DRAFT

Lower Owens River Project

Annual Report

2014

December 2014

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EXECUTIVE SUMMARY

The 2014 Lower Owens River Project (LORP) Annual Report contains the results from the eighth year of monitoring for the LORP. Monitoring results contained in this report include hydrologic monitoring, land management (including range management, rare plant monitoring, and streamside monitoring for woody recruitment), rapid assessment and creel surveys. Also included in this report is a LORP water quality data review, description and results from a new study on tule eradication methods, and summaries on Saltcedar (*Tamarix ramosissima*) and other weed control efforts in the LORP area.

Hydrologic Monitoring

The hydrologic monitoring section describes flow conditions in the LORP regarding attainment with the 2007 Stipulation & Order flow and reporting requirements and *1991 Environmental Impact Report* (EIR) goals. For the 2013-14 water year, which covers October 2013 to September 2014, LADWP was fully compliant with all the 2007 Stipulation & Order flow and reporting requirements. The mean flow to the Delta Habitat Area (DHA) was 11.2 cfs, achieving the required 6-9 cfs annual flow. The agreement to manage wetted acreage in the Blackrock Waterfowl Management Area (BWMA) by setting constant flows by seasons, continued with generally good results. The section also describes flow measurement issues and finishes with a commentary on flow losses and gains through the different reaches of the Lower Owens River.

There was no seasonal habitat flow in 2014 based on hydrologic conditions; thus no seasonal habitat flow data to report.

Water Quality Data Review

A review of the LORP water quality data was requested by the Owens Valley Committee at the LORP Summit, held July 29-31, 2014. Section 3 of this report summarizes this data, which dates back over 25 years. The data are divided into two time classifications relative to LORP project implementation: 1) data collected starting before the LORP project was implemented, including the project EIR, and 2) data collected starting after the LORP project was implemented.

Land Management

2014 LORP land management monitoring efforts continued with monitoring utilization across all leases, range trend monitoring on two of the leases inside the LORP management area, irrigated pasture evaluations on pastures that scored lower than 80% the previous year, rare plant monitoring, and streamside monitoring for woody recruitment.

The LORP area is currently experiencing its third year of extreme drought. Effects from this are a decreased forage production in the uplands and decreased availability of irrigation water. Despite the drought, ranch lessees were able to keep their utilization levels within the allowable use levels in 2013-14. Pasture utilization for leases within the LORP was below the allowable levels of use established for both riparian (up to 40%) and upland (up to 65%) areas except the Islands and Lone Pine Leases. Use on the Blackrock Lease was lower than most other leases in the project area remaining well below all grazing standards. The Twin Lakes Lease had a prescribed burn on the riparian sections of the Lower Blackrock Riparian and Upper Blackrock fields in 2013 and the burned area recovered well and use was below allowable utilization. The Islands Lease has started to show signs of stressed meadow vegetation and aquatic vegetation spreading due to prolonged inundation from flow augmentations for the LORP project. Use on the Thibaut Lease in the Thibaut Field was below the allowable upland standard. The Lone Pine Lease has recovered well from the 2013 fire; the only major loss was to mature willow trees.

Range trend results in 2014 indicate that in most areas where plant communities are dependent on groundwater to some degree, trends have either remained static or only slightly decreased. All irrigated pastures were monitored in 2013; pastures that scored 80% or below were checked in 2014, including pastures in the Islands, Lone Pine, and Delta Leases. Many leases rated below the 80% minimum irrigated pasture score and reflect a below normal precipitation year.

2014 marks the sixth year of examining the effects of excluding rare plants from livestock grazing. Results over the course of the monitoring period show a statistically significant increase in numbers over time in grazed sites and a decrease in numbers over time in ungrazed sites. However, external factors during a given year may be confounding the results of the study and monitoring is recommended for one additional year.

Streamside monitoring results again showed light use by livestock and elk, high survivorship, and continued growth of young tree willows monitored since 2012. However, sustained high summer flows continue to negatively impact approximately one third of the juvenile trees monitored, as they were partially submerged for 2-3 months. These sustained high summer flows stressed trees and enabled the expansion of tule and cattails onto the gravel and sand bars and adjacent floodplains, placing the young willows in direct competition with emergent wetland plant species and decreasing future opportunities for tree willow germination events on those sites.

Rapid Assessment Survey

Annual LORP Rapid Assessment Surveys were conducted in August 2014. Inyo County staff surveyed the wetted edges of the river riparian area, the BWMA, Off-River Lakes and Ponds (OLP), and the DHA. Data recorded in the RAS are used as rough indicators of basic trends in the ecological development of the riparian and riverine environments, especially when RAS data is compiled with information gathered from other LORP studies. Observations recorded include documentation of woody recruitment sites, Saltcedar, Russian Olive (*Elaeagnus angustifolia*), and noxious weed infestations, recreation impacts (including new roads and trash), and elk and beaver activity.

In 2014, observers located 6 tree willow recruits and two cottonwood recruits. All of the willow recruitment was located in the river-riparian corridor or in the area of the off-river ponds. Woody recruitment in 2014 was down 80% from 2013, and less than all prior years.

Beaver activity was noted at six locations, and elk sightings and evidence were noted in 115 locations and browsing on woody vegetation was noted in 77 locations. Antler rubs were also noted.

Saltcedar continues to be found throughout the LORP, and is the most abundant noxious weed in the project area. In 2014, resprouts and seedlings were recorded at 219 locations. Other than Saltcedar, perennial pepperweed (*Lepidium latifolia*) was the only noxious species reported within the LORP this year. Six new significant pepperweed populations were discovered this year in Reach 3, and two populations were discovered in the Winterton Unit of the BWMA.

Seventy-five discrete impacts associated with recreation, as evidenced by litter, fire rings, etc., were recorded in the LORP in all river reaches. This is up from 25 observations in 2013. Recreation evidence was most abundant near roads, and in the Lone Pine area. Miscellaneous trash was observed at 26 locations, roughly twice as many locations as in 2013.

Tule Management and Control

Tule encroachment in the Lower Owens River is a marked issue, as it has greatly reduced open water, compromised water conveyance, limited recreational opportunities in the river, and is creating a monoculture of instream aquatic vegetation. In the event that more active management to control the tules is warranted, several experimental test plots were established along the Lower Owens River to evaluate the effectiveness of reducing and controlling tules using a variety of methods. These treatments included herbicide application, repeat cutting of stems, planting of competing vegetation, and a control in which no treatments were administered. Monitoring to evaluate the effectiveness of these treatments consisted of monthly repeat photo-points and density count of tule stems at the end of the growing season. Initial results indicate that when compared to the control, herbicide and repeat cutting are equally effective, while the planting of competing vegetation is less effective. Despite these initial results, the long-term effectiveness of these treatments is unknown and implementing a more natural hydrograph with select treatments may prove to be the most beneficial over time.

Creel Survey

Although not originally slated for 2014, the creel survey was conducted to determine if there were residual effects on the LORP's warmwater fishery from a fish kill that resulted from a July 2013 flood event. Methods developed during the 2003 creel survey were utilized in the May 2014 creel survey and will be used in future monitoring. Creel survey data will assist with the adaptive management decision making process for the LORP warmwater fishery, as it provides information about the health, abundance, and distribution of game fish throughout the LORP.

In 2014, volunteer anglers fished five separate fishing areas for a total of 150.5 hours and caught 415 fish, 94.7% of which were reported to be in good condition. Fish caught included bass, bluegill, brown bullhead, common carp, channel catfish, and brown trout. The 2014 creel survey results demonstrate that the 2013 LORP fish kill had little to no effect on the warmwater fisheries and that the LORP still contains a healthy, diverse warmwater fish community that is self-sustaining with multiple age classes.

Weed Management

LORP invasive plant management during 2014 included both treatment of known sites throughout the growing season, as well as ongoing survey activities to identify new infestations. Field staff numbers were the same as 2013, supported by both joint contributions from Inyo County and LADWP as well as grant funding through the Sierra Nevada Conservancy.

All known perennial pepperweed (*Lepidium latifolium*) sites within the LORP area were treated three times. Invasive plant populations totaled 1.36 net acres, up significantly over 2013. Increases occurred exclusively within two sites near Blackrock, and these areas will receive additional scrutiny in 2015. The Blackrock area also contributed 5 of the 7 newly discovered sites, all of which were found along roadways. Individual sites totaled 46 in 2014, up 7 sites discovered by field staff during surveys. Of the 46 known sites, 22 sites had no plants present in 2014. Of these 22 no growth sites, 11 had no growth for 4 years. After five continuous years of no growth, sites may be considered eradicated, so if current trends continue, these 11 sites will be dropped from the total in 2015.

Saltcedar

From October 2013-March 2014, Inyo County Water Department Saltcedar field crews cut and treated with herbicide 180 acres of Saltcedar within the boundaries described in the Wildlife Conservation Board (WCB) grant work site, including the water-spreading basins that lie just to the west of the Lower Owens River and river-riparian area. These spreading basins harbor mature Saltcedar thickets that serve as vast reservoirs of windborne seed. This past season, Saltcedar crews continued to treat resprouts, pull seedlings, and remove mature plants along the Lower Owens River, which were identified in the previous year's RAS data. This year, crews covered approximately 89 miles of riverbank and floodplain.

Approximately 120 piles of dry slash that had accumulated over several years were burned in the 2013-2014 field season. This effort was assisted by the California Department of Forestry and Fire Protection and LADWP.

1.0 LOWER OWENS RIVER PROJECT INTRODUCTION

The Lower Owens River Project (LORP) is a large-scale habitat restoration project in Inyo County, California being implemented through a joint effort by the Los Angeles Department of Water and Power (LADWP) and Inyo County (County). The LORP was identified in a *1991 Environmental Impact Report* (EIR) as mitigation for impacts related to groundwater pumping by LADWP from 1970 to 1990. The description of the project was augmented in a *1997 Memorandum of Understanding* (MOU), signed by LADWP, the County, California Department of Fish and Game (CDFG), California State Lands Commission (SLC), Sierra Club, and the Owens Valley Committee. The MOU specifies the goal of the LORP, timeframe for development and implementation, and specific actions. It also provides certain minimum requirements for the LORP related to flows, locations of facilities, and habitat and species to be addressed.

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 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.”

LORP implementation included release of water from the Los Angeles Aqueduct (LAA) to the Lower Owens River, flooding of up to approximately 500 acres depending on the water year forecast in the Blackrock Waterfowl Management Area (BWMA), maintenance of several Off-River Lakes and Ponds, modifications to land management practices, and construction of new facilities including a pumpback station to capture a portion of the water released to the river.

The LORP was evaluated under CEQA resulting in the completion of an EIR in 2004.

1.1 Monitoring and Reporting Responsibility

Section 2.10.4 of the Final LORP EIR states that the County and LADWP will prepare an annual report that includes data, analysis, and recommendations. Monitoring of the LORP will be conducted annually by the Inyo County Water Department (ICWD), LADWP and the MOU consultants, Mr. Mark Hill and Dr. William Platts of Ecosystem Sciences (ES) according to the methods and schedules described under each monitoring method as described in Section 4 of the *Lower Owens River Monitoring Adaptive Management and Reporting Plan* (Ecosystem Sciences, 2008).

