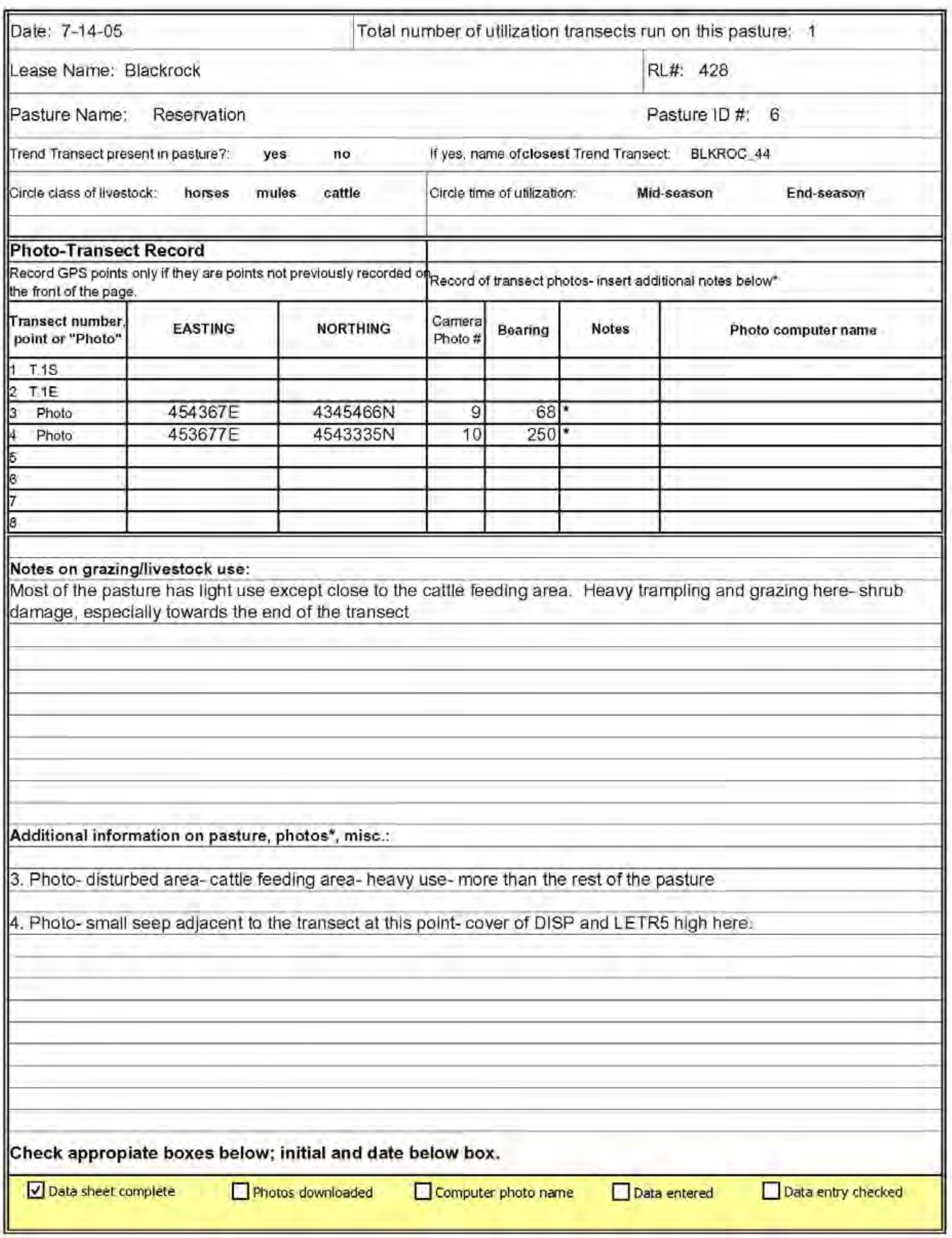
Notes on grazing/livestock use:

Additional information on pasture, photos*, misc.:

Check appropiate boxes below; initial and date below box.

☐ Data sheet complete ☐ Photos downloaded ☐ Computer photo name ☐ Data entered ☐ Data entry checked

Utilization Data Form- Information (Example)



Date: 7-14-05

Total number of utilization transects run on this pasture: 1

Lease Name: Blackrock

RL#: 428

Pasture Name: Reservation

Pasture ID #: 6

Trend Transect present in pasture?: **yes** **no**

If yes, name of**closest** Trend Transect: BLKROC_44

Circle class of livestock: **horses** **mules** **cattle**

Circle time of utilization: **Mid-season** **End-season**

Photo-Transect Record

Record GPS points only if they are points not previously recorded on the front of the page.

Record of transect photos- insert additional notes below*

Transect number, point or "Photo"	EASTING	NORTHING	Camera Photo #	Bearing	Notes	Photo computer name
1 T.1S						
2 T.1E						
3 Photo	454367E	4345466N	9	68	*	
4 Photo	453677E	4543335N	10	250	*	
5						
6						
7						
8						

Notes on grazing/livestock use:

Most of the pasture has light use except close to the cattle feeding area. Heavy trampling and grazing here- shrub damage, especially towards the end of the transect

Additional information on pasture, photos*, misc.:

3. Photo- disturbed area- cattle feeding area- heavy use- more than the rest of the pasture

4. Photo- small seep adjacent to the transect at this point- cover of DISP and LETR5 high here.

Check appropiate boxes below; initial and date below box.

☑ Data sheet complete ☐ Photos downloaded ☐ Computer photo name ☐ Data entered ☐ Data entry checked

Instructions for Pasture Utilization Datasheets

FRONT SIDE OF DATA SHEET:

Note: Utilization is on the **Pasture**, and any references such as page number, number of transects run, or Trend Transect information should reflect this.

Fill out Date, Observers, Pasture, Lease Name, RL#, Pasture Name, Pasture ID#, and page number.

Page # is the number of sheets needed for the Pasture on which you are recording utilization. A lease may have several pastures, and a pasture may have one to several Trend Transects (permanent 100m transects). If you begin recording utilization on a second pasture of a lease, start a new set of pages. The back side of the datasheet is not considered another page.

Entering Data:

Transect	Sample	SPECIES	GRAZED	HEIGHT
	#	CODE		cm
T.1S	1	LECI4	√	5
	2	SPAI		60
	3	SPAI		67
	4	DISP		50
	5	DISP		49
	6	DISP		60

Transect or Midpoint #	Easting / Northing
T.1S	345723E / 4345654N
M.1	345726E / 4345699N
T.1E	345567E / 4345889N

Information concerning the transect itself is recorded in 2 places (see above boxes):

1. The shaded columns “Transects” are reserved for the transect number and point only. No other information is to be entered here. (left box)

T.1 S= Transect # 1, Start point (T.2 S, T.3 S).

M.1= Midpoint #1 (M.2, M.3). A midpoint is recorded when there is a change in the direction (bearing) of your transect line. A line may or may not have a midpoint.

T.1 E= End point of Transect #1 (T.2 E, T.3 E).

2. At the top, right hand corner of the page, repeat the transect number, and in the columns to the right, add your Easting and Northing. An Easting always has 6 numbers. It increases as you travel east. A Northing has 7 numbers and increases as you go north (box upper right).

Bearings do not have to be taken because the UTM start, end, and mid points will reflect the bearings.

Plant Data Information:

Data records include Sample #, Species (USDA plant code), Height (in centimeters), and note is taken (checked) if plant has been Grazed. It is important to reserve this area for Plant information ONLY. Do not enter any other data about transects, GPS points, or start, mid, or end points in this area (see below).

CORRECT:

Transect	Sample	SPECIES	GRAZED	HEIGHT
	#	CODE		Cm
T.1S	1	LECI4	√	5
	2	SPAI		60
	3	SPAI		67
	4	DISP		50
	5	DISP		49
	6	DISP		60
	7	DISP		76
	8	SPAI	√	9
	9	SPAI	√	14

X INCORRECT: X

Transect	Sample	SPECIES	GRAZED	HEIGHT
	#	CODE		Cm
T.1S	1 354265E / 4573245N			
	2	SPAI		60
	3	SPAI		67
	4	DISP		50
	5	DISP		49
	6	DISP		60
	7	DISP		76
M1	8 546322E / 4356768N			
	9	SPAI	√	14

BACK SIDE OF DATASHEET:

If you have more than one datasheet for the Pasture you are working, you only need to fill out the back side of the 1st datasheet. Leave the others blank unless you need to record additional information.

- ✓ Date: Current date
- ✓ Pasture, Lease Name, RL#, Pasture Name, Pasture ID#, and closest Trend Transect for the area you are working in.
- ✓ Class of livestock: Circle cattle, horses, and/or mules.
- ✓ Circle either Mid-season or End-season, for the mid or end of season readings.

Date: 7-14-05	Total number of utilization transects run on this pasture: 1
Lease Name: Blackrock	RL#: 428
Pasture Name: Reservation	Pasture ID #: 6
Trend Transect present in pasture?: **yes** **no**	If yes, name of **closest** Trend Transect: BLKROC_44
Circle class of livestock: **horses** **mules** **cattle**	Circle time of utilization: **Mid-season** **End-season**

Transect Photo Record:

Transect number, point or "Photo"	**EASTING**	**NORTHING**	Camera Photo #	**Bearing**	**Notes**	**Photo computer name**
1 T.1S			7			
2 T.1E			8			
3 Photo	454367E	4345466N	9	68	*	
4 Photo	453677E	4543335N	10	250	*	
5						
6						
7						
8						

Two types of photos are taken and recorded:

1. Utilization Transect start and end points
2. Additional photos of specific areas/ sites that need to be noted

1. Recording Utilization Transect Photos:

- ✓ A photo should be taken at each Utilization Transect Start AND End points. Take the photo at the start point in the direction in which you are going to run the transect and the end photo in the direction in which you ran the transect. For these points, Eastings and Northings are recorded on the front of the sheet, so do not have to be re-recorded here.

- ✓ Camera Photo # is the number on the camera in **review** mode.

- ✓ Bearings do not need to be recorded with transect start, mid or end points. GPS points will compute this.

- ✓ Notes can be recorded below with additional information- asterick here if needed.

- ✓ Photo computer name will be added when photos are downloaded.

2. Recording additional photos not associated with Transect start or end points:

- ✓ Record UTMs and the BEARING of the photo, since you are just recording a point.

- ✓ Put “Photo” in the first column.

- ✓ Asterick “Notes” column and add additional information about the photo below, under “Additional information on pasture, photos, misc.”

Additional Information:

Record any additional information about the pasture or transect in the areas that apply.