Specific reporting procedures are also described under each monitoring method. The MOU requires that the County and LADWP provide annual reports describing the environmental conditions of the LORP. LADWP and the County are to prepare an annual report and include the summarized monitoring data collected, the results of analysis, and recommendations regarding the need to modify project actions as recommended by the MOU consultants, ES. This LORP Annual Report describes monitoring data, analysis, and recommendations for the LORP based on data collected during the 2014 field season (March-October). The development of the LORP Annual Report is a collaborative effort between the ICWD, LADWP,

and the MOU consultants. Personnel from these entities participated in different sections of the report writing, data collection, and analysis.
The 2007 Stipulation & Order also requires the release to the public and representatives of the Parties identified in the MOU a draft of the annual report. The 2007 Stipulation & Order states in Section L:

> "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."

Generally, LADWP is the lead author for a majority of the document and is responsible for overall layout, and content management. Specifically, LADWP wrote: The Executive Summary; Sections 1.0 Introduction; 2.0 Hydrologic Monitoring; 4.0 Land Management; 6.0 Tule Management and Control; 7.0 LORP Creel Survey; and Section 12.0 Public Comments.

ICWD completed Section 3.0 Lower Owens River Water Quality, Section 5.0 Rapid Assessment Survey, and Section 9.0 Saltcedar Report. Section 8.0 Weed Control was authored by the Inyo/Mono Counties Agricultural Commission.

The annual report will be available to download from the LADWP website link: http://www.ladwp.com/LORP.

This document represents the reporting requirements for the LORP Annual Report for 2014.

2.0 HYDROLOGIC MONITORING

2.1 River Flows

On July 12, 2007, a Court Stipulation & Order was issued requiring LADWP to meet specific flow requirements for the LORP. From the issue date through September 2014, LADWP has been in compliance with the flow requirements outlined in the Stipulation & Order. The flow requirements are listed below:

1. Minimum of 40 cubic feet per second (cfs) released from the Intake at all times.
2. None of the in-river measuring stations has a 15-day running average of less than 35 cfs.
3. The mean daily flow at each of the in-river measuring stations must equal or exceed 40 cfs on 3 individual days out of every 15 days.
4. The 15-day running average of the in-river flow measuring stations is no less than 40 cfs.

On July 14, 2009, 6 of the 10 original temporary in-river measuring stations were taken out of service, while the Below LORP Intake, Mazourka Canyon Road, Reinhackle Springs, and Pumpback Stations remained in service.

The flow data graphs show that LADWP was in compliance with the Stipulation & Order, from October 2013 through September 2014, for the 4 in-river stations (see Hydrological Appendix 2).

2.1.1 Web Posting Requirements

The Stipulation & Order also outlined web posting requirements for the LORP data. LADWP has met all the posting requirements for the daily reports, monthly reports, and real time data.

Daily reports listing the flows for the LORP, Blackrock Waterfowl Management Area (BWMA) wetted acreage, and Off-River Lakes and Ponds depths are posted each day on the Web at <http://www.ladwp.com> under About Us → Los Angeles Aqueduct → LA Aqueduct Conditions Reports → LORP Flow Reports and click on the 'List of LORP Flow Reports' link.

Monthly reports summarizing each month and listing all of the raw data for the month are posted to the Web at <http://www.ladwp.com> under About Us → Los Angeles Aqueduct → LA Aqueduct Conditions Reports → LORP Monthly Reports.

Real time data showing flows at Below LORP Intake, Owens River at Mazourka Canyon Road, Owens River at Reinhackle Springs, and Pumpback Station are posted to the Web at <http://www.ladwp.com> under About Us → Los Angeles Aqueduct → LA Aqueduct Conditions Reports → Real Time Data and click on the 'Lower Owens River Project' link.

2.1.2 Measurement Issues

LORP in-river flows are measured using Sontek SW acoustic flow meters. Both of the Sontek SW meters located in the main channel of the LORP are mounted on the bottom of concrete sections. These devices are highly accurate and final records for the LORP generally fall within normal water measurement standards of +/- 5%.

The accuracy of the Sontek meters are affected by factors which change the levels or velocities in the river. One of those factors is seasonal changes, such as spring/summer vegetation growth, which cause water levels to increase and velocities to decrease. Another factor is sediment build-up. As a band of sediment builds up on or near the measuring station section, the water levels of the section can increase or velocities can be shifted-both of which affect the accuracy of the Sontek meters. In order to account for these environmental changes, LADWP manually meters flows at all of the stations along the LORP to check the accuracy of the meters. Each time current metering is performed, a 'shift' is applied to the station to take into account the difference in flow determined by the current metering. If a fundamental change in the flow curve is observed then a new index is created from the current metering data and downloaded to the meter. All of the meters on the LORP are calibrated at a minimum of once per month, per the 2007 Stipulation & Order, to maintain the accuracy of the meters.

A commentary on each station along the LORP follows:

<u>Below LORP Intake</u>

Measurement Devices: Langemann Gate & WaterLOG H-350XL Bubbler System

The Langemann Gate regulates and records the flow values at the Intake. This has had very good accuracy and reliability as long as the gate does not become submerged (submergence may be possible at higher flows such as when the seasonal habitat flows are released). In case of submergence, the WaterLOG H-350XL was installed as a back up to the Langemann Gate measurement.

The WaterLOG H-350XL is a bubbler system that uses pressurized air to measure stage, which is applied to a rating curve. It was hoped the bubbler system would possibly allow for an accurate measurement of stage even in silt/sediment conditions. However, any system of water measurement using stage must be calibrated through the full range of flows and in similar seasonal conditions in order for measurements to be accurate. Also, due to the flat slope of the river channel in the LORP, velocities in the river are extremely low causing large fluctuations in stage as conditions in the river channel go through the normal seasonal cycles of vegetation activity and dormancy in the summer and winter, respectively. To date, calibrating the bubbler for seasonal habitat flows has proven difficult and will likely never give accurate results. LADWP plans to remove the bubbler and abandon this second measurement at the Intake.

<u>LORP at Mazourka Canyon Road</u>

Measurement Devices: Sontek SW Meter

The station utilizes a single Sontek SW flow meter in a concrete measuring section and flow measurement accuracy has been excellent.

LORP at Reinhackle Springs

Measurement Device: Sontek SW Meter

The station utilizes a single Sontek SW flow meter in a concrete measuring section and measurement accuracy has been excellent.

LORP at Pumpback Station

Measurement Devices: Pumpback Station Discharge Meter, Langemann Gate, Weir

At the Pumpback Station, the flow is a calculated by adding the Pumpback Station, Langemann Gate Release to Delta, and Weir to Delta. In most flow conditions these stations have proven to be very accurate. However, during the higher flows, the Weir and/or the Langemann Gate can become submerged, thus lowering the measuring accuracy of the submerged device.

2.2 Flows to the Delta

Based upon a review of the flow to Brine Pool and flow to Delta data, and after filtering out unintended spillage at the Pumpback Station to average a flow of 6 to 9 cfs, the flows to the Delta were set to the following approximate schedule (per the LORP *1991 Environmental Impact Report* (EIR), section 2.4):

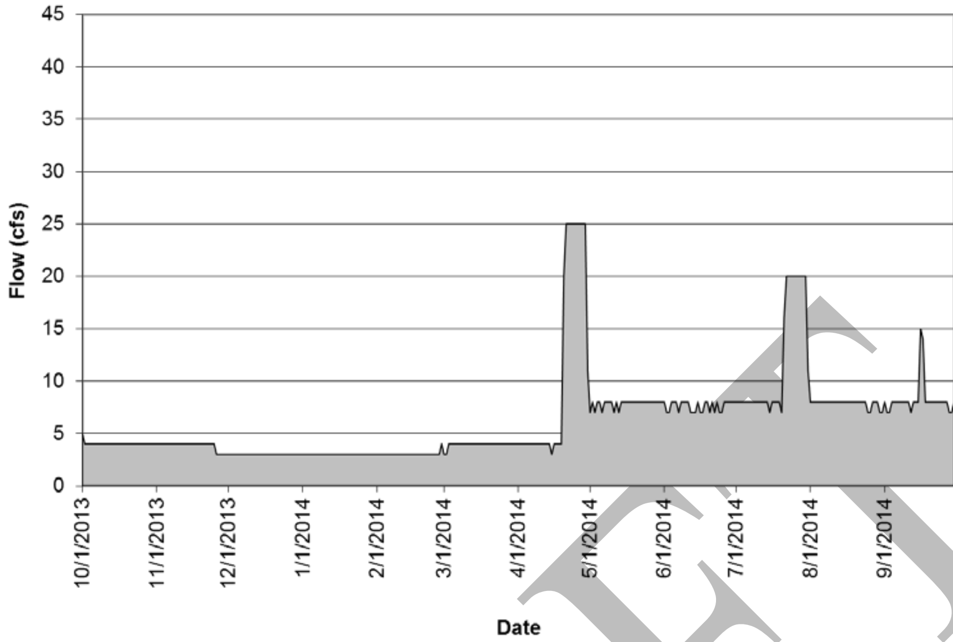
- October 1 to November 30   4 cfs
- December 1 to February 28   3 cfs
- March 1 to April 30   4 cfs
- May 1 to September 30   7.5 cfs

Additionally, pulse flows were scheduled to be released to the Delta (LORP EIR, section 2.4):

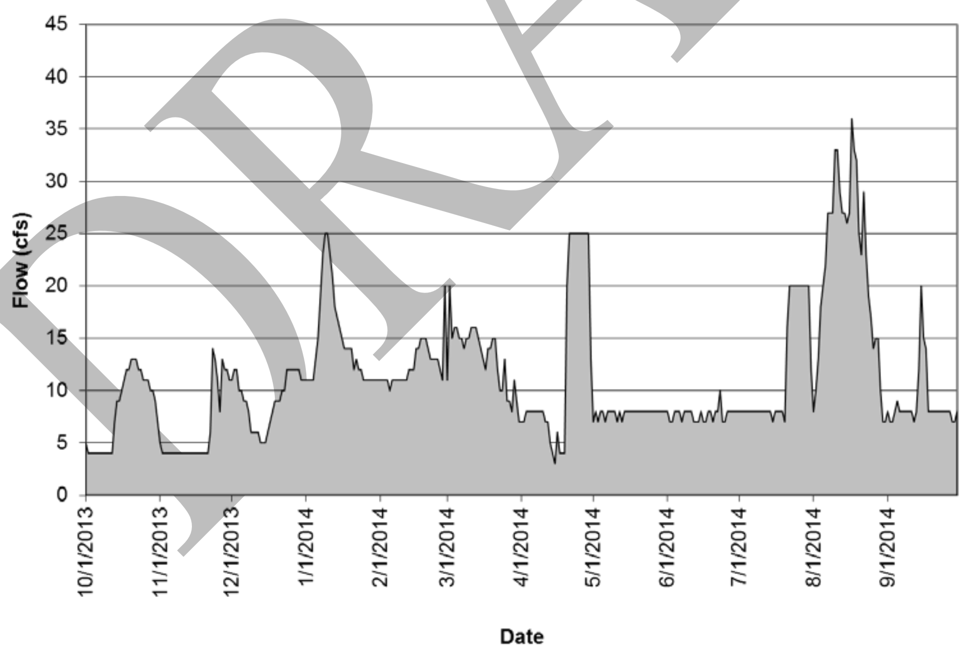
- Period 1: March-April   10 days at 25 cfs
- Period 2: June-July   10 days at 20 cfs
- Period 3: September   10 days at 25 cfs
- Period 4: November-December   5 days at 30 cfs

The scheduled base and pulse flows for the 2013-14 water year targeted an average of 7 cfs to the Delta. Due to unintended flows, the release to the Delta was much higher than the planned 7 cfs. Unintended flows are released to the Delta when intense rainstorms cause river flows to exceed the limited maximum capacity of the Pumpback Station or when pump outages occur at the Pumpback Station. Flows over the weir are generally unintended flows and flows over the Langemann Gate are scheduled flows (see figures below). The final October 2013 to September 2014 average flow to the Delta was 11.2 cfs.

All of the scheduled flows to the Delta were released as planned except for the Period 3, 2014 September pulse release. This pulse release was cancelled due to an adaptive management recommendation resulting from the large amount of water spilling into the Delta during August. Additionally, the Period 4, 2013 November-December Delta pulse flow was released from the LORP Intake in late December per an adaptive management recommendation.



Hydrologic Figure 1. Langemann Release to Delta



Hydrologic Figure 2. Langemann and Weir Release to Delta

2.2.1 Adaptive Management Results

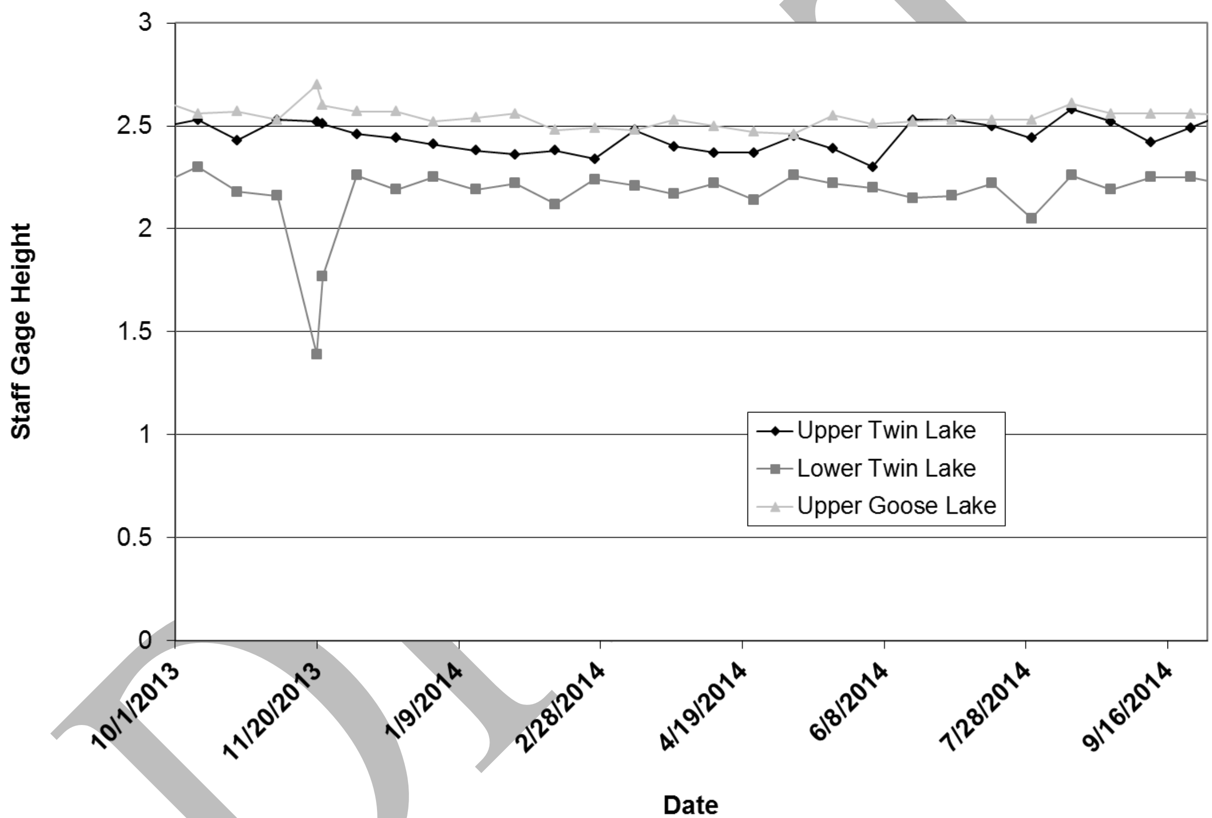
For Period 4, 2013 November-December pulse flow, operations followed an adaptive management recommendation and the pulse flow was released from the LORP Intake rather than the Pumpback Station Langemann Gate. On December 24, 2013, the LORP Intake was increased from 44 cfs to 71 cfs (a 27 cfs increase, which follows the normal 3 cfs to 30 cfs increase for the Period 4 pulse flow) where it remained for 5 days until being reduced back to normal operational flows. River flow at the Pumpback Station was 60 cfs at the time of the release and increased up to a high of 73 cfs as the increased flows reached the Pumpback Station. As a result, for Period 4, the release to the Delta was as follows:

Date	Flow (cfs)
1/6/2014	15
1/7/2014	19
1/8/2014	23
1/9/2014	25
1/10/2014	25
1/11/2014	23
1/12/2014	21
1/13/2014	18
1/14/2014	17
1/15/2014	16
1/16/2014	15

As can be seen from the data above, although the peak flow was reduced, the spillage continued for a longer period of time. The river was also already spilling into the Delta prior to the pulse flow due to river make during the winter period. Overall, this caused a much larger flow to reach the Delta than the amount increased at the Intake.

2.2.2 Off-River Lakes and Ponds

The BWMA and Off-River Lakes and Ponds Hydrologic Data Reporting Plan requires that Upper Twin Lake, Lower Twin Lake, and Goose Lake be maintained between 1.5 and 3.0 feet on their respective staff gauges, and that Billy Lake be maintained full (i.e., at an elevation that maintains outflow from the lake). For all but a very short time in November, the ponds were maintained at a level between 1.5 and 3.0 feet. However, on November 20, the staff gage read at Lower Twin Lake was read and found to be 1.39 ft. The reason why this occurred is unknown, but likely occurred due to a clot of vegetation breaking free from the exit of Lower Twin Lakes, which in turn caused the pond to drain down to the 1.39 ft level fairly rapidly. Immediately upon discovery of the low pond level, the inflow gate was adjusted and by November 22, 2013, the staff gage read at Lower Twin Lake was back up to 1.77 ft. See figure below.



Hydrologic Figure 3. Off-River Lakes and Ponds Staff Gages

<u>Billy Lake</u>

Due to the topography of Billy Lake in relation to the Billy Lake Return station, whenever the Billy Lake Return station is showing flow, Billy Lake is full. LADWP maintains Billy Lake by monitoring the Billy Lake Return station to always ensure some flow is registering there. The table in Hydrological Appendix 2 presents the annual summary of flows, and shows that at no time did the flow at Billy Lake Return Station fall to zero for a day. Billy Lake Return had a minimum daily average flow of 0.8 cfs for the year, so Billy Lake remained full for the entire year (see the following table).

Hydrologic Table 1. LORP Flows – Water Year 2013-14

Station Name	Average Flow (cfs)	Maximum Flow (cfs)	Minimum Flow (cfs)
Below River Intake	56.4	86.0	42.0
Blackrock Return Ditch	1.2	4.0	0.5
Goose Lake Return	1.3	2.2	0.7
Billy Lake Return	1.3	3.4	0.8
Mazourka Canyon Road	51.3	72.0	38.0
Locust Ditch Return	0.0	0.3	0.0
Georges Ditch Return	0.2	11.7	0.0
Reinhackle Springs	51.1	80.0	41.0
Alabama Gates Return	0.0	0.0	0.0
At Pumpback Station	53.8	82.0	37.0
Pump Station	42.6	48.0	22.0
Langemann Gate to Delta	6.3	25.0	3.0
Weir to Delta	4.9	28.0	0.0

Thibaut Pond

Thibaut Pond is contained completely within the Thibaut Unit of the BWMA. Each day the Thibaut Pond acreage is posted to the web in the LORP daily reports.

An adaptive management recommendation was implemented on April 1, 2011, and flow to Thibaut Pond was turned off to dry out the pond. No further water was released through the middle of October 2013. However, due to a 2012 adaptive management recommendation, flow to Thibaut Pond was turned on once again on October 16, 2013 and remained on for the winter season until the end of February 2014. The wetted perimeter was measured in the middle of the winter period in January and was 35 acres.

2.3 Blackrock Waterfowl Management Area

Flows for the BWMA are set based upon previous data relationships between inflows to an area and the resulting wetted acreage measurements during each of the four seasons based on evapotranspiration (ET) rates.

The seasons are defined as:

Spring	April 16 – May 31
Summer	June 1 – August 15
Fall	August 16 – October 15
Winter	October 16 – April 15

Up until the end of the 2012-13 Runoff Year, wetted acreage measurements were collected eight times per year, once in the middle of each season and once at the end of each season. Since the beginning of the 2013-14 Runoff Year, only the middle of each season measurements have been collected. The end of season measurements were discontinued because they added very little information compared to the middle of season measurements and required extensive manpower for taking the each measurement. The measurements are performed by using GPS and walking the perimeter of the wetted edges of the waterfowl area. When both middle and end of season measurements are made the measurement in the middle of the season counts as the average for the entire season (see table below).

Hydrologic Table 2. BWMA Wetted Acreage

Winterton Unit				Thibaut Unit			
ET Season	**Read Date**	**Wetted Acreage**	**Average Inflow**	**ET Season**	**Read Date**	**Wetted Acreage**	**Average Inflow**
Spring				Spring			
Summer				Summer			
Fall				Fall			
Winter				Winter	1/15/2014	7***	0.72
Spring				Spring			
Summer				Summer			
Fall				Fall			

Drew Unit				Waggoner Unit			
ET Season	**Read Date**	**Wetted Acreage**	**Average Inflow**	**ET Season**	**Read Date**	**Wetted Acreage**	**Average Inflow**
Spring	5/6/2013 N/A	299* N/A	5.15	Spring			
Summer	7/9/2013 N/A	278* N/A	5.68	Summer			
Fall	9/19/2013 10/16/2013	287* 312	4.49	Fall			
Winter	1/15/2014 N/A	330* N/A	2.15	Winter			
Spring	5/8/2014 N/A	309** N/A	4.71	Spring			
Summer	7/8/2014 N/A	278** N/A	4.83	Summer			
Fall	9/16/2014 N/A	270** N/A	N/A	Fall			

** These measurements count towards the 2013-2014 runoff year acreage goal.*
*** These measurements count towards the 2014-2015 runoff year acreage goal.*
**** This acreage does not include the 28 acres of the Thibaut Pond area.*

2.3.1 Blackrock Waterfowl Management Area Results for April 2013 to March 2014

The runoff forecast for runoff year 2013-14 was 54%, so the waterfowl acreage goal for this year was set at 270 acres.

On April 16 the spring flows were set and the inflows to the Drew Unit were increased to 5.6 cfs. When the wetted perimeter was measured with GPS in the middle of the spring season, the wetted area in the Drew Unit was 299 acres.

On June 3 the summer flows were set and the inflows to the Drew Unit were increased to 5.7 cfs. When the wetted perimeter was measured with GPS in the middle of the summer season, the wetted area in the Drew Unit was 278 acres.

On August 19 the fall flows were set and the inflows to the Drew Unit were decreased to 4.7 cfs. When the wetted perimeter was measured with GPS in the middle of the fall season, the wetted area in the Drew Unit was 287 acres.

On October 16 the Thibaut Unit inflow was turned on to 1.0 cfs and the winter flows were set for the Drew Unit decreasing it to 1.8 cfs. When the wetted perimeter was measured with GPS in the middle of the winter season, the wetted area was 330 acres for the Drew Unit and 35 acres for the Thibaut Unit.