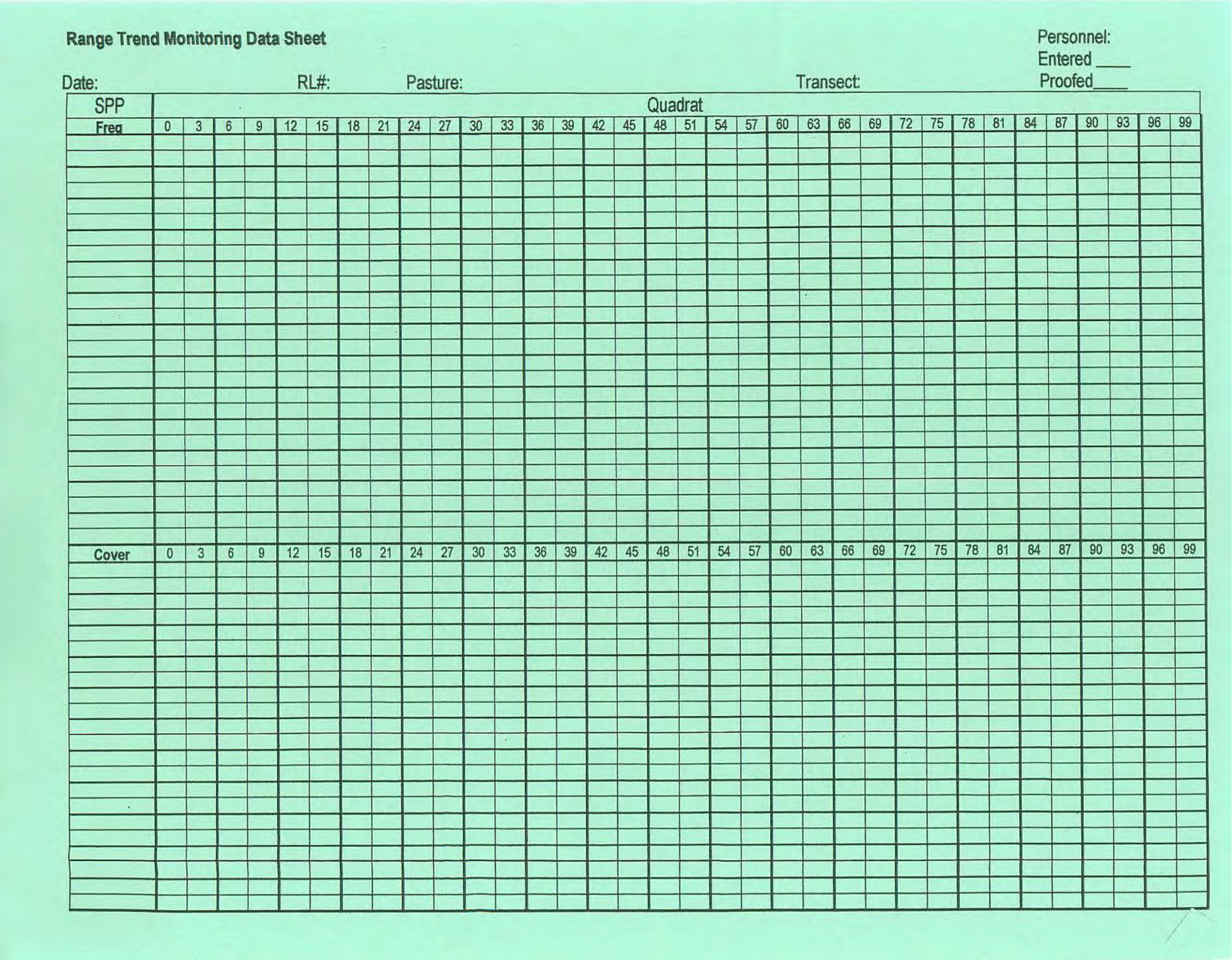
Check boxes

- ✓ **Data sheet complete**- Make sure ALL boxes/areas have been filled in and information is clear and complete.

- ✓ **Photo downloaded** and **Computer photo name** should be done at the same time. Make sure the photo name is clear and reflects the photo: **BKLROC_11-T1S** or **DELTA_05-Burn**

- ✓ **Data entered**- Enter data. Be sure to fill in the **Transect ID #** on the front of the data sheet (lower right corner). This number will be available in the database.

- ✓ **Data entry checked-** check when complete.

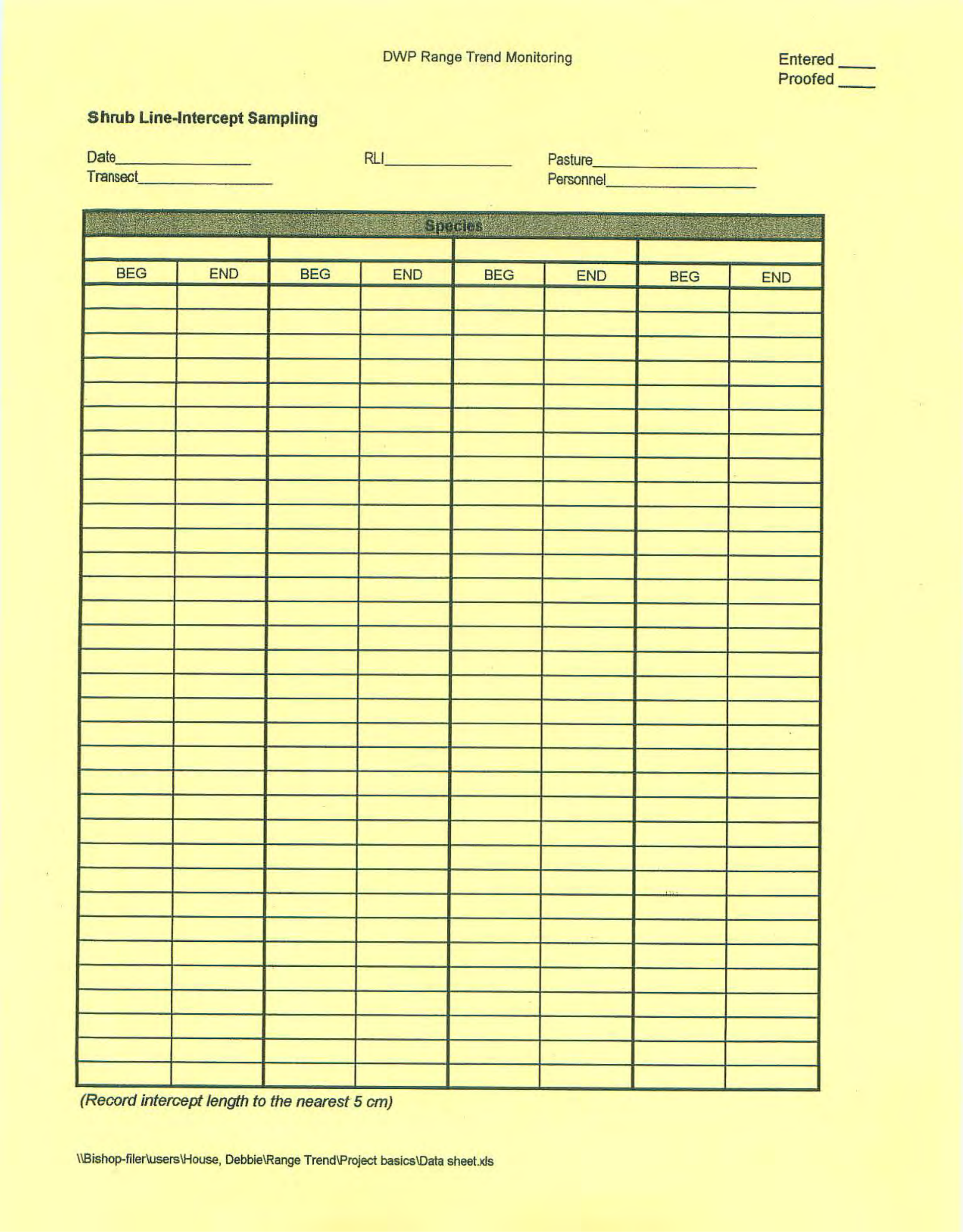


Range Trend Monitoring Data Sheet

Personnel:
Entered ____
Proofed____

Date: RL#: Pasture: Transect:

SPP	Quadrat																																	
Freq	0	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63	66	69	72	75	78	81	84	87	90	93	96	99
Cover	0	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63	66	69	72	75	78	81	84	87	90	93	96	99