The average waterfowl wetted acreage for the 2013-14 year was 308 acres, which was above the goal of 270 acres.

2.3.2 Blackrock Waterfowl Management Area Results for April 2014 to September 2014

The runoff forecast for runoff year 2014-15 was 50%, so the waterfowl acreage goal for this year was set at 250 acres.

On April 7 the Thibaut Unit inflow was turned off for the summer.

On April 16 the spring flows were set and the inflows to the Drew Unit were increased to 4.9 cfs. When the wetted perimeter was measured with GPS in the middle of the spring season, the wetted area was 309 acres for Drew.

On May 29 the summer flows were set and the inflows to Drew were decreased to 4.7 cfs. When the wetted perimeter was measured with GPS in the middle of the summer season, the wetted area was 278 acres for the Drew Unit.

On August 16 the fall flows were set and the inflows to the Drew Unit were decreased to 4.1 cfs. When the wetted perimeter was measured with GPS in the middle of the fall season, the wetted area was 270 acres for the Drew Unit.

The average waterfowl wetted acreage so far through fall is 283 acres, which is above the goal of 250 acres.

2.4 Assessment of River Flow Gains and Losses

This section describes river flow gains and losses for all reaches in the Lower Owens River from the LORP Intake to the Pumpback Station during the period of October 2013 to September 2014. The reaches referred to in this report indicate areas of river between specified permanent gaging stations. This analysis is an attempt at understanding flow losses and gains in the Lower Owens River so that estimates of future water requirements can be made.

2.4.1 River Flow Loss or Gain by Month and Year

Flow losses or gains can vary over time as presented in the table below. ET rates fall sharply during late fall - winter and increase dramatically during the spring - summer plant growing seasons. Thus, the river can lose water to ET during certain periods of the year and maintain or gain water during other periods of the year. December through March are winter periods with low ET that result in gains from increased flows from water stored in the shallow aquifer where groundwater levels are higher than adjacent river levels. Other incoming winter water sources such as local sporadic runoff from storms also result in flow increases.

Hydrologic Table 3. Average Monthly River Flow Losses/Gains
From the Intake to the Pumpback Station during the 2013 and 2014 Water Year

	Month	Gain(+) or Loss(-) (cfs)	Acre-Feet-Per-Day
2013	OCT	-3	-5
	NOV	+4	+9
	DEC	+3	+6
2014	JAN	+13	+26
	FEB	+9	+17
	MAR	+10	+20
	APR	+3	+5
	MAY	-14	-28
	JUN	-31	-62
	JUL	-41	-81
	AUG	-11	-21
	SEP	-21	-41
	AVG MONTH	**-7 cfs**	**-13 AcFt**

For the entire river, the overall gain or loss is calculated by subtracting Pumpback Station outflow from inflows at the Intake and augmentation spillgates. Inflows from the Intake were 40,862 acre-feet, inflows from augmentation spillgates were 2,865 acre-feet, and outflows from the Pumpback Station were 38,946 acre-feet. This yields a loss of 4,782 acre-feet for the year, a daily average of approximately 6.6 cfs between the Intake and the Pumpback Station. Water loss during the 2013-14 water year (October 2013 to September 2014) represents about 11% of the total released flow from the Intake and augmentation spillgates into the river channel.

For the year, the river lost an average of 6.6 cfs (11%). The previous year yielded a loss of 10.4 cfs (17%).

2.4.2 Flow Loss or Gain by River Reach during the Winter Period

From December 2013 to March 2014, an average flow of 47 cfs was released into the Lower Owens River from the Intake. An additional 4 cfs was provided from augmentation ditches, for a total accumulated release of 51 cfs. The average flow reaching the Pumpback Station was 60 cfs, an increase of 9 cfs during the period. During the winter, ET is low and any “make water” coming into the river is additive. Part of the “make water” was probably stored during earlier periods in subsurface aquifers and may also be a result of higher winter season precipitation.

The river reach from the Intake to the Mazourka Canyon Road gaging station lost 6 cfs, while the reach from Mazourka Canyon Road to the Reinhackle gaging station gained 2 cfs and Reinhackle to the Pumpback Station gained 12 cfs (see table below). A water “gaining” reach, during harsh winter conditions, can benefit an ecosystem in many ways. Incoming water, especially if it is subsurface, tends to increase winter river water temperatures, reduces icing effects, increases dissolved oxygen, when water surface ice is melted by increasing the re-aeration rate, and adds nutrients.

Hydrologic Table 4. Winter Flow Losses/Gains, December 2013 to March 2014

Recording Station	Average Flow (cfs)	Gain or Loss (cfs)	Accumulative (cfs)
Intake*	47	N/A	N/A
Mazourka	45	-6	-6
Reinhackle	48	+2	-4
Pumpback	60	+12	+9

Note: All numbers are rounded to the nearest whole value

* The following augmentation stations are added

1 cfs added at the Blackrock Return Ditch

1 cfs added at the Goose Lake Return

1 cfs added at the Billy Lake Return

2.4.3 Flow Loss or Gain by River Reach during the Summer Period

During the summer period of June 2014 to September 2014, all river reaches lost water. The effects of ET are evident from the high total flow loss (-26 cfs) between the Intake to the Pumpback Station. Summer flow losses were 35 cfs higher than conditions during the winter season. The largest flow losses occurred at the Intake to Mazourka reach (-14 cfs) (see following table).

Hydrologic Table 5. Summer Flow Losses/Gains, June 2014 to September 2014

Recording Station	Average Flow (cfs)	Gain or Loss (cfs)	Accumulative (cfs)
Intake*	72	N/A	N/A
Mazourka	61	-14	-14
Reinhackle	58	-4	-18
Pumpback	50	-8	-26

Note: All numbers are rounded to the nearest whole value

* The following augmentation stations are added

1 cfs added at the Blackrock Return Ditch

1 cfs added at the Goose Lake Return

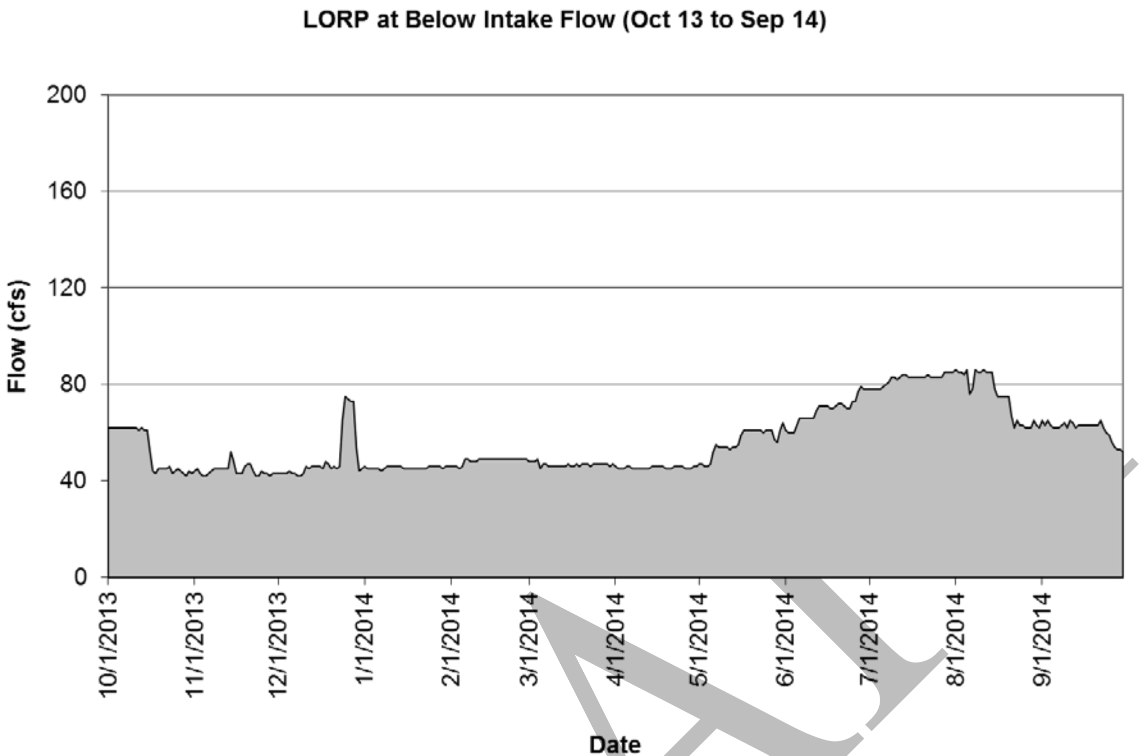
1 cfs added at the Billy Lake Return

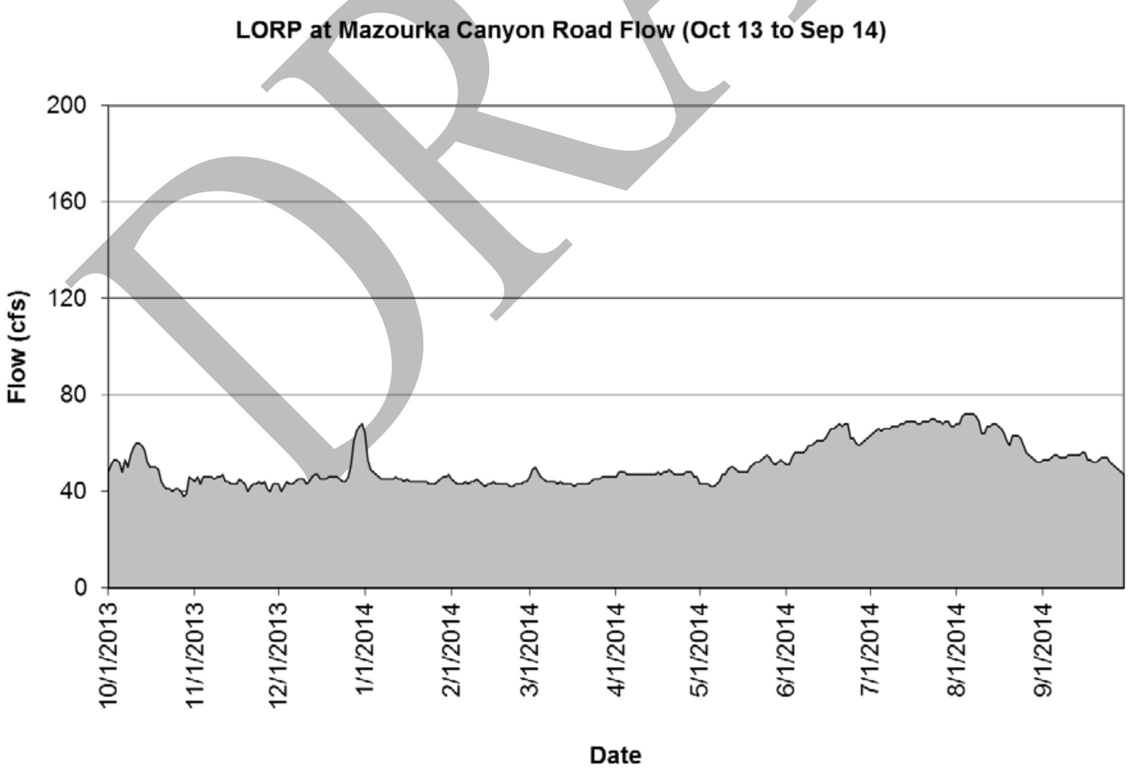
2.5 Seasonal Habitat Flow

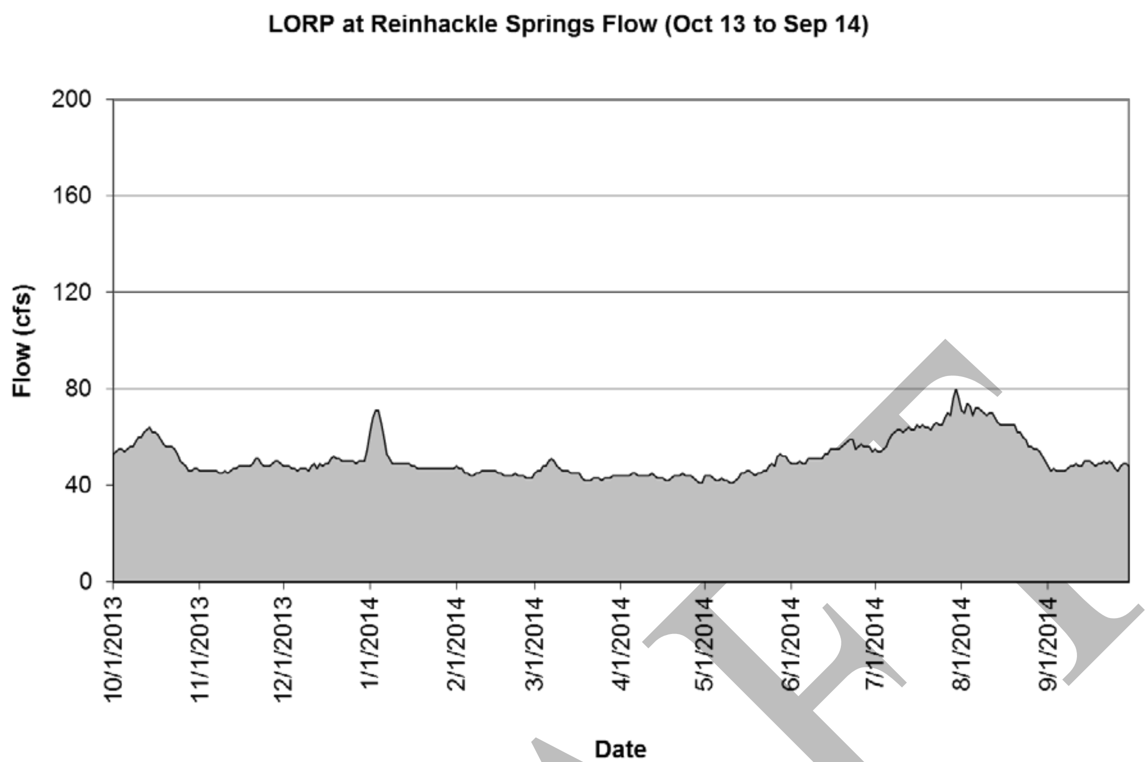
The runoff forecast for runoff year 2014-15 was 50%, so there was no seasonal habitat flow for the year.

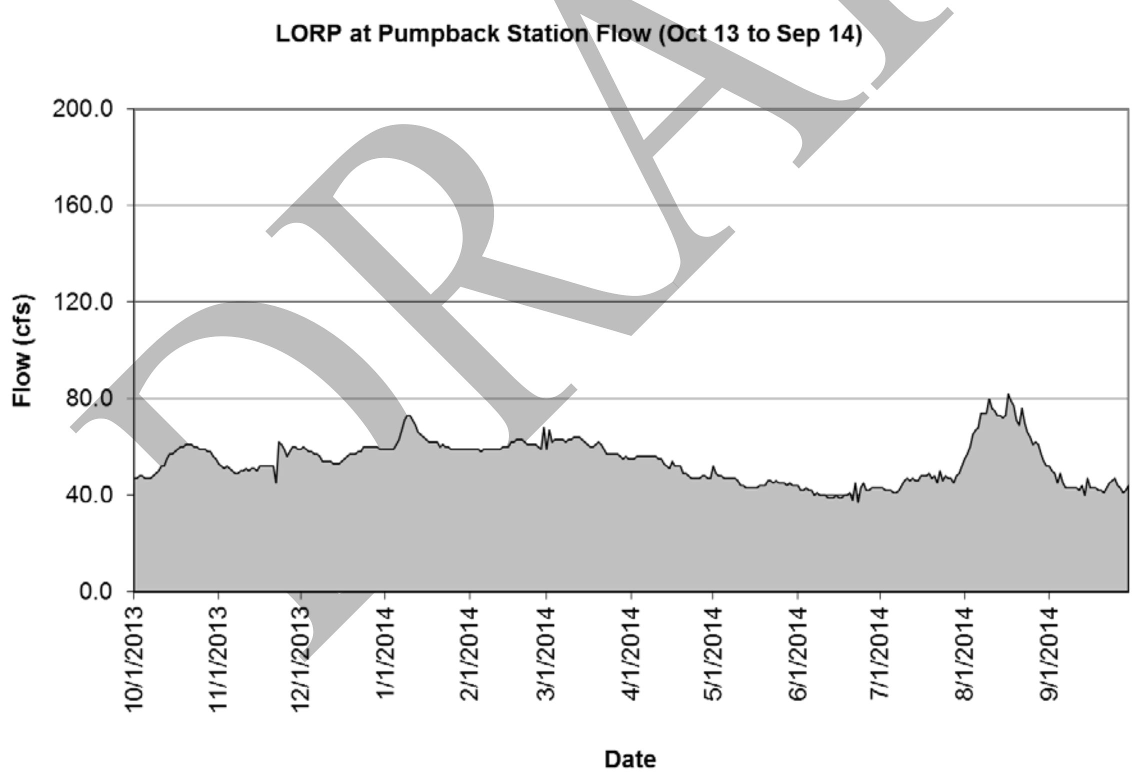
2.6 Appendix

2.6.1 Appendix 1. Hydrologic Monitoring Graphs






LORP at Reinhackle Springs Flow (Oct 13 to Sep 14)
Flow (cfs)
200
160
120
80
40
0
10/1/2013
11/1/2013
12/1/2013
1/1/2014
2/1/2014
3/1/2014
4/1/2014
5/1/2014
6/1/2014
7/1/2014
8/1/2014
9/1/2014
Date


LORP at Pumpback Station Flow (Oct 13 to Sep 14)
Flow (cfs)
200.0
160.0
120.0
80.0
40.0
0.0
10/1/2013
11/1/2013
12/1/2013
1/1/2014
2/1/2014
3/1/2014
4/1/2014
5/1/2014
6/1/2014
7/1/2014
8/1/2014
9/1/2014
Date

2.6.2 Appendix 2. River Flow Tables

Flow Gaging Station / Date	Below River Intake	Blackrock Ditch Return	Goose Lake Return	Billy Lake Return	Mazourka Canyon Road	Locust Ditch Return	Georges Ditch Return	Reinhackle Springs	Alabama Gates Return	At Pumpback Station	Pump Station	Langeman n Gate to Delta	Weir to Delta	In Channel Average Flow
10/1/2013	62.0	1.0	1.5	1.3	48.0	0.0	0.0	53.0	0.0	47.0	42.0	5.0	0.0	52.5
10/2/2013	62.0	1.0	1.5	1.4	51.0	0.0	0.0	54.0	0.0	47.0	43.0	4.0	0.0	53.5
10/3/2013	62.0	2.0	1.5	1.4	53.0	0.0	0.0	55.0	0.0	48.0	44.0	4.0	0.0	54.5
10/4/2013	62.0	1.0	1.4	1.4	53.0	0.0	0.0	55.0	0.0	48.0	44.0	4.0	0.0	54.5
10/5/2013	62.0	1.0	1.4	1.4	52.0	0.0	0.0	54.0	0.0	47.0	43.0	4.0	0.0	53.8
10/6/2013	62.0	1.0	1.4	1.4	48.0	0.0	0.0	55.0	0.0	47.0	43.0	4.0	0.0	53.0
10/7/2013	62.0	2.0	1.4	1.4	53.0	0.0	0.0	56.0	0.0	47.0	43.0	4.0	0.0	54.5
10/8/2013	62.0	1.0	1.4	1.3	50.0	0.0	0.0	56.0	0.0	48.0	44.0	4.0	0.0	54.0
10/9/2013	62.0	1.0	1.5	1.4	55.0	0.0	0.0	58.0	0.0	49.0	45.0	4.0	0.0	56.0
10/10/2013	62.0	2.0	1.7	1.5	58.0	0.0	0.0	60.0	0.0	50.0	46.0	4.0	0.0	57.5
10/11/2013	62.0	2.0	1.8	1.5	60.0	0.0	0.0	60.0	0.0	52.0	48.0	4.0	0.0	58.5
10/12/2013	61.0	2.0	1.9	1.5	60.0	0.0	0.0	62.0	0.0	52.0	48.0	4.0	0.0	58.8
10/13/2013	62.0	2.0	1.9	1.4	59.0	0.0	0.0	63.0	0.0	55.0	48.0	4.0	3.0	59.8
10/14/2013	61.0	2.0	1.9	1.4	57.0	0.0	0.0	64.0	0.0	57.0	48.0	4.0	5.0	59.8
10/15/2013	61.0	1.0	2.0	1.4	52.0	0.0	0.0	62.0	0.0	57.0	48.0	4.0	5.0	58.0
10/16/2013	52.0	1.0	2.0	1.4	50.0	0.0	0.0	62.0	0.0	58.0	48.0	4.0	6.0	55.5
10/17/2013	44.0	2.0	2.0	1.3	50.0	0.0	0.0	61.0	0.0	59.0	48.0	4.0	7.0	53.5
10/18/2013	43.0	1.0	1.9	1.3	50.0	0.0	0.0	59.0	0.0	60.0	48.0	4.0	8.0	53.0
10/19/2013	45.0	2.0	1.9	1.3	49.0	0.0	0.0	57.0	0.0	60.0	48.0	4.0	8.0	52.8
10/20/2013	45.0	1.0	1.9	1.3	44.0	0.0	0.0	56.0	0.0	61.0	48.0	4.0	9.0	51.5
10/21/2013	45.0	2.0	1.9	1.3	42.0	0.0	0.0	56.0	0.0	61.0	48.0	4.0	9.0	51.0
10/22/2013	45.0	2.0	1.8	1.2	41.0	0.0	0.0	56.0	0.0	61.0	48.0	4.0	9.0	50.8
10/23/2013	46.0	1.0	1.7	1.2	41.0	0.0	0.0	55.0	0.0	60.0	48.0	4.0	8.0	50.5
10/24/2013	43.0	1.0	1.4	1.3	40.0	0.0	0.0	53.0	0.0	60.0	48.0	4.0	8.0	49.0
10/25/2013	44.0	1.0	1.4	1.4	41.0	0.0	0.0	50.0	0.0	59.0	48.0	4.0	7.0	48.5
10/26/2013	45.0	1.0	1.4	1.4	41.0	0.0	0.0	49.0	0.0	59.0	48.0	4.0	7.0	48.5
10/27/2013	44.0	2.0	1.4	1.4	40.0	0.0	0.0	48.0	0.0	59.0	48.0	4.0	7.0	47.8
10/28/2013	43.0	2.0	1.3	1.4	38.0	0.0	0.0	46.0	0.0	58.0	48.0	4.0	6.0	46.3
10/29/2013	42.0	1.0	1.3	1.6	39.0	0.0	0.0	46.0	0.0	58.0	48.0	4.0	6.0	46.3
10/30/2013	44.0	1.0	1.3	1.7	46.0	0.0	0.0	47.0	0.0	56.0	47.0	4.0	5.0	48.3
10/31/2013	43.0	1.0	1.3	1.7	45.0	0.0	0.0	47.0	0.0	55.0	48.0	4.0	3.0	47.5

Notes: These measurements are not on the main channel of the Owens River, therefore highlighted columns are not included in average calculations.