DWP Range Trend Monitoring

Entered ____
Proofed ____

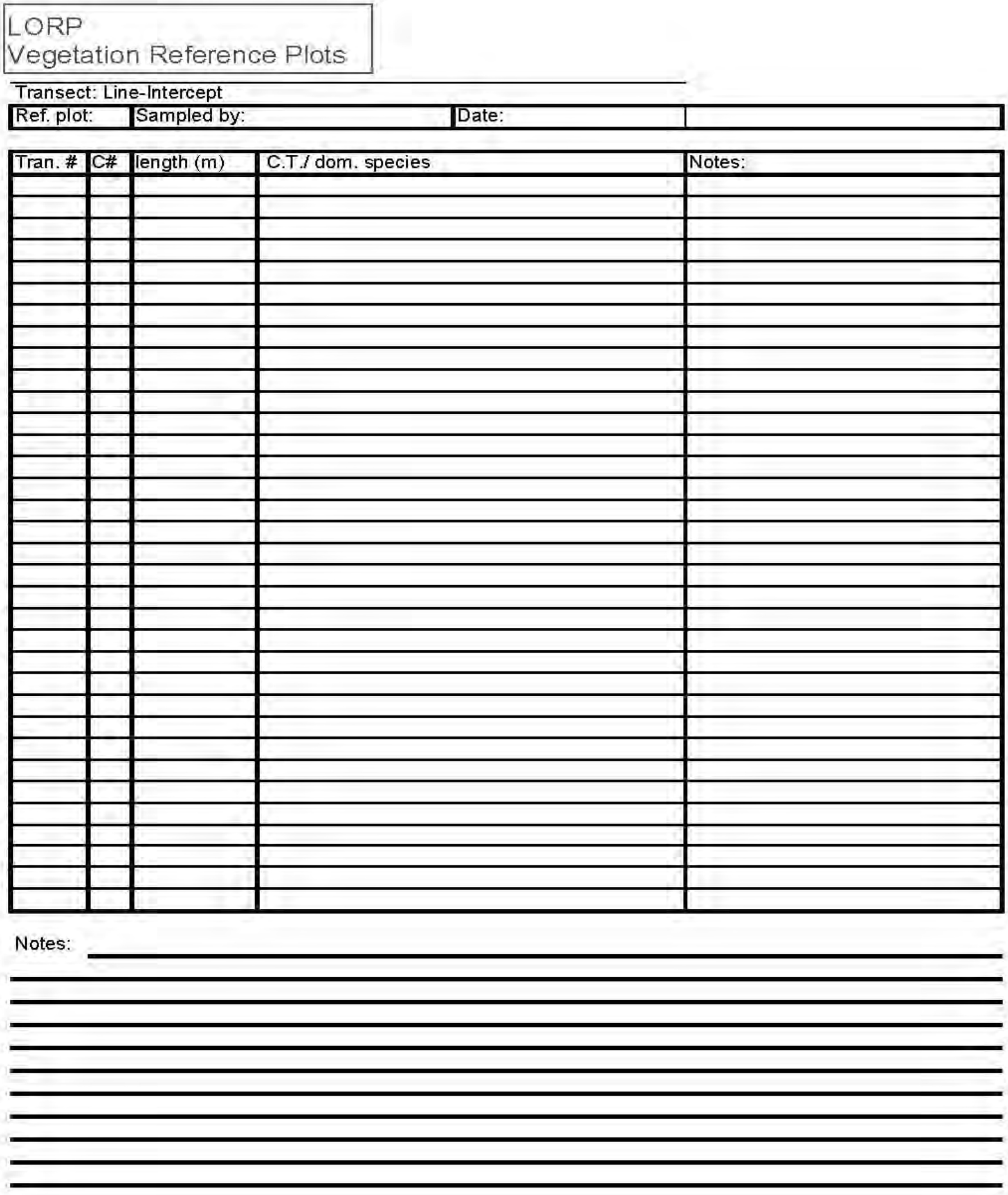
Shrub Line-Intercept Sampling

Date__________________
Transect__________________
RLI________________
Pasture____________________
Personnel____________________

Species							
BEG	END	BEG	END	BEG	END	BEG	END

(Record intercept length to the nearest 5 cm)

\\Bishop-filer\users\House, Debbie\Range Trend\Project basics\Data sheet.xls



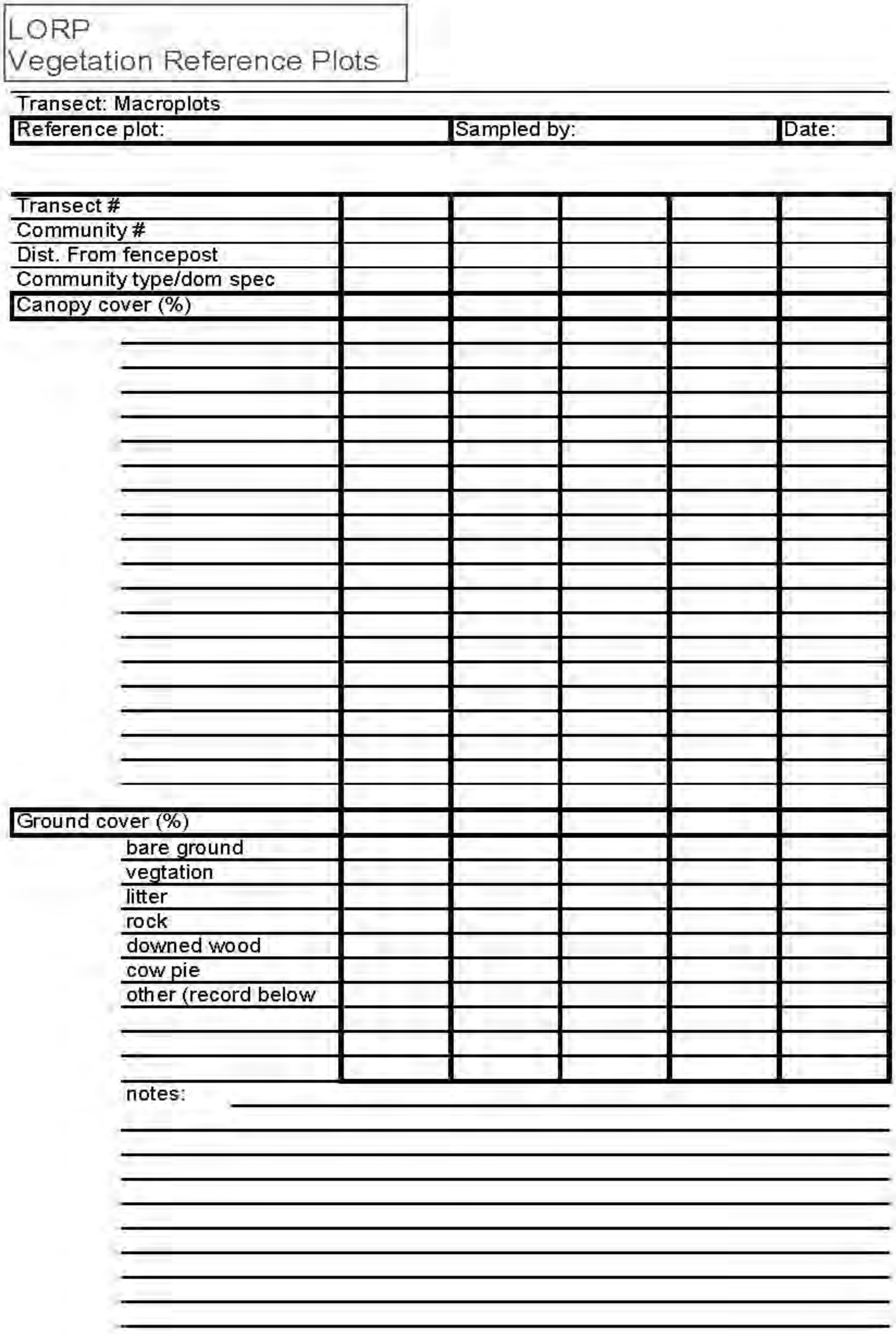
LORP
Vegetation Reference Plots

Transect: Line-Intercept

Ref. plot:	Sampled by:	Date:	

Tran. #	C#	length (m)	C.T./ dom. species	Notes:

Notes:



LORP
Vegetation Reference Plots

Transect: Macroplots

Reference plot: | Sampled by: | Date:

Transect #					
Community #					
Dist. From fencepost					
Community type/dom spec					
Canopy cover (%)					
Ground cover (%)					
bare ground					
vegtation					
litter					
rock					
downed wood					
cow pie					
other (record below					

notes:

LORP

Photo Record
River Channel Rapid
Assessment and
Obstructions

Spring 2002
Ecosystem Sciences

Photo No.	Location / GPS coordinates	Description Notes and Character	Other

LORP
Reference Plots
Microhabitat/Fisheries Data

Ecosystem Sciences
Field Monitoring Summer 2002

Plot#________________
Date:________________
Researchers:______________

PLOT	Tsect	Channel Width (m)	Wetted Width (m)	Boulder Substrate (m)	Cobble Substrate (m)	Gravel Substrate (m)	Fines Substarte (m)	Canopy Cover (%)	Organic Debris (%)	Right Bank Undercut (cm)	Left Bank Undercut (cm)

Field Notes / Observations

LORP Habitat Characterization – Wildlife Protocols GPS WAYPOINT # ____________

Area ____________________ Date ____________________ Surveyors ____________________

CHANNEL PLOT (perpendicular to transect, 1st 5m)

Percent Cover visual estimate – use density example charts Cover classes: <1, 1-5, 5-25, 25-50, 50-75, 75-100	
aWetRatio percent cover **live** emergent vegetation	
Shoreline – near	
Shoreline – far	
Entire Channel Plot	
aWetBare percent cover **residual** emergent vegetation	
Shoreline - near	

Height or Depth measurements – require Meter Stick or Tape Measure All measurements taken at near shoreline			
aWetTall height (cm) of live emergent vegetation near shoreline			
aWetOld height (cm) of residual emergent veg near shoreline			
AWetDeep2 depth (cm) of water at near shoreline			

4 TREES NEAREST TO POST A (within 50 meters, mature or pole willows and cottonwoods only)

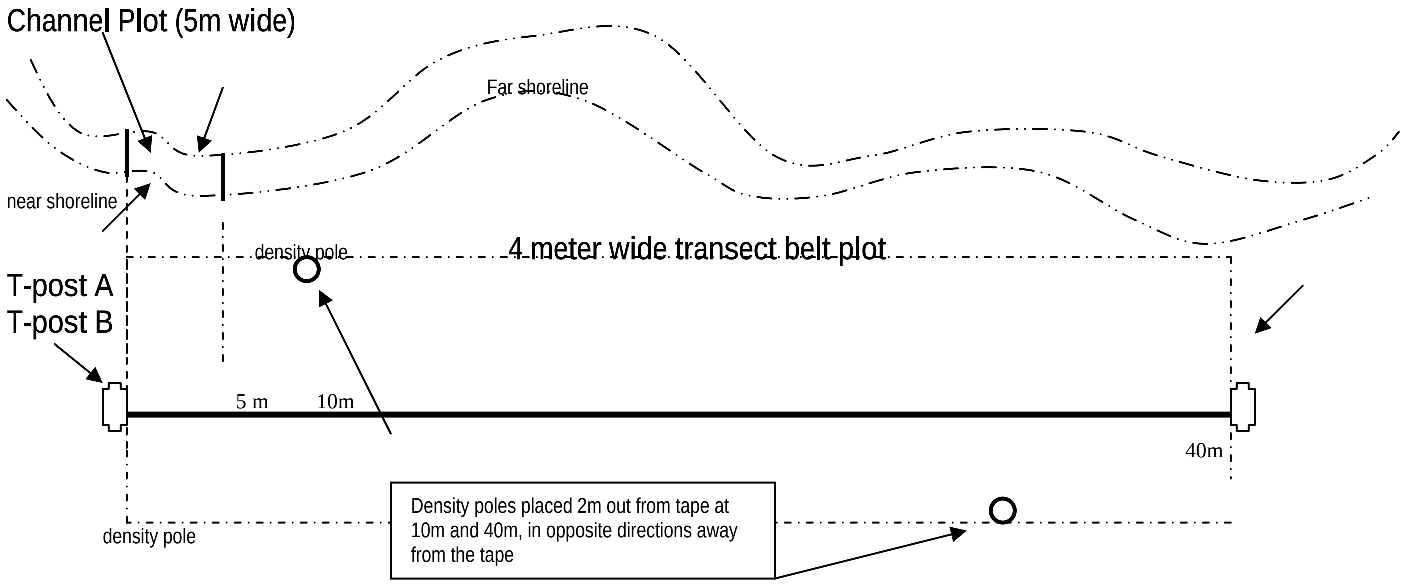
TREE CONDITION INDICATORS – circle single or multi-trunked for each of the four trees sampled								
	Tree 1 Single Multi		Tree 2 Single Multi		Tree 3 Single Multi		Tree 4 Single Multi	
Live Crown Diameter (cm)								
Diameter @ widest point								
Diameter perpendicular								
Live Crown Ratio (cm)								
Tallest point of live canopy								
Tallest point of dead canopy								
Live Crown Density Use density example charts to estimate % cover in the following classes: 0, 1-5, 5-10, 10-25, 25-40, 40-55, 55-70, 70-85, 85-100%								
Estimate 1								
Estimate 2								
Crown Die-Back % dead / % live canopy (total = 100)	%Dead	%Live	%Dead	%Live	%Dead	%Live	%Dead	%Live
Browsed/unbrowsed tree sprouts from 0-2.0 m height (limit sample to first 25 sprouts encountered)	Total #	# Browsed	Total #	# Browsed	Total #	#Browsed	Total #	# Browsed