Flow Gaging Station / Date	Below River Intake	Blackrock Ditch Return	Goose Lake Return	Billy Lake Return	Mazourka Canyon Road	Locust Ditch Return	Georges Ditch Return	Reinhackle Springs	Alabama Gates Return	At Pumpback Station	Pump Station	Langeman n Gate to Delta	Weir to Delta	In Channel Average Flow
11/1/2013	44.0	2.0	1.3	2.5	44.0	0.0	0.0	46.0	0.0	53.0	48.0	4.0	1.0	46.8
11/2/2013	45.0	1.0	1.4	2.0	46.0	0.0	0.0	46.0	0.0	52.0	48.0	4.0	0.0	47.3
11/3/2013	43.0	1.0	1.4	1.6	43.0	0.0	0.0	46.0	0.0	51.0	47.0	4.0	0.0	45.8
11/4/2013	42.0	2.0	1.4	1.6	46.0	0.0	0.0	46.0	0.0	52.0	48.0	4.0	0.0	46.5
11/5/2013	42.0	2.0	1.4	1.5	46.0	0.0	0.0	46.0	0.0	51.0	47.0	4.0	0.0	46.3
11/6/2013	43.0	2.0	1.4	1.5	46.0	0.0	0.0	46.0	0.0	50.0	46.0	4.0	0.0	46.3
11/7/2013	44.0	2.0	1.3	1.5	46.0	0.0	0.0	46.0	0.0	49.0	45.0	4.0	0.0	46.3
11/8/2013	45.0	2.0	1.3	1.5	45.0	0.0	0.0	45.0	0.0	49.0	45.0	4.0	0.0	46.0
11/9/2013	45.0	2.0	1.3	1.5	46.0	0.0	0.0	45.0	0.0	50.0	46.0	4.0	0.0	46.5
11/10/2013	45.0	1.0	1.3	1.4	46.0	0.0	0.0	46.0	0.0	50.0	46.0	4.0	0.0	46.8
11/11/2013	45.0	1.0	1.3	1.4	47.0	0.0	0.0	45.0	0.0	51.0	47.0	4.0	0.0	47.0
11/12/2013	45.0	1.0	1.4	1.4	44.0	0.0	0.0	46.0	0.0	50.0	46.0	4.0	0.0	46.3
11/13/2013	45.0	1.0	1.3	1.4	44.0	0.0	0.0	47.0	0.0	51.0	47.0	4.0	0.0	46.8
11/14/2013	52.0	1.0	1.3	1.4	43.0	0.0	0.0	47.0	0.0	51.0	47.0	4.0	0.0	48.3
11/15/2013	48.0	1.0	1.3	1.4	43.0	0.0	0.0	48.0	0.0	50.0	46.0	4.0	0.0	47.3
11/16/2013	43.0	1.0	1.2	1.4	43.0	0.0	0.0	48.0	0.0	52.0	48.0	4.0	0.0	46.5
11/17/2013	43.0	1.0	1.0	1.4	45.0	0.0	0.0	48.0	0.0	52.0	48.0	4.0	0.0	47.0
11/18/2013	43.0	1.0	0.7	1.4	44.0	0.0	0.0	48.0	0.0	52.0	48.0	4.0	0.0	46.8
11/19/2013	46.0	1.0	0.8	1.3	43.0	0.0	0.0	48.0	0.0	52.0	48.0	4.0	0.0	47.3
11/20/2013	47.0	1.0	1.6	1.3	40.0	0.0	0.0	49.0	0.0	52.0	48.0	4.0	0.0	47.0
11/21/2013	47.0	1.0	1.6	1.3	42.0	0.0	0.0	51.0	0.0	52.0	48.0	4.0	0.0	48.0
11/22/2013	44.0	1.0	1.7	1.3	43.0	0.0	0.0	51.0	0.0	45.0	39.0	4.0	2.0	45.8
11/23/2013	42.0	2.0	1.8	1.4	43.0	0.1	0.0	49.0	0.0	62.0	48.0	4.0	10.0	49.0
11/24/2013	42.0	1.0	1.8	1.5	44.0	0.1	0.0	48.0	0.0	61.0	48.0	4.0	9.0	48.8
11/25/2013	44.0	2.0	1.7	2.9	43.0	0.1	0.1	48.0	0.0	59.0	48.0	4.0	7.0	48.5
11/26/2013	43.0	1.0	1.7	3.4	44.0	0.3	0.1	48.0	0.0	56.0	48.0	3.0	5.0	47.8
11/27/2013	43.0	1.0	1.8	1.4	41.0	0.2	0.1	49.0	0.0	58.0	45.0	3.0	10.0	47.8
11/28/2013	42.0	1.0	1.8	1.4	40.0	0.0	0.1	50.0	0.0	60.0	48.0	3.0	9.0	48.0
11/29/2013	43.0	1.0	1.7	1.4	43.0	0.0	0.1	50.0	0.0	60.0	48.0	3.0	9.0	49.0
11/30/2013	43.0	1.0	1.8	1.4	43.0	0.0	0.1	49.0	0.0	59.0	48.0	3.0	8.0	48.5

Notes: These measurements are not on the main channel of the Owens River, therefore highlighted columns are not included in average calculations.

Flow Gaging Station / Date	Below River Intake	Blackrock Ditch Return	Goose Lake Return	Billy Lake Return	Mazourka Canyon Road	Locust Ditch Return	Georges Ditch Return	Reinhackle Springs	Alabama Gates Return	At Pumpback Station	Pump Station	Langeman n Gate to Delta	Weir to Delta	In Channel Average Flow
12/1/2013	43.0	2.0	1.8	1.4	43.0	0.0	0.1	48.0	0.0	59.0	48.0	3.0	8.0	48.3
12/2/2013	43.0	1.0	1.8	1.4	40.0	0.0	0.1	48.0	0.0	60.0	48.0	3.0	9.0	47.8
12/3/2013	43.0	1.0	1.7	1.5	42.0	0.0	0.1	48.0	0.0	59.0	47.0	3.0	9.0	48.0
12/4/2013	43.0	1.0	1.6	1.5	44.0	0.0	0.1	47.0	0.0	58.0	48.0	3.0	7.0	48.0
12/5/2013	44.0	1.0	2.2	1.5	43.0	0.0	0.0	47.0	0.0	58.0	48.0	3.0	7.0	48.0
12/6/2013	43.0	1.0	2.1	1.6	43.0	0.0	0.0	46.0	0.0	57.0	48.0	3.0	6.0	47.3
12/7/2013	43.0	1.0	2.2	1.6	44.0	0.0	0.0	47.0	0.0	57.0	48.0	3.0	6.0	47.8
12/8/2013	42.0	2.0	2.2	1.6	45.0	0.0	0.0	47.0	0.0	56.0	48.0	3.0	5.0	47.5
12/9/2013	42.0	1.0	2.2	1.6	45.0	0.0	0.0	47.0	0.0	54.0	48.0	3.0	3.0	47.0
12/10/2013	43.0	1.0	2.2	1.6	45.0	0.0	0.0	46.0	0.0	54.0	48.0	3.0	3.0	47.0
12/11/2013	46.0	1.0	2.1	1.5	43.0	0.0	0.1	48.0	0.0	54.0	48.0	3.0	3.0	47.8
12/12/2013	45.0	1.0	2.1	1.5	44.0	0.0	0.2	49.0	0.0	54.0	48.0	3.0	3.0	48.0
12/13/2013	46.0	2.0	2.1	1.5	46.0	0.0	0.1	47.0	0.0	53.0	48.0	3.0	2.0	48.0
12/14/2013	46.0	2.0	2.0	1.5	47.0	0.0	0.0	49.0	0.0	53.0	48.0	3.0	2.0	48.8
12/15/2013	46.0	2.0	2.1	1.5	47.0	0.0	0.1	48.0	0.0	53.0	48.0	3.0	2.0	48.5
12/16/2013	46.0	1.0	2.1	1.6	45.0	0.0	0.1	49.0	0.0	54.0	48.0	3.0	3.0	48.5
12/17/2013	45.0	1.0	2.1	1.6	45.0	0.0	0.1	49.0	0.0	55.0	48.0	3.0	4.0	48.5
12/18/2013	48.0	1.0	2.2	1.6	45.0	0.0	0.1	51.0	0.0	56.0	48.0	3.0	5.0	50.0
12/19/2013	47.0	1.0	2.2	1.6	46.0	0.0	0.1	52.0	0.0	57.0	48.0	3.0	6.0	50.5
12/20/2013	45.0	2.0	2.1	1.6	46.0	0.0	0.1	51.0	0.0	57.0	48.0	3.0	6.0	49.8
12/21/2013	46.0	1.0	2.0	1.6	46.0	0.0	0.1	51.0	0.0	57.0	48.0	3.0	6.0	50.0
12/22/2013	45.0	1.0	1.9	1.6	46.0	0.0	0.1	50.0	0.0	58.0	48.0	3.0	7.0	49.8
12/23/2013	46.0	2.0	1.9	1.6	45.0	0.0	0.1	50.0	0.0	58.0	48.0	3.0	7.0	49.8
12/24/2013	65.0	1.0	1.9	1.7	44.0	0.0	0.1	50.0	0.0	60.0	48.0	3.0	9.0	54.8
12/25/2013	75.0	1.0	2.0	1.6	44.0	0.0	0.0	50.0	0.0	60.0	48.0	3.0	9.0	57.3
12/26/2013	74.0	2.0	2.1	1.5	46.0	0.0	0.0	50.0	0.0	60.0	48.0	3.0	9.0	57.5
12/27/2013	73.0	2.0	2.0	1.4	51.0	0.0	0.0	49.0	0.0	60.0	48.0	3.0	9.0	58.3
12/28/2013	73.0	1.0	1.9	1.4	61.0	0.0	0.1	50.0	0.0	60.0	48.0	3.0	9.0	61.0
12/29/2013	54.0	2.0	1.8	1.4	65.0	0.0	0.1	50.0	0.0	60.0	48.0	3.0	9.0	57.3
12/30/2013	44.0	1.0	1.5	1.4	67.0	0.0	0.1	50.0	0.0	59.0	48.0	3.0	8.0	55.0
12/31/2013	45.0	1.0	1.3	1.5	68.0	0.0	0.1	55.0	0.0	59.0	48.0	3.0	8.0	56.8

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Flow Gaging Station / Date	Below River Intake	Blackrock Ditch Return	Goose Lake Return	Billy Lake Return	Mazourka Canyon Road	Locust Ditch Return	Georges Ditch Return	Reinhackle Springs	Alabama Gates Return	At Pumpback Station	Pump Station	Langeman n Gate to Delta	Weir to Delta	In Channel Average Flow
1/1/2014	46.0	1.0	1.3	1.5	64.0	0.0	0.1	62.0	0.0	59.0	48.0	3.0	8.0	57.8
1/2/2014	45.0	1.0	1.3	1.5	53.0	0.0	0.1	68.0	0.0	59.0	48.0	3.0	8.0	56.3
1/3/2014	45.0	1.0	1.4	1.5	49.0	0.0	0.1	71.0	0.0	59.0	48.0	3.0	8.0	56.0
1/4/2014	45.0	2.0	1.4	1.6	48.0	0.0	0.1	71.0	0.0	59.0	48.0	3.0	8.0	55.8
1/5/2014	45.0	2.0	1.4	1.6	47.0	0.0	0.0	66.0	0.0	61.0	48.0	3.0	10.0	54.8
1/6/2014	45.0	1.0	1.3	1.5	46.0	0.0	0.0	60.0	0.0	63.0	48.0	3.0	12.0	53.5
1/7/2014	44.0	1.0	1.3	1.5	45.0	0.0	0.0	53.0	0.0	67.0	48.0	3.0	16.0	52.3
1/8/2014	45.0	1.0	1.3	1.5	45.0	0.0	0.0	51.0	0.0	71.0	48.0	3.0	20.0	53.0
1/9/2014	46.0	1.0	1.3	1.5	45.0	0.0	0.0	49.0	0.0	73.0	48.0	3.0	22.0	53.3
1/10/2014	46.0	1.0	1.4	1.5	45.0	0.0	0.0	49.0	0.0	73.0	48.0	3.0	22.0	53.3
1/11/2014	46.0	1.0	1.4	1.5	45.0	0.0	0.0	49.0	0.0	71.0	48.0	3.0	20.0	52.8
1/12/2014	46.0	1.0	1.3	1.6	46.0	0.0	0.0	49.0	0.0	69.0	48.0	3.0	18.0	52.5
1/13/2014	46.0	1.0	1.3	1.6	45.0	0.0	0.1	49.0	0.0	66.0	48.0	3.0	15.0	51.5
1/14/2014	46.0	1.0	1.3	1.5	45.0	0.0	0.1	49.0	0.0	65.0	48.0	3.0	14.0	51.3
1/15/2014	45.0	1.0	1.3	1.5	44.0	0.0	0.1	49.0	0.0	64.0	48.0	3.0	13.0	50.5
1/16/2014	45.0	1.0	1.3	1.4	45.0	0.0	0.1	48.0	0.0	63.0	48.0	3.0	12.0	50.3
1/17/2014	45.0	1.0	1.5	1.4	44.0	0.0	0.0	48.0	0.0	62.0	48.0	3.0	11.0	49.8
1/18/2014	45.0	2.0	1.5	1.4	44.0	0.0	0.1	47.0	0.0	62.0	48.0	3.0	11.0	49.5
1/19/2014	45.0	2.0	1.5	1.4	44.0	0.0	0.0	47.0	0.0	62.0	48.0	3.0	11.0	49.5
1/20/2014	45.0	2.0	1.4	1.4	44.0	0.0	0.0	47.0	0.0	62.0	48.0	3.0	11.0	49.5
1/21/2014	45.0	1.0	1.4	1.3	44.0	0.0	0.0	47.0	0.0	60.0	48.0	3.0	9.0	49.0
1/22/2014	45.0	1.0	1.3	1.3	44.0	0.0	0.0	47.0	0.0	61.0	48.0	3.0	10.0	49.3
1/23/2014	45.0	2.0	1.3	1.3	44.0	0.0	0.0	47.0	0.0	60.0	48.0	3.0	9.0	49.0
1/24/2014	46.0	2.0	1.4	1.4	43.0	0.0	0.0	47.0	0.0	60.0	48.0	3.0	9.0	49.0
1/25/2014	46.0	1.0	1.5	1.4	43.0	0.0	0.0	47.0	0.0	59.0	48.0	3.0	8.0	48.8
1/26/2014	46.0	2.0	1.5	1.4	43.0	0.0	0.0	47.0	0.0	59.0	48.0	3.0	8.0	48.8
1/27/2014	46.0	2.0	1.5	1.4	44.0	0.0	0.0	47.0	0.0	59.0	48.0	3.0	8.0	49.0
1/28/2014	46.0	2.0	1.5	1.4	45.0	0.0	0.0	47.0	0.0	59.0	48.0	3.0	8.0	49.3
1/29/2014	45.0	1.0	1.5	1.3	46.0	0.0	0.0	47.0	0.0	59.0	48.0	3.0	8.0	49.3
1/30/2014	46.0	1.0	1.5	1.3	46.0	0.0	0.0	47.0	0.0	59.0	48.0	3.0	8.0	49.5
1/31/2014	46.0	2.0	1.5	1.4	47.0	0.0	0.0	47.0	0.0	59.0	48.0	3.0	8.0	49.8

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Flow Gaging Station / Date	Below River Intake	Blackrock Ditch Return	Goose Lake Return	Billy Lake Return	Mazourka Canyon Road	Locust Ditch Return	Georges Ditch Return	Reinhackle Springs	Alabama Gates Return	At Pumpback Station	Pump Station	Langeman Gate to Delta	Weir to Delta	In Channel Average Flow
2/1/2014	46.0	1.0	1.5	1.4	45.0	0.0	0.0	48.0	0.0	59.0	48.0	3.0	8.0	49.5
2/2/2014	46.0	1.0	1.5	1.4	44.0	0.0	0.0	47.0	0.0	59.0	48.0	3.0	8.0	49.0
2/3/2014	46.0	1.0	1.4	1.4	43.0	0.0	0.0	47.0	0.0	59.0	48.0	3.0	8.0	48.8
2/4/2014	45.0	1.0	1.5	1.4	43.0	0.0	0.0	45.0	0.0	59.0	48.0	3.0	8.0	48.0
2/5/2014	46.0	1.0	1.5	1.4	43.0	0.0	0.0	45.0	0.0	58.0	48.0	3.0	7.0	48.0
2/6/2014	49.0	1.0	1.4	1.4	44.0	0.0	0.0	44.0	0.0	59.0	48.0	3.0	8.0	49.0
2/7/2014	49.0	1.0	1.3	1.3	43.0	0.0	0.0	44.0	0.0	59.0	48.0	3.0	8.0	48.8
2/8/2014	48.0	1.0	1.2	1.3	44.0	0.0	0.0	45.0	0.0	59.0	48.0	3.0	8.0	49.0
2/9/2014	48.0	1.0	1.1	1.3	44.0	0.0	0.0	45.0	0.0	59.0	48.0	3.0	8.0	49.0
2/10/2014	48.0	1.0	1.1	1.3	45.0	0.0	0.0	46.0	0.0	59.0	48.0	3.0	8.0	49.5
2/11/2014	49.0	1.0	1.1	1.3	44.0	0.0	0.2	46.0	0.0	59.0	48.0	3.0	8.0	49.5
2/12/2014	49.0	1.0	1.1	1.2	43.0	0.0	0.2	46.0	0.0	59.0	48.0	3.0	8.0	49.3
2/13/2014	49.0	1.0	1.1	1.1	42.0	0.0	0.2	46.0	0.0	60.0	48.0	3.0	9.0	49.3
2/14/2014	49.0	1.0	1.1	1.1	43.0	0.0	0.2	46.0	0.0	60.0	48.0	3.0	9.0	49.5
2/15/2014	49.0	1.0	1.1	1.0	43.0	0.0	0.2	46.0	0.0	60.0	48.0	3.0	9.0	49.5
2/16/2014	49.0	1.0	1.1	1.0	44.0	0.0	0.1	45.0	0.0	62.0	48.0	3.0	11.0	50.0
2/17/2014	49.0	1.0	1.1	1.0	43.0	0.0	0.1	45.0	0.0	62.0	48.0	3.0	11.0	49.8
2/18/2014	49.0	1.0	1.1	1.0	43.0	0.0	0.1	44.0	0.0	63.0	48.0	3.0	12.0	49.8
2/19/2014	49.0	1.0	1.1	1.1	43.0	0.0	0.1	44.0	0.0	63.0	48.0	3.0	12.0	49.8
2/20/2014	49.0	1.0	1.1	1.0	43.0	0.0	0.1	44.0	0.0	63.0	48.0	3.0	12.0	49.8
2/21/2014	49.0	1.0	1.2	1.1	43.0	0.0	0.1	44.0	0.0	62.0	48.0	3.0	11.0	49.5
2/22/2014	49.0	1.0	1.2	1.1	42.0	0.0	0.1	45.0	0.0	61.0	48.0	3.0	10.0	49.3
2/23/2014	49.0	1.0	1.1	1.0	42.0	0.0	0.2	44.0	0.0	61.0	48.0	3.0	10.0	49.0
2/24/2014	49.0	1.0	1.1	0.9	43.0	0.0	0.2	44.0	0.0	61.0	48.0	3.0	10.0	49.3
2/25/2014	49.0	1.0	1.1	1.0	43.0	0.0	0.2	44.0	0.0	61.0	48.0	3.0	10.0	49.3
2/26/2014	49.0	1.0	1.1	1.0	43.0	0.0	0.1	43.0	0.0	60.0	48.0	3.0	9.0	48.8
2/27/2014	49.0	1.0	1.2	1.0	44.0	0.0	0.1	43.0	0.0	59.0	48.0	3.0	8.0	48.8
2/28/2014	49.0	1.0	1.6	1.0	44.0	0.0	0.1	43.0	0.0	68.0	48.0	4.0	16.0	51.0