Crown Structure Indicator Percent obstruction in each of the layers listed below. Cover classes: 0, 1-5, 5-10, 10-25, 25-40, 40-55, 55-70, 70-85, 85-100%																	
	0-1m		1-3m		3-6m		>6m			0-1m		1-3m		3-6m		>6m	
Tree #1									Tree #3								
Tree #2									Tree #4								

TRANSECT BELT PLOT **GPS WAYPOINT # ______________**

(4 meter wide belt, centered on the tape)

aWET lay1 – Live foliage density in layers, 0-2 m (density pole reading, pole @ 10 m)					aWET lay1 – Live foliage density in layers, 0-2 m (density pole reading, pole @ 40 m)			
Habitat pole placed in? marsh/ meadow/ scrub woodland/ transition		*Compass direction of pole Placement relative to transect?*			*Habitat pole placed in?* marsh/ meadow/ scrub woodland/ transition		*Compass direction of pole Placement relative to transect?*	
	Hit or Miss*	% obstruction	% obstruction	Hit or Miss reading viewed in imaginary 1dm cylinder around pole		Hit or Miss	% obstruction	% obstruction
0- 0.2 m					0- 0.2 m			
0.2- 0.4 m					0.2- 0.4 m			
0.4- 0.6 m					0.4- 0.6 m			
0.6- 0.8 m					0.6- 0.8 m			
0.8- 1.0 m					0.8- 1.0 m			
1.0- 1.2 m				Cover classes for %obstruction: 0% 1-5% 5-10% 10-20% 20-40% 40-60% 60-80% 80-90% 90-95% 95-100%	1.0- 1.2 m			
1.2- 1.4 m					1.2- 1.4 m			
1.4- 1.6 m					1.4- 1.6 m			
1.6m- 1.8 m					1.6m- 1.8 m			
1.8- 2.0 m					1.8- 2.0 m			
aWET lay2 – Live foliage density, 2 –4 m					aWET lay2 – Live foliage density, 2 –4 m			
2.0- 2.2 m					2.0- 2.2 m			
2.2- 2.4 m					2.2- 2.4 m			
2.4- 2.6 m					2.4- 2.6 m			
2.6- 2.8 m					2.6- 2.8 m			
2.8- 3.0 m					2.8- 3.0 m			
3.0- 3.2 m					3.0- 3.2 m			
3.2- 3.4 m					3.2- 3.4 m			
3.4- 3.6 m					3.4- 3.6 m			
3.6- 3.8 m					3.6- 3.8 m			
3.8- 4.0 m					3.8- 4.0 m			



Density poles placed 2m out from tape at 10m and 40m, in opposite directions away from the tape

LORP Transect Riparian Tree Inventory **Date ____________**

GPS Waypoint_____________

**Inventory conducted within 10 meters each side of the transect (20m wide total)* Surveyors ______________

SPECIES	SEEDLING	***YOUNG***	MATURE 0-5% DEAD	MATURE 5-25% DEAD	MATURE 25-50% DEAD	MATURE 50-75% DEAD	MATURE 75-100% DEAD	DEAD
Gooding's Willow **Salix goodingii**								
Salt Cedar Tamarisk spp.								
Red Willow *Salix laevigata*								
Arroyo Willow **Salix lasiolepis**								
Fremont Cottonwood Populus fremontii								
Russian Olive *Eleagnus angustifolia*								

If seedlings or sapling trees are present in the sample area (including salt cedar and Russian olive), complete the following*:

- *After counting the first 25, you may use the following size classes:* 25-50, 50-75, 75-100, 100-200, >200

Species	**0 – 1 meter** **(height)**	**1 – 2 meters**	**2 – 3 meters**	**>3 meters** **(young trees only)**	**# browsed by grazing animals**	**# damaged by beaver**
Gooding's Willow **Salix goodingii**						
Salt Cedar Tamarisk spp.						
Red Willow *Salix laevigata*						
Arroyo Willow **Salix lasiolepis**						
Fremont Cottonwood Populus fremontii						
Russian Olive *Eleagnus angustifolia*						

Description of site where regeneration is occurring (circle all applicable features or conditions):

(physiographic setting) shoreline low terrace mid-terrace high terrace

(distance from channel) 0-1m 1-5m 5-10m 10-50m >50m

(hydrology) frequently flooded seasonally flooded infrequently flooded
depression in uplands

(cover density of other competing veg) <10% cover 10-50% 50-75% 75-100%

(invasives present in quantities sufficient to compete with seedling/saplings? ___________________
Species?_______________________

Comments

____

____

Species List

List all additional species encountered within 2 meters each side of the transect (4 meters wide belt transect)

Habitat Assessment Surveys - Vegetation

Date ________________ Surveyors ________________ GPS Unit__________ Bearing (A --> B) ___________ Transect length___________

UTM A ________________/_________________ Accuracy A _______ UTM B ________________/_________________ Accuracy B _________

Photo A #_________________time_________ Photo B # (1)_________________________(2)___________________________time_________

Landscp 1 # ____________ bearing #1_____ Landscp 2 # ____________ bearing #2_____ Landscp 3#________________bearing#3_______

Distance channel/water ____________ Terrace/Microtopography _____________________________ Impacts _________________________

#	Species Code(s)			Series or Association	2 m both sides of point: dominant spp. > 20% cover
	Herb layer (0-1m)	Shrub layer (1-3m)	Tree layer (3+m)		
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					

Table A.6. Noxious Weed Ratings

Eastern Sierra Weed Management Area (ESWMA). 1999. Noxious weed identification handbook.

Scientific Name	**Common Name**	**CDFA**	**CalEPPC**
Cardaria draba	Hoary cress	B	A-2
Carduus mutans	Musk thistle/ Nodding thistle	A	N/A
Centaurea diffusa	Diffuse knapweed	A	N/A
Centaurea maculosa	Spotted knapweed	A	N/A
Centaurea repens	Russian knapweed	N/A	N/A
Centaurea solstitialis	Yellow starthistle	C	A-1
Centaurea squarrosa	Squarrose knapweed	N/A	N/A
Chondrilla juncea	Rush skeletonweed	A	N/A
Circium arvense	Canada thistle	B	B
Conium maculatum	Poison-hemlock	N/A	N/A
Crupina vulgaris	Common crupina	A	N/A
Cynoglossum officinale	Houndstongue	N/A	N/A
Euphorbia esula	Leafy spurge	A	A-2
Halogeton glomeratus	Halogeton	A	Red Alert
Hypericum perforatum	St. Johnswort/Klamath weed	C	N/A
Isatis tinctoria	Dyer’s woad/Marlahan mustard	B	N/A
Lepidium Latifolium	Perennial Pepperweed	B	A-1
Linaria genistifolia spp. *dalmatica*	Dalmation toadflax	A	N/A
Lythrum salicaria	Purple loosestrife/Lythrum	B	Red Alert
Onopordum acanthium ssp. *acanthium*	Scotch thistle	A	N/A
Pontentilla recta	Sulfur cinquefoil	N/A	N/A
Salsola tragus	Russian thistle	C	N/A
Taeniatherum caput-medusae	Medusahead	C	A-1
Tamarix ramosissima	Saltcedar	N/A	A-1
Tribulus terrestris	Puncture vine	C	N/A

California Department of Food and Agriculture (CDFA) Ratings:

A Eradication, containment, rejection, or other holding action
B Eradication, containment, control or other holding action at the discretion of the County Agricultural Commissioner
C State endorsed holding action and eradication only when found in a nursery

California Exotic Pest Plant Council (CalEPPC) Ratings:

A-1 Widespread and aggressive weeds that displace natives
A-2 Regional aggressive weeds that displace natives
B Wildland weeds of secondary importance
C Wildland weeds watch list

A.7 Stipulation and Order for Baseflow Compliance

APPENDICES

A.7

5

RECEIVED
JUL 17 2007
OFFICE OF COUNTY COUNSEL
INDEPENDENCE

FILED
JUL 11 2007
INYO CO. SUPERIOR COURT
NANCY A. MOXLEY, CLERK
BY DEPUTY

SUPERIOR COURT OF THE STATE OF CALIFORNIA

COUNTY OF INYO

SIERRA CLUB and OWENS VALLEY COMMITTEE,
Plaintiffs,
vs.
CITY OF LOS ANGELES, et al.,
Defendants.

CALIFORNIA DEPARTMENT OF FISH AND GAME and CALIFORNIA STATE LANDS COMMISSION,
Real Parties in Interest and Cross-Complainants.

COUNTY OF INYO and DOES 51-100
Real Party in Interest

Case No. S1CVCV01-29768

(The Honorable Lee Cooper, Assigned)

STIPULATION & ORDER

A. PURPOSE:

The purpose of this Stipulation and Order is to resolve certain outstanding issues related to LADWP's compliance with the August 8, 2005 Order of this Court "*Order Re: Defendants' Violations of Court Orders*" (hereinafter "Court Order") pertaining to the Lower Owens River Project ("LORP"). A copy of the Court Order is attached as Exhibit "A." In so doing, this Stipulation and Order will also serve to establish certain data reporting requirements, provide criteria as to what constitutes a permanent baseflow of approximately 40 cubic feet per second ("cfs") in the Lower Owens River as required by Section II.C.1.b.i of the 1997 Memorandum of Understanding, and provide a mechanism for the enforcement of the provisions of this Stipulation and Order.

B. THE PARTIES:

The parties to this Stipulation and Order are: The City of Los Angeles acting by and through its Department of Water and Power ("LADWP'); the County of Inyo ("County"); State of California Department of Fish and Game ("DFG"); the State Lands Commission ("SLC"); the Owens Valley Committee ("OVC"); and the Sierra Club; all hereinafter collectively referred to as the Parties.

C. BACKGROUND:

In March 1997, the Parties entered into a Memorandum of Understanding ("MOU"). Among its provisions, the MOU required LADWP to implement the LORP. A copy of the MOU is attached as Exhibit "B." The LORP is compensatory mitigation for impacts related to LADWP's groundwater pumping in the Owens Valley from 1970 to 1990 that were difficult to quantify or mitigate directly. The LORP includes the restoration of flow in the portion of the Lower Owens River from which the water was diverted by LADWP in 1913. In June 2004, LADWP adopted a final environmental impact report that addressed the LORP (Final LORP EIR).

On September 26, 2003, the OVC and the Sierra Club filed a Second Amended and Supplemental Complaint for Declaratory Relief and Petition for Writ of Mandate ("Amended Complaint"). On December 3, 2004, DFG and SLC filed a Cross Complaint for Declaratory Relief and Petition for Writ of Mandate ("Cross Complaint"). Each of these actions alleged violations of the MOU and sought to enforce the provisions of the MOU.

On February 13, 2004, this Court entered an order to which the Parties had stipulated. By further stipulation of the Parties, on September 15, 2004, the February 13, 2004 order was amended by the Court ("Amended Stipulation and Order"). A copy of the Amended Stipulation and Order is attached as Exhibit "C." The purpose of the Amended Stipulation and Order was to resolve the issues raised in the Amended Complaint and the Cross Complaint.

On April 25, 2005, proceedings were commenced to hear motions that LADWP was in violation of the Amended Stipulation and Order. On June 24, 2005, this Court issued a written Statement of Decision that found that LADWP violated the Amended Stipulation and Order. The

Court found that the imposition of immediate sanctions was necessary to force LADWP to meet its obligations under the Amended Stipulation and Order. The Court Order issued on August 8, 2005 imposed an Injunction against the use of the Second Los Angeles Aqueduct ("Injunction"). The Injunction is set forth in Section 1 of the Court Order; however, the Court Order stayed the Injunction so long as LADWP remained in compliance with several conditions ("Conditions"). The Conditions are set forth in Section 2 of the Court Order.

On February 27, 2007, LADWP moved the Court to vacate the Injunction and lift the Conditions. On March 12, 2007, this Court found that LADWP was not in compliance with all of the Conditions and denied LADWP's motion. In its March 12, 2007 Ruling, this Court strongly urged the Parties to meet and confer concerning a resolution of the issues identified in the March 12, 2007 Ruling.

D. VACATION OF THE INJUNCTION AND THE LIFTING OF CONDITIONS:

The Parties agree that the changes in the flow measuring stations addressed in the LORP EIR Addendum described below, together with the provisions of this Stipulation and Order, constitute an adequate substitute for compliance with the requirements of Section 2.E and Section 4 of the Court Order. This Stipulation and Order resolves all issues pertaining to LADWP's compliance with the Court Order. The Parties hereby agree that, upon entry of this Stipulation and Order as an order of the Court, the Injunction shall be vacated, and the Conditions shall be terminated and lifted.

E. THE 40 CFS BASEFLOW CRITERIA:

Upon the entry of this Stipulation and Order as an order of the Court, baseflows shall be deemed in compliance with this Stipulation and Order as long as each of the following conditions in the Lower Owens River exists:

1. A minimum flow of 40 cfs is released from the Intake at all times;

2. None of the 10 in-river flow measuring stations described in Section F below has a 15 day running average of less than 35 cfs;

3. The mean daily flow at each of the 10 in-river flow measuring stations must equal or exceed 40 cfs on at least 3 individual days per any continuous 15 day period, except that this

requirement shall not apply to the flow measuring stations at Reinhackle Springs and Lone Pine Narrow Gage Road between November 1 and April 30 of each runoff year;

4. The 15-day running average of the 10 in-river flow measuring stations is no less than 40 cfs.

In order to comply with the foregoing conditions, LADWP has the discretion and responsibility to augment flows as needed. Except as provided in Section I.4 ("Planned Events Resulting in an Inability to Comply"), at all times, LADWP will release a sufficient amount of water to the Lower Owens River to maintain the required baseflows.

The mean daily flow shall be the 24-hour mean of the flow data from midnight to midnight at each measuring station, or a current meter measurement if the automated gauge is not functioning. For the purpose of this Stipulation and Order, the 15-day running average is the mean of the mean daily flow for 15 consecutive days up to the date of calculation. Running averages shall be calculated daily, beginning on the 15th day after the entry of this Stipulation and Order as an order of the Court. Further, the Parties acknowledge that as temporary flow monitoring stations are taken out of service, the identified number of stations in the baseflow and monitoring/reporting criteria will be reduced accordingly. Commencing on the date that the Inyo County/Los Angeles Standing Committee ("Standing Committee") has designated 4 or more permanent flow measuring stations pursuant to Section F.2, compliance with the baseflow criteria will be based only on the designated permanent flow measuring stations.

F. FLOW MEASURING STATIONS:

1. Modifications to the Configuration of the Flow Measuring Stations:

The LORP EIR identified seventeen flow measuring stations. As constructed, there are sixteen flow measuring stations. For the reasons set forth in the "Flow Station Modification for the Lower Owens River Project, Addendum to the LORP Environmental Impact Report," ("LORP EIR Addendum") attached hereto as Exhibit "D" and incorporated by reference, six flow measuring stations that the LORP EIR identified as to be constructed in the river channel were not constructed. Instead, five of these stations were placed in ditches that convey water to augment flow in the river channel and one was eliminated. The ten in-river flow measuring stations that have been constructed are: Intake (a permanent station), Owens River above Blackrock Ditch Return, Owens River East of Goose Lake, Owens River at 2 Culverts (formerly 5 Culverts), Owens River at Mazourka Canyon Road, Owens River at Manzanar Reward Road, Owens River at Reinhackle Springs, Owens River at Lone Pine Narrow Gage Road, Owens River at Keeler Bridge and the Pumpback Station. (For the purposes of flow criteria compliance, flow measurement at the Pumpback Station shall be considered an in-river station and shall be the sum of the outflow from the pumps' outlet pipe and releases to the Delta Habitat Area from the Langemann Gate and the overflow weir as described in the LORP EIR Addendum. Reporting of flows from the Pumpback Station shall include the three separate measurements from the outlet pipe, Langemann Gate and overflow weir along with the sum of those three flow measurements.) Six flow measuring stations for augmentation ditches are located at the Blackrock Ditch Return at Owens River, Goose Lake Return at Owens River, Billy Lake Return at Owens River, Locust Ditch Return at Owens River, George's Ditch Return at Owens River and the Alabama Gates Return.

2. Temporary and Permanent Flow Measuring Stations:

The MOU calls for at least 4 permanent flow monitoring stations; therefore, the Parties recognize that up to six of the 10 in-river flow measuring stations are temporary. Except as provided below, the temporary flow monitoring stations will be maintained and operated for at least 24 months after the entry of this Stipulation and Order as an order of the Court and after the 24 month period, until the Standing Committee designates the permanent flow measuring stations, as provided below.

As provided in Section II.C.1. of the MOU, the permanent flow measuring stations will be sited so that baseflows and seasonal habitat flows can be managed in each of the hydrologically varying sections of the river channel in order to meet the goals and objectives of the LORP. The Standing Committee shall notify all the Parties of the intended designations in advance of making final designations of the permanent flow measuring sites. In addition to designating the permanent sites, the Standing Committee may also designate 1 or more temporary flow measuring stations, which will continue to be monitored after the permanent stations have been designated. The Standing Committee shall not make a final decision on the permanent flow measuring stations or on the temporary flow measuring stations that will continue to be monitored until the Parties have had at least 15 workdays to submit comments to the Standing Committee on the selection of the permanent stations. (As used in this Stipulation and Order, a workday is a day that is not a Saturday, Sunday or a legal LADWP holiday.) While the Parties shall be offered the opportunity to comment, the determination, consistent with the requirements set forth in the MOU, on the designation of the permanent flow measuring stations, and on the determination of which, if any, temporary flow measuring stations will continue to be monitored, shall rest with the Standing Committee; however, this provision does not affect Section II.C.1.b.ii of the MOU which requires the Standing Committee to consult with DFG prior to setting the amount of the seasonal habitat flow.

It is currently anticipated by LADWP that all 10 in-river flow measuring stations will have the capability of accurately measuring the full amount of seasonal habitat flows required by the MOU and by applicable permits. However, if it is determined by LADWP, with input from the County, that a flow measuring station is not capable of accurately measuring the first full seasonal habitat flow, LADWP will, with the approval, cooperation and financial participation of the County, modify the station to accurately measure the full seasonal habitat flow prior to the first seasonal habitat flow. If, because of permitting requirements or other reasons, a flow measuring station cannot be modified before the first seasonal habitat flow, or if during the first seasonal habitat flow it is determined by LADWP, with input from the County, that a flow measuring station is not capable of accurately measuring the full seasonal habitat flow, LADWP will, with the approval, cooperation and financial participation of the County, modify the station to accurately measure the full seasonal habitat flow prior to the next seasonal habitat flow.

If prior to the time that the permanent flow measuring stations are designated by the Standing Committee, but after the first seasonal habitat flow, a temporary flow measuring station is destroyed, damaged, becomes inoperable, or is incapable of measuring the seasonal habitat flow, the Standing Committee will determine whether or not the station will be repaired, replaced, or modified. The Standing Committee shall notify all the Parties of an intended decision to not repair, replace or modify a temporary flow measuring station in advance of making final designations of the permanent flow measuring sites. The Standing Committee will not make a final decision on the matter until the Parties have had at least 15 workdays to submit comments on the proposed decision to not repair, replace, or modify a station.

Data from a temporary flow measuring station that the Standing Committee has determined will continue to be monitored after 4 or more permanent flow measuring stations have been designated, will be reported as provided in Sections G.2.a, b, and c; however, if the electronic measuring or radio equipment at such a temporary measuring station does not function properly for 24 hours or should the integrity of a flow measuring station be compromised, LADWP is not required to commence either current meter measurements or daily manual data collection at the affected station. Moreover, such temporary stations shall not be included in the calculation of a noncompliance payment pursuant to Sections H.2 and H.3. If such a temporary station is destroyed, damaged, becomes inoperable, is incapable of measuring the seasonal habitat flow, or if it appears that monitoring at the temporary station is no longer necessary, the Standing Committee will determine whether or not the station will be repaired, replaced, modified or discontinued.

G. MONITORING AND REPORTING:

1. Monitoring Requirements:

Electronic measuring devices shall be used at all temporary and permanent flow measuring stations. In the event that electronic measuring or radio equipment does not function properly for 24 hours or should the integrity of a flow measuring station be compromised, LADWP will commence either current meter measurements or daily manual data collection at the affected station(s) as soon as practical, but not later than the second workday after discovery. The site(s) will be current metered daily until the problem is resolved. The frequency of current metering can be reduced if the flows at the flow measuring stations above and below the affected measuring station are considered stable by LADWP. LADWP will provide the rationale for this consideration to the other MOU parties.

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LADWP will perform routine current metering at all the in-river flow measuring sites (except the pumpback station) on at least a monthly basis to insure that the measuring devices are properly calibrated.

2. Reporting Requirements:

a. Daily Data:

Daily LORP flow reports showing mean daily flows and summary statistics (in-river station average and running average at each station) at all in-river flow measuring stations and all augmentation stations will be posted on the LADWP website at: http://www.ladwp.com/ladwp/cms/ladwp009121.jsp. The daily LORP flow report will cover a midnight to midnight period and will be posted on the website before midnight of the following workday. If a problem with equipment or another reason prevents the mean daily flows for any day from being posted on time, then this data will be posted on the website the first subsequent workday. If there are technical problems that prevent the posting, the parties will be notified of this problem by email. LORP daily summary statistics for the previous 2 months will be displayed on the website. Data suspected to be in error will be reported as an estimated value and will be appended with an "E" with an explanation at the bottom of the page for the estimated value.

b. LORP Real Time Data:

Within 2 years of the entry of this Stipulation and Order as an order of the Court, real time flows will be added and posted to the current LADWP real-time website at: http://www.ladwp.com/ladwp/aqueduct/showAqueductMap.ladwp?contentId=LADWP_AQUERTD_SCID for the Intake, Owens River at 2 Culverts, Owens River at Reinhackle Springs, Keeler Bridge and Pumpback Station flow measuring stations. Currently real time data typically has a 3-hour transmission and reporting lag time. Real time data will be posted on workdays, weekends and holidays. LADWP will implement the posting of the real time data as soon as possible within the required 2-year period. While it is LADWP's intent to add the real time data to the LADWP real-time website within 1 year of the entry of this Stipulation and Order as an order of the Court, if this cannot be accomplished within the 1-year period, LADWP will report on the status of the posting. Once 4 or more permanent flow measuring stations have been designated by the Standing Committee, real time data will be posted only from the designated in-river permanent flow measuring stations and from any of the temporary flow measuring stations identified in this paragraph that the Standing Committee has designated for continued monitoring.

c. **Monthly Reports of Final Archived Data:**

Monthly data reports will be generated and provided to all the Parties by the last workday of each month unless all the Parties agree to another schedule. The monthly data reports will report data from the month ending approximately 60 days prior to the data report. The data will be provided to all the Parties on CD and posted to the website at: http://www.ladwp.com/ladwp/cms/ladwp009121.jsp. The website will retain data for the most recent 12 months. LADWP is planning to place the data, to be included in the monthly data reports, on a public http website where the Parties may download it. Once the data is placed on such a website, the data will no longer be provided to all the Parties on CD. The monthly report will be the official record for determining compliance with the flow criteria of this Stipulation and Order and the seasonal habitat flow requirements of the MOU.

The monthly reports will include final archived data for the flow measuring stations (both in-river and augmentation ditch stations), current meter measurements, stage data, mean daily flow values, and other routinely collected data, as well as a synopsis of events for the month. Monthly reports will identify data indicating possible noncompliance with the baseflow criteria set forth in Section E.

Final archived data is defined as the dataset that has been reviewed under quality assurance and calibration procedures ("QA procedures"). The final archived data will be provided at the sampling interval at which it was recorded. LADWP will provide a description of the QA procedures that it employs to review the data (and a description of any future changes to the procedures) to all the Parties.

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The synopsis of events will describe events that occurred during the month including current metering dates, adjustments to the flow meters, maintenance to flow measuring stations, any changes to the project that affect flows, and any other information that would be helpful to allow an accurate interpretation of the final archived data and other relevant data.

d. Measurement of Outflow from the Delta:

Section 2.10.2 of the Final LORP EIR provides that during the first year, outflow from the Delta will be recorded hourly and collected biweekly from continuous recorders at temporary gauging stations established where the vegetation ends in the channel of the lower west branch and lower east branch.

During the first year following the completion of the pump station, LADWP will post the outflow data from the two temporary gauging stations on the LADWP website at: http://www.ladwp.com/ladwp/cms/ladwp009121.jsp within 5 workdays following the biweekly collection of the data. If outflow data is collected after the first year, the data will be posted on the LADWP website within 5 workdays following the collection of the data.

e. Changes in Web Sites:

Should the address of any websites described in this Stipulation and Order be changed, LADWP will notify all the Parties of the new address within three workdays.

f. Hydrologic Data for Other LORP Components:

Within 210 days of the entry of this Stipulation and Order as an order of the Court, the Standing Committee will adopt a reporting program for hydrologic data for the Blackrock Waterfowl Area and Off-River Lakes and Ponds. The proposed reporting program will be provided to the parties for their comments at least 15 days before the Standing Committee considers adoption of the reporting program. Provision shall be made in the reporting programs for providing the data to the MOU parties.

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H. NONCOMPLIANCE PAYMENTS:

1. Noncompliance Payments are Not In Lieu of Maintaining Baseflows or In Lieu of Other Remedies:

The payments for noncompliance described below are not intended to allow payment in lieu of meeting the baseflow requirements described in Section E or meeting the monitoring and reporting requirements described in Section G, nor are such payments intended to supersede or waive any of the other remedies which may be available to the Parties, including a motion to enforce the requirements of this Stipulation and Order.

2. Interim Noncompliance Payments Until the Time that the Decision on Permanent Stations Is Made:

a. Flow Requirements at Individual Measuring Stations and Monitoring Requirements (Sections E.1, E.2, E.3, and G.1):

Until such time as the Standing Committee has designated 4 or more permanent stations pursuant to Section F.2, for each station that is out of compliance with the flow requirements set forth in Sections E.1, E.2, E.3, or the monitoring requirements set forth in Section G.1, LADWP shall pay into the Trust Account described in Section H.4 the following amounts:

1) $500 per day for the first 3 days for each station that is out of compliance;
2) $1,000 per day for days 4 through 6 for each station that is out of compliance;
3) $1,250 per day for days 7 through 9 for each station that is out of compliance;
4) $1,500 per day for day 10 and onward for each station that is out of compliance.

Any payments made pursuant to Sections H.2.b (for noncompliance with the average river flow requirement of Section E.4 and the reporting requirements of Sections G.2.a through G.2.d) are in addition to any payments made pursuant to this section. Provided, however, that the cumulative total payments pursuant to this section (H.2.a) and Section H.2.b for all instances of noncompliance shall not exceed $5,000 per day.

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b. Average River Flow Requirements and Reporting Requirements (Sections E.4 and G.2.a through G.2.d):

Until such time that the Standing Committee has designated 4 or more permanent stations pursuant to Section F.2, in the event that LADWP is out of compliance with the average flow requirements set forth in Section E.4, or any reporting requirement set forth in sections G.2.a through G.2.d, it shall pay into the Trust Account described in Section H.4 the following amounts:

1) $500 per day for the first 3 days;
2) $1,000 per day for days 4 through 6;
3) $1,250 per day for days 7 through 9;
4) $1,500 per day for day 10 and onward.

Any payments made pursuant to Sections H.2.a (for noncompliance with the flow requirements of Sections E.1, E.2, E.3, or with the monitoring requirements of Section G.1) are in addition to any payments made pursuant to this section. Provided, however, that the cumulative total payments pursuant to this section (H.2.b) and Section H.2.a for all instances of noncompliance shall not exceed $5,000 per day. Additionally, any violation or simultaneous violations of Section E.4 and the reporting requirements set forth in section G.2.a through G.2.d shall only be considered as one violation for purposes of noncompliance payments under this section (H.2.b).

3. Noncompliance Payments Commencing on the Date that the Standing Committee has Designated 4 or More Permanent Stations:

a. Flow Requirements at Individual Measuring Stations and Monitoring Requirements (Sections E.1, E.2, E.3, and G.1):

Commencing on the date that the Standing Committee has designated 4 or more permanent stations pursuant to Section F.2, for each permanent station that is out of compliance with the flow requirements set forth in Sections E.1, E.2, E.3, or with the monitoring requirements set forth in Section G.1, LADWP shall pay into the Trust Account described in Section H.4 the following amounts:

1) $1,000 per day for the first 3 days for each station that is out of compliance;
2) $2,000 per day for days 4 through 6 for each station that is out of compliance;
3) $2,500 per day for days 7 through 9 for each station that is out of compliance;
4) $3,000 per day for day 10 and onward for each station that is out of compliance.

Any payments made pursuant to Sections H.3.b (for noncompliance with Sections E.4 and G.2.a through G.2.d) are in addition to any payments made pursuant to this section. Provided, however, that the cumulative total payments pursuant to this section (H.3.a) for noncompliance shall not exceed $5,000 per day.

b. Average River Flow Requirements and Reporting Requirements (Sections E.4 and G.2.a through G.2.d)

Commencing on the date that the Standing Committee has designated 4 or more permanent stations pursuant to Section F.2, in the event that LADWP is out of compliance with the average flow requirements set forth in Section E.4, as applicable to the permanent stations, or any reporting requirement set forth in sections G.2.a through G.2.d, as applicable to the permanent stations, it shall pay into the Trust Account described in Section H.4 the following amounts:

1) $1,000 per day for the first 3 days;
2) $2,000 per day for days 4 through 6;
3) $2,500 per day for days 7 through 9;
4) $3,000 per day for day 10 and onward.

Any payments made pursuant to Section H.3.a (for noncompliance with Sections E.1, E.2, E.3, or G.1) are in addition to any payments made pursuant to this section. Additionally, any violation or simultaneous violations of Section E.4 and the reporting requirements set forth in Sections G.2.a through G.2.d shall only be considered as one violation for purposes of noncompliance payments under this section (H.3.b). Provided, however, that the cumulative total payments pursuant to this section (H.3.b) and Section H.3.a for all instances of noncompliance shall not exceed $8,000 per day.

4. Noncompliance Payments Payee:

Section 2.D of the Court Order provides that LADWP will pay $5,000 per day into an escrow account to be established by LADWP and the County. Pursuant to an agreement dated September 16, 2005, LADWP and County agreed that the escrow account required by the Court Order would be established in the Inyo County Treasury as a trust account ("Trust Account"). Any noncompliance payments made pursuant to this Stipulation and Order shall be made into the Trust Account. The principal and interest in the Trust Account shall be used only for the purposes described in Section 2.D of the Court Order. With regard to the Trust Account, the County shall provide the Parties with a monthly accounting of funds received, an itemization of debits and a statement of the remaining balance.

5. Inflation Adjustments:

Beginning January 1, 2008, and continuing each year thereafter, the amount of each of the payment amounts described for non-compliance shall be adjusted upward or downward in accordance with the U.S. Department of Labor Los Angeles-Anaheim-Riverside All Urban Consumer Price Index or its successor. The County shall calculate the adjustment and notify the parties of the adjusted amount on an annual basis starting January 1, 2008.

6. Waiver of Noncompliance Payment

Within 30 calendar days after the release of Final Archived Data pursuant to Section G.2.c above that shows that the flows are not in compliance with the requirements of this Stipulation and Order, or within 30 calendar days of a failure to report monitoring data as required by Sections G.2.a, G.2.b, G.2.c, and G.2.d, LADWP may request a waiver of a noncompliance payment described in this Stipulation and Order. A waiver request shall be submitted in writing to the Parties. A failure by LADWP to request a waiver within the 30 calendar day period shall constitute a waiver of the right to seek a waiver. Each Party shall respond to LADWP's request in writing or via email within 30 calendar days. So long as LADWP's waiver request is in good faith and LADWP, using reasonable diligence and reasonable efforts, has repaired the damage, remedied the operational problem or provided the monitoring data in a reasonable and timely manner under the circumstances or has shown that LADWP will remedy the operational problem using reasonable diligence and reasonable efforts in a reasonable and timely manner under the circumstances, the waiver request shall not be unreasonably denied. If a Party determines that it will not grant the waiver requested, that party shall specifically set forth the reasons in writing via email for its denial of the requested waiver. A failure by a Party to respond to a waiver request within the 30 calendar day period shall be deemed an approval of the requested waiver. In the event that one or more of the Parties has denied the waiver request, within 60 calendar days of submitting the written waiver request to the Parties, LADWP may apply to the Court for a waiver by way of a noticed motion. A failure by LADWP to request a waiver within the 60 calendar day period shall constitute a waiver of the right to seek a waiver from the Court.

7. Timing of Noncompliance Payments:

Any noncompliance payment required by this Stipulation and Order shall be made on whichever of the following dates occurs later in time: (a) not later than the 60th calendar day after the release of Final Archived Data pursuant to Section G.2.c. above that shows that the flows are not in compliance with the requirements of this Stipulation and Order; (b) not later than the 60th calendar day after LADWP waives its right to seek a waiver from the Court; or (c) not later than the 60th calendar day after a ruling by the Court that a waiver of a noncompliance payment should not be granted.

8. Refund of Noncompliance Payments

If, after the payment of a noncompliance payment, subsequent review by LADWP, utilizing quality assurance and calibration procedures, shows that the data upon which a noncompliance payment was based is incorrect, LADWP shall provide all Parties with the corrected data and an explanation of the quality assurance and calibration procedures that were utilized to correct the data. Under such circumstances, LADWP may request a refund of all or part of a noncompliance payment. A refund request shall be submitted in writing to the Parties. Each Party shall respond to LADWP's request in writing or via email within 30 calendar days. So long as LADWP's refund request is in good faith, the refund request shall not be unreasonably denied. If a Party determines that it will not grant the refund requested, that party shall specifically set forth the reasons in writing via email for its denial of the requested refund. A failure by a Party to respond to a refund request within the 30 calendar day period shall be deemed an approval of the requested refund. In the event that one or more of the Parties has denied the refund request, within 60 calendar days of submitting the written refund request to the Parties, LADWP may apply to the Court for an order for a refund by way of a noticed motion. A failure by LADWP to request a refund from the Court within the 60 calendar day period shall constitute a waiver of the right to seek an order for a refund from the Court.

I. EVENTS IMPACTING LADWP'S ABILITY TO COMPLY WITH THE 40 CFS BASEFLOW CRITERIA:

As recognized by the MOU, the goal of the LORP is in part, "the establishment of a healthy, functioning Lower Owens River riverine-riparian ecosystem, and the establishment of healthy, functioning ecosystems in the other physical features of the LORP, for the benefit of biodiversity and Threatened and Endangered Species, while providing for the continuation of sustainable uses including recreation, livestock grazing, agriculture and other activities." The Parties recognize that implementation of flows to the Lower Owens River Project only commenced in late 2006. In all likelihood, events and conditions will be encountered in the management of LORP flows that cannot be predicted or accounted for in this Stipulation and Order. The Parties agree to cooperatively work in good faith towards addressing any such events or conditions which may impact LADWP'S ability to meet the baseflow criteria and monitoring and reporting requirements set forth in this Stipulation and Order.

1. Emergency Events Resulting in an Inability to Comply:

The Parties recognize emergency events may impact LADWP's ability to comply with the baseflow criteria established by this Stipulation and Order. In the event of the need for immediate emergency work necessary to protect life or property; or damage to the system due to a catastrophic emergency such as, without limitation, fire, flood, storm, earthquake, land subsidence, gradual earth movement or landslide; either of which interferes with LADWP being able to carry out the required monitoring or to maintain the baseflow criteria, LADWP shall notify via e-mail the Parties of such emergency event as soon as possible, but in no event more than 5 workdays after the emergency event, that one or more of the requirements cannot be met due to the emergency work or damage. The notification shall set forth the nature of the emergency, the actions that LADWP is taking to remedy the situation, and how long it will take to remedy the situation. A failure of the electronic monitoring system for a gauging station shall not be considered an emergency unless daily current meter measurements are also precluded by the emergency. In the absence of a showing of good cause, a failure by LADWP to provide a notification within the required 5-workday period shall constitute a waiver of the right to seek a waiver of the obligation to make noncompliance payments that accrue as a result of the emergency.

2. Non-Emergency Events Resulting in an Inability to Comply:

The Parties recognize that operational or other reasons, such as, without limitation, beaver dams and freezing, may impact LADWP's ability to comply with the flow criteria and/or monitoring criteria. In the event that LADWP is unable to comply with the baseflow or reporting criteria, LADWP shall notify the Parties within 5 workdays of its discovery of the situation or event, describe the actions that LADWP is taking to remedy the situation, and how long it will take to remedy the situation. In the absence of a showing of good cause, a failure by LADWP to provide a notification within the required 5-workday period shall constitute a waiver of the right to seek a waiver of the obligation to make noncompliance payments that accrue as a result of the non-emergency event.

3. Operational Problems of Monitoring/Reporting Equipment:

The Parties acknowledge that monitoring and reporting criteria described in this Stipulation and Order rely heavily on computers and technology. The Parties recognize that issues may arise with hardware, software, servers, other technologies or equipment, which will impact LADWP's ability to comply with the monitoring and reporting requirements. In the event LADWP encounters events that will result in an inability to comply with the monitoring or reporting criteria, LADWP shall notify the Parties within 5 workdays of its discovery of the situation or the event, the actions that LADWP is taking to remedy the situation, and how long it will take to remedy the situation. In the absence of a showing of good cause, a failure by LADWP to provide a notification within the required 5-workday period shall constitute a waiver of the right to seek a waiver of the obligation to make noncompliance payments that accrue as a result of the non-emergency event.

4. Planned Events Resulting in an Inability to Comply:

Should LADWP plan an operational or maintenance activity, or should LADWP and the County plan to implement an adaptive management measure that would result in temporary noncompliance with the baseflow criteria in this Stipulation and Order, LADWP may seek an advance waiver of noncompliance payments from the other Parties. A waiver request shall be submitted in writing to the Parties. A failure to seek an advance waiver request shall not prevent the implementation of the planned activity or adaptive management measure or prevent LADWP from seeking a waiver pursuant to Section H.6. If an activity or adaptive management measure is implemented without first obtaining an advance waiver, LADWP shall notify the Parties within 5 workdays after commencement of the temporary noncompliance with the baseflow criteria in this Stipulation and Order. In the absence of a showing of good cause, a failure by LADWP to provide a notification within the required 5-workday period shall constitute a waiver of the right to seek a waiver of the obligation to make noncompliance payments that accrue as a result of the non-emergency event.

J. FREEZE PROTECTION GROUNDWATER PUMPING DURING THE 2006-2007 RUNOFF YEAR:

Section 4 of the Court Order recognizes the need for emergency groundwater pumping to prevent the freezing of the Los Angeles Aqueduct. The Court Order requires that the amount of any such emergency groundwater pumping shall be deducted from LADWP's groundwater pumping during the following year. During the 2006-2007 runoff year, LADWP pumped 2,116 acre-feet of groundwater for freeze protection. The pumping of this amount of groundwater for freeze protection caused LADWP's groundwater pumping for the year to exceed the annual groundwater pumping limit of 57,412 acre-feet imposed by the Court Order by 1,218 acre-feet. LADWP will deduct 1,218 acre-feet from its groundwater pumping from the Owens Valley during the 2007-2008 runoff year.

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K. MODIFICATION OF 2007-2008 PUMPING PLAN:

As required by Section 2.H of the Court Order, within 45 days of the entry of this Stipulation and Order as an order of this Court, LADWP shall submit to the Parties an updated version of all applicable sections of its 2007-2008 Operations Plan that covers the portion of the runoff year that remains after the entry of the order.

L. ANNUAL LORP MEETING:

Section 2.10.4 of the Final LORP EIR provides that:

> *The County and LADWP will prepare an annual report that includes data collected during the habitat and flow compliance monitoring, results of analysis and recommendations on the need for adaptive management actions. The annual report will be reviewed by the Inyo/Los Angeles Technical Group and will also be made available to the public. The Technical Group meetings are open to the public, and meeting agendas are provided to the public in advance of each meeting.*

Section 2.10.5 of the Final LORP EIR provides in pertinent part:

> *The Technical Group, Standing Committee and the governing boards of LADWP and the County will make the ultimate decision on implementing adaptive management actions after reviewing the annual report and any other relevant monitoring data.*

LADWP and the County will release to the public and to the representatives of the Parties identified in the MOU a draft of the annual report described in section 2.10.4 of the Final LORP EIR. The County and LADWP shall conduct a public meeting on the information contained in the draft report. The draft report will be released at least 15 calendar days in advance of the meeting. The public and the Parties will have the opportunity to offer comments on the draft report at the meeting and to submit written comments within a 15 calendar day period following the meeting. Following consideration of the comments submitted, the Technical Group will conduct the meeting described in Section 2.10.4 of the Final LORP EIR.

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For the first 7 years following the entry of this Stipulation and Order as an order of the Court, LADWP shall reimburse the Sierra Club and the OVC for the reasonable fees and expenses, up to a collective maximum of $4,000 for scientific/technical consultants to assist Sierra Club and OVC in connection with their participation in the annual meeting. After this initial period, during 4 of the next 8 years (years 8 through 15), LADWP shall reimburse the Sierra Club and the OVC for the reasonable fees and expenses, up to a collective maximum of $4,000 for scientific/technical consultants to assist Sierra Club and OVC in connection with their participation in the annual meeting. The Sierra Club and the OVC shall decide in which years such reimbursement is to be made by LADWP. Beginning January 1, 2008, and continuing each year thereafter, the amount of each of the reimbursements shall be adjusted upward or downward in accordance with the U.S. Department of Labor Los Angeles-Anaheim-Riverside All Urban Consumer Price Index or its successor.

M. DOCUMENTATION OF TECHNICAL GROUP ACTIONS AND PROVISION OF STANDING COMMITTEE AGENDA MATERIALS:

In addition to the requirement of Section III.G of the MOU that all Technical Group meetings shall be open to the public, as soon as a Technical Group meeting is scheduled, LADWP shall provide the representatives of the Parties identified in the MOU with notice of the meeting. If the meeting is subsequently cancelled or rescheduled, LADWP shall provide notice of the cancellation or rescheduling to the representatives of the Parties identified in the MOU. LADWP shall provide to the representatives of the Parties identified in the MOU proposed meeting agendas of upcoming Technical Group meetings at least 48 hours prior to a Technical Group meeting.

Within 5 workdays after a Technical Group meeting, LADWP shall provide to the representatives of the Parties identified in the MOU an audio recording of the Technical Group meeting. Additionally, within 5 workdays after the scheduled Technical Group meeting, LADWP shall post on its website its understanding of any final action taken by the Technical Group at the meeting with respect to any item on the meeting agenda that pertained to implementation of the LORP. The posting shall represent LADWP's understanding of the final action taken, and shall not be binding on the County. The County does not have an obligation to respond to the posting and a non-response by the County to the posting shall not be considered to be an agreement with its content or waiver of any objections to the content of the posting.

The Parties have made a standing request under the California Public Records Act to be provided with copies of all agenda materials that are provided to the Standing Committee in advance of a Standing Committee meeting. Up to the close of business on the last workday prior to a Standing Committee meeting, LADWP will provide such materials via email to the representatives of the Parties identified in the MOU at the same time as such materials are provided to the Standing Committee. Any agenda materials provided to the Standing Committee after the close of business on the last workday prior to a Standing Committee meeting will be distributed to the public at the Standing Committee meeting and will be provided to the representatives of the Parties identified in the MOU via email within 10 workdays after the Standing Committee meeting.

N. NOTICES:

Except for any motions or proceedings filed with the Court, any notice required to be given by this Stipulation and Order including requests for waivers to the Parties and responses thereto shall be given by e-mail. It shall be the responsibility of each party to notify the other Parties if there is change of individuals to receive notice, or if there is a change in the e-mail address of the designated individuals. Except for recipients of notices identified in Sections L and M, the Parties hereby designate the following individuals as those to whom notice shall be given in accordance with this Stipulation and Order.

LADWP:

Thomas Erb: Thomas.Erb@ladwp.com
Gene Coufal: Gene.Coufal@ladwp.com
Joseph Brajevich: Joseph.Brajevich@ladwp.com

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County:	
Inyo County Administrator, Ron Juliff:	rjuliff@qnet.com
Director, Inyo County Water Department Tom Brooks:	tbrooks@inyowater.org
Inyo County Counsel, Paul Bruce:	pbruce@inyocounty.us
Sierra Club:	
MOU Representative, Mark Bagley:	markbagley@qnet.com
Coordinating Attorney for Sierra Club:	aaronisherwood@sierraclub.org
Attorney for Sierra Club, Larry Silver	larrysilver@celproject.net
OVC:	
President, Carla Scheidlinger:	carla@agarian.org
Derrick Vocelka	dvocelka@cebridge.net
Attorney for OVC, Don Mooney:	dbmooney@dcn.org
DFG:	
Bruce Kinney, Deputy Regional Manager, Region 6:	bkinney@dfg.ca.gov
Steve Parmenter, Senior Biologist:	spar@dfg.ca.gov
Nancee Murray, Senior Legal Counsel:	nmurray@dfg.ca.gov
Marian Moe, Deputy Attorney General:	marian.moe@doj.ca.gov
SLC:	
Barbara Dugal, Chief Land Management Division:	dugalb@slc.ca.gov
Jack Rump, Chief Counsel:	rumpj@slc.ca.gov
Marian E. Moe, Deputy Attorney General:	marian.moe@doj.ca.gov

O. SPECIAL MASTER:

As provided in the Order Re: Appointment of Special Master filed October 3, 2005, upon the entry of an order as provided in this Stipulation and Order, the service of the Special Master shall be terminated.

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P. MODIFICATIONS:

This Stipulation and Order may be modified or amended by written stipulation of the Parties and approval of the stipulation by the Court. The Parties recognize that as this project evolves modifications will likely become necessary. The Parties shall meet 24 months after the entering of this Stipulation and Order to evaluate the criteria set forth herein and to discuss any changes and modifications, including, but not limited to, the need for this Stipulation and Order to continue to require noncompliance payments. Nothing herein shall prevent a party from requesting a modification to the Stipulation and Order before the end of the 24-month period.

Q. DURATION:

This Stipulation and Order shall remain in effect until it is terminated by order of the Court.

R. JURISDICTION AND ENFORCEMENT:

The Court shall retain jurisdiction to enforce any of the terms of this Stipulation and Order and to grant or deny requests for waivers. A party to this Stipulation and Order may seek enforcement of this Stipulation and Order by filing and serving a noticed motion to set a hearing for an order to show cause why a remedy, sanctions, or other order proposed in the motion, or otherwise determined to be appropriate by the Court, should not be imposed. A party making a motion seeking to enforce this Stipulation and Order need not comply with the dispute resolution provisions set forth in Section VI of the MOU before making such a motion. This Court shall retain jurisdiction for the purpose of hearing and ruling on such motions and making and enforcing such further orders as justice may require.

S. COUNTERPARTS

This Stipulation and Order may be executed in counterparts by the Parties. Signature pages that have been executed by the Parties and submitted via facsimile may be attached to the Stipulation and Order that is submitted to the Court.

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Dated: July 7, 2007

LAW OFFICE OF DONALD B. MOONEY

By: Donald B. Mooney
Attorney for Plaintiff
Owens Valley Committee

Dated: July , 2007

CALIFORNIA ENVIRONMENTAL
LAW PROJECT

By: Laurens H. Silver
Attorney for Plaintiff
Sierra Club

Dated: July , 2007

EDMUND G. BROWN JR.
Attorney General of the State of California

By: Marian E. Moe
Deputy Attorney General
Attorney for Real Parties in Interest
And Cross-Complaints California Department of Fish and Game and California State Lands Commission

Dated: July , 2007

ROCKARD J. DELGADILLO
City Attorney of the City of Los Angeles

By: Joseph A. Brajevich
Assistant General Counsel, Water and Power
Attorney for Defendants City of Los Angeles;
Los Angeles Department of Water and Power;
Board of Commissioners of the Department of Water and Power

Dated: July , 2007

LAW OFFICE OF DONALD B. MOONEY

By: Donald B. Mooney
Attorney for Plaintiff
Owens Valley Committee

Dated: July 6, 2007

CALIFORNIA ENVIRONMENTAL
LAW PROJECT

Laurens H Silver

By: Laurens H. Silver
Attorney for Plaintiff
Sierra Club

Dated: July , 2007

EDMUND G. BROWN JR.
Attorney General of the State of California

By: Marian E. Moe
Deputy Attorney General
Attorney for Real Parties in Interest
And Cross-Complaints California Department
of Fish and Game and California State Lands
Commission

Dated: July 1, 2007

ROCKARD J. DELGADILLO
City Attorney of the City of Los Angeles

By: Joseph A. Brajevich
Assistant General Counsel, Water and Power
Attorney for Defendants City of Los Angeles;
Los Angeles Department of Water and Power;
Board of Commissioners of the Department of
Water and Power

Dated: July , 2007

LAW OFFICE OF DONALD B. MOONEY

By: Donald B. Mooney
Attorney for Plaintiff
Owens Valley Committee

Dated: July , 2007

CALIFORNIA ENVIRONMENTAL
LAW PROJECT

By: Laurens H. Silver
Attorney for Plaintiff
Sierra Club

Dated: July 2 , 2007

EDMUND G. BROWN JR.
Attorney General of the State of California

Marian E. Moe

By: Marian E. Moe
Deputy Attorney General
Attorney for Real Parties in Interest
And Cross-Complaints California Department
of Fish and Game and California State Lands
Commission

Dated: July , 2007

ROCKARD J. DELGADILLO
City Attorney of the City of Los Angeles

By: Joseph A. Brajevich
Assistant General Counsel, Water and Power
Attorney for Defendants City of Los Angeles;
Los Angeles Department of Water and Power;
Board of Commissioners of the Department of
Water and Power

Dated: July , 2007

LAW OFFICE OF DONALD B. MOONEY

By: Donald B. Mooney
Attorney for Plaintiff
Owens Valley Committee

Dated: July , 2007

CALIFORNIA ENVIRONMENTAL
LAW PROJECT

By: Laurens H. Silver
Attorney for Plaintiff
Sierra Club

Dated: July , 2007

EDMUND G. BROWN JR.
Attorney General of the State of California

By: Marian E. Moe
Deputy Attorney General
Attorney for Real Parties in Interest
And Cross-Complaints California Department
of Fish and Game and California State Lands
Commission

Dated: July 1, 2007

ROCKARD J. DELGADILLO
City Attorney of the City of Los Angeles

By: Joseph A. Brajevich
Assistant General Counsel, Water and Power
Attorney for Defendants City of Los Angeles;
Los Angeles Department of Water and Power;
Board of Commissioners of the Department of
Water and Power

Dated: July 3 , 2007

County of Inyo County Counsel

Paul N. Bruce

By: Paul N. Bruce
Counsel for Real Party in Interest
County of Inyo

RECEIVED
JUL 17 2007
OFFICE OF COUNTY COUNSEL
INDEPENDENCE

FILED
JUL 11 2007
INYO CO. SUPERIOR COURT
NANCY A. MOXLEY, CLERK
BY DEPUTY

SUPERIOR COURT OF THE STATE OF CALIFORNIA
COUNTY OF INYO

SIERRA CLUB and OWENS VALLEY COMMITTEE,
Plaintiffs,
vs.
CITY OF LOS ANGELES, et al.,
Defendants.

CALIFORNIA DEPARTMENT OF FISH AND GAME and CALIFORNIA STATE LANDS COMMISSION,
Real Parties in Interest and Cross-Complainants.

COUNTY OF INYO and DOES 51-100
Real Party in Interest

Case No. S1CVCV01-29768

[The Honorable Lee Cooper, Assigned)

ORDER

Good cause appearing therefore, it is hereby ordered that the above Stipulation is approved and is hereby an order of this Court.

Dated: July 11, 2007

The Honorable Lee E. Cooper
Judge of the Superior Court