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3/1/2014	48.0	1.0	2.0	1.0	46.0	0.0	0.1	45.0	0.0	59.0	48.0	3.0	8.0	49.5
3/2/2014	48.0	1.0	2.0	1.0	49.0	0.0	0.1	46.0	0.0	67.0	47.0	3.0	17.0	52.5
3/3/2014	48.0	1.0	1.8	1.0	50.0	0.0	0.2	46.0	0.0	62.0	47.0	4.0	11.0	51.5
3/4/2014	49.0	1.0	1.6	1.1	48.0	0.0	0.1	48.0	0.0	63.0	47.0	4.0	12.0	52.0
3/5/2014	45.0	1.0	1.5	1.1	46.0	0.0	0.1	48.0	0.0	63.0	47.0	4.0	12.0	50.5
3/6/2014	47.0	1.0	1.4	1.2	45.0	0.0	0.1	50.0	0.0	63.0	48.0	4.0	11.0	51.3
3/7/2014	47.0	1.0	1.3	1.1	44.0	0.0	0.1	51.0	0.0	63.0	48.0	4.0	11.0	51.3
3/8/2014	46.0	1.0	1.3	1.1	44.0	0.0	0.1	50.0	0.0	62.0	48.0	4.0	10.0	50.5
3/9/2014	46.0	1.0	1.2	1.0	44.0	0.0	0.1	48.0	0.0	63.0	48.0	4.0	11.0	50.3
3/10/2014	46.0	1.0	1.2	1.0	44.0	0.0	0.1	47.0	0.0	63.0	48.0	4.0	11.0	50.0
3/11/2014	46.0	1.0	1.2	1.0	43.0	0.0	0.2	46.0	0.0	64.0	48.0	4.0	12.0	49.8
3/12/2014	46.0	1.0	1.1	1.1	44.0	0.0	0.2	46.0	0.0	64.0	48.0	4.0	12.0	50.0
3/13/2014	46.0	1.0	1.1	1.1	43.0	0.0	0.2	46.0	0.0	64.0	48.0	4.0	12.0	49.8
3/14/2014	46.0	1.0	1.2	1.2	43.0	0.0	0.2	45.0	0.0	63.0	48.0	4.0	11.0	49.3
3/15/2014	47.0	1.0	1.2	1.2	43.0	0.0	0.2	45.0	0.0	62.0	48.0	4.0	10.0	49.3
3/16/2014	46.0	1.0	1.1	1.2	43.0	0.0	0.2	45.0	0.0	61.0	48.0	4.0	9.0	48.8
3/17/2014	46.0	1.0	1.2	1.2	42.0	0.0	0.2	45.0	0.0	60.0	48.0	4.0	8.0	48.3
3/18/2014	47.0	1.0	1.1	1.2	43.0	0.0	0.2	43.0	0.0	60.0	46.0	4.0	10.0	48.3
3/19/2014	46.0	1.0	1.1	1.2	43.0	0.0	0.3	42.0	0.0	61.0	47.0	4.0	10.0	48.0
3/20/2014	47.0	1.0	1.2	1.2	43.0	0.0	0.3	42.0	0.0	62.0	47.0	4.0	11.0	48.5
3/21/2014	47.0	1.0	1.2	1.3	43.0	0.0	0.2	42.0	0.0	61.0	46.0	4.0	11.0	48.3
3/22/2014	47.0	1.0	1.2	1.3	43.0	0.0	0.2	43.0	0.0	59.0	47.0	4.0	8.0	48.0
3/23/2014	46.0	1.0	1.2	1.4	44.0	0.0	0.2	43.0	0.0	57.0	47.0	4.0	6.0	47.5
3/24/2014	47.0	1.0	1.2	1.4	45.0	0.0	0.2	43.0	0.0	57.0	47.0	4.0	6.0	48.0
3/25/2014	47.0	1.0	1.2	1.4	45.0	0.0	0.3	42.0	0.0	57.0	44.0	4.0	9.0	47.8
3/26/2014	47.0	1.0	1.2	1.4	45.0	0.0	0.4	43.0	0.0	57.0	48.0	4.0	5.0	48.0
3/27/2014	47.0	1.0	1.2	1.4	46.0	0.0	0.2	43.0	0.0	57.0	48.0	4.0	5.0	48.3
3/28/2014	47.0	1.0	1.2	1.4	46.0	0.0	0.3	43.0	0.0	56.0	48.0	4.0	4.0	48.0
3/29/2014	47.0	1.0	1.1	1.4	46.0	0.0	0.3	44.0	0.0	55.0	44.0	4.0	7.0	48.0
3/30/2014	46.0	1.0	1.1	1.4	46.0	0.0	0.2	44.0	0.0	56.0	47.0	4.0	5.0	48.0
3/31/2014	47.0	1.0	1.1	1.4	46.0	0.0	0.2	44.0	0.0	55.0	48.0	4.0	3.0	48.0
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4/1/2014	46.0	1.0	1.0	1.4	46.0	0.0	0.2	44.0	0.0	55.0	48.0	4.0	3.0	47.8
4/2/2014	45.0	1.0	1.0	1.4	48.0	0.0	0.2	44.0	0.0	55.0	48.0	4.0	3.0	48.0
4/3/2014	45.0	1.0	1.0	1.4	48.0	0.0	0.2	44.0	0.0	56.0	48.0	4.0	4.0	48.3
4/4/2014	45.0	2.0	1.1	1.4	48.0	0.0	0.2	44.0	0.0	56.0	48.0	4.0	4.0	48.3
4/5/2014	46.0	1.0	1.1	1.4	47.0	0.0	0.2	45.0	0.0	56.0	48.0	4.0	4.0	48.5
4/6/2014	46.0	1.0	1.1	1.4	47.0	0.0	0.2	45.0	0.0	56.0	48.0	4.0	4.0	48.5
4/7/2014	45.0	1.0	1.0	1.4	47.0	0.0	0.2	44.0	0.0	56.0	48.0	4.0	4.0	48.0
4/8/2014	45.0	1.0	1.0	1.3	47.0	0.0	0.2	44.0	0.0	56.0	48.0	4.0	4.0	48.0
4/9/2014	45.0	1.0	1.0	1.2	47.0	0.0	0.2	44.0	0.0	56.0	48.0	4.0	4.0	48.0
4/10/2014	45.0	1.0	1.0	1.0	47.0	0.0	0.1	44.0	0.0	56.0	48.0	4.0	4.0	48.0
4/11/2014	45.0	1.0	1.0	1.0	47.0	0.0	0.2	44.0	0.0	55.0	48.0	4.0	3.0	47.8
4/12/2014	45.0	2.0	1.0	1.1	47.0	0.0	0.3	45.0	0.0	55.0	48.0	4.0	3.0	48.0
4/13/2014	45.0	1.0	1.0	1.1	47.0	0.0	0.5	44.0	0.0	53.0	48.0	4.0	1.0	47.3
4/14/2014	46.0	1.0	1.0	1.0	47.0	0.0	0.4	43.0	0.0	52.0	48.0	4.0	0.0	47.0
4/15/2014	46.0	1.0	1.0	1.0	47.0	0.0	0.4	43.0	0.0	51.0	48.0	3.0	0.0	46.8
4/16/2014	46.0	2.0	1.0	1.1	48.0	0.0	0.2	43.0	0.0	54.0	48.0	4.0	2.0	47.8
4/17/2014	46.0	2.0	1.1	1.2	47.0	0.0	0.2	42.0	0.0	52.0	48.0	4.0	0.0	46.8
4/18/2014	46.0	1.0	1.1	1.2	48.0	0.0	0.3	42.0	0.0	52.0	48.0	4.0	0.0	47.0
4/19/2014	45.0	0.5	1.1	1.2	48.0	0.0	0.7	43.0	0.0	52.0	48.0	4.0	0.0	47.0
4/20/2014	45.0	1.0	1.1	1.2	49.0	0.0	0.6	44.0	0.0	49.0	29.0	20.0	0.0	46.8
4/21/2014	45.0	2.0	1.1	1.2	48.0	0.0	0.5	44.0	0.0	49.0	24.0	25.0	0.0	46.5
4/22/2014	46.0	2.0	1.1	1.1	47.0	0.0	0.3	44.0	0.0	48.0	23.0	25.0	0.0	46.3
4/23/2014	46.0	2.0	1.0	1.1	47.0	0.0	0.2	45.0	0.0	47.0	22.0	25.0	0.0	46.3
4/24/2014	46.0	1.0	1.0	1.0	47.0	0.0	0.2	44.0	0.0	47.0	22.0	25.0	0.0	46.0
4/25/2014	46.0	1.0	1.0	1.0	47.0	0.0	0.2	44.0	0.0	47.0	22.0	25.0	0.0	46.0
4/26/2014	45.0	1.0	1.0	1.1	48.0	0.0	0.2	44.0	0.0	47.0	22.0	25.0	0.0	46.0
4/27/2014	45.0	1.0	1.0	1.1	48.0	0.0	0.4	43.0	0.0	48.0	23.0	25.0	0.0	46.0
4/28/2014	45.0	1.0	1.1	1.1	48.0	0.0	0.4	42.0	0.0	48.0	23.0	25.0	0.0	45.8
4/29/2014	46.0	1.0	1.2	1.1	46.0	0.0	0.4	41.0	0.0	47.0	22.0	25.0	0.0	45.0
4/30/2014	46.0	1.0	1.2	1.1	46.0	0.0	0.4	41.0	0.0	47.0	34.0	11.0	2.0	45.0
Notes:	These measurements are not on the main channel of the Ow ens River, therefore highlighted columns are not included in average calculations.													

Flow Gaging Station / Date	Below River Intake	Blackrock Ditch Return	Goose Lake Return	Billy Lake Return	Mazourka Canyon Road	Locust Ditch Return	Georges Ditch Return	Reinhackle Springs	Alabama Gates Return	At Pumpback Station	Pump Station	Langeman n Gate to Delta	Weir to Delta	In Channel Average Flow
5/1/2014	47.0	1.0	1.1	1.1	43.0	0.0	0.4	44.0	0.0	52.0	45.0	7.0	0.0	46.5
5/2/2014	47.0	1.0	1.1	1.1	43.0	0.0	0.4	44.0	0.0	49.0	41.0	8.0	0.0	45.8
5/3/2014	46.0	1.0	1.1	1.0	43.0	0.0	0.4	44.0	0.0	48.0	41.0	7.0	0.0	45.3
5/4/2014	46.0	2.0	1.0	1.0	43.0	0.0	0.4	43.0	0.0	48.0	40.0	8.0	0.0	45.0
5/5/2014	47.0	2.0	1.0	0.9	42.0	0.0	0.4	42.0	0.0	47.0	39.0	8.0	0.0	44.5
5/6/2014	52.0	1.0	1.0	0.9	42.0	0.0	0.4	42.0	0.0	47.0	40.0	7.0	0.0	45.8
5/7/2014	55.0	1.0	1.0	0.9	43.0	0.0	0.4	43.0	0.0	47.0	39.0	8.0	0.0	47.0
5/8/2014	54.0	1.0	1.0	0.9	44.0	0.0	0.4	42.0	0.0	47.0	39.0	8.0	0.0	46.8
5/9/2014	54.0	1.0	1.1	0.9	47.0	0.0	0.3	42.0	0.0	47.0	39.0	8.0	0.0	47.5
5/10/2014	54.0	1.0	1.2	1.0	47.0	0.0	0.2	41.0	0.0	46.0	38.0	8.0	0.0	47.0
5/11/2014	54.0	1.0	1.2	0.9	49.0	0.0	0.1	41.0	0.0	44.0	37.0	7.0	0.0	47.0
5/12/2014	53.0	1.0	1.2	0.9	50.0	0.0	0.1	42.0	0.0	44.0	36.0	8.0	0.0	47.3
5/13/2014	54.0	1.0	1.1	1.0	50.0	0.0	0.1	43.0	0.0	43.0	36.0	7.0	0.0	47.5
5/14/2014	54.0	1.0	1.1	1.1	49.0	0.0	0.1	45.0	0.0	43.0	35.0	8.0	0.0	47.8
5/15/2014	55.0	1.0	1.1	1.1	48.0	0.0	0.1	45.0	0.0	43.0	35.0	8.0	0.0	47.8
5/16/2014	59.0	1.0	1.2	1.1	48.0	0.0	0.0	46.0	0.0	43.0	35.0	8.0	0.0	49.0
5/17/2014	61.0	4.0	1.2	1.2	48.0	0.0	0.0	46.0	0.0	43.0	35.0	8.0	0.0	49.5
5/18/2014	61.0	2.0	1.1	1.1	48.0	0.0	0.0	45.0	0.0	44.0	36.0	8.0	0.0	49.5
5/19/2014	61.0	1.0	1.2	1.1	50.0	0.0	0.0	44.0	0.0	44.0	36.0	8.0	0.0	49.8
5/20/2014	61.0	1.0	1.2	1.1	51.0	0.0	0.0	45.0	0.0	44.0	36.0	8.0	0.0	50.3
5/21/2014	61.0	1.0	1.3	1.1	52.0	0.0	0.0	45.0	0.0	46.0	38.0	8.0	0.0	51.0
5/22/2014	61.0	1.0	1.3	1.0	52.0	0.0	0.3	46.0	0.0	46.0	38.0	8.0	0.0	51.3
5/23/2014	61.0	1.0	1.4	1.0	53.0	0.0	0.3	46.0	0.0	45.0	37.0	8.0	0.0	51.3
5/24/2014	60.0	1.0	1.4	1.0	54.0	0.0	0.6	48.0	0.0	46.0	38.0	8.0	0.0	52.0
5/25/2014	61.0	0.5	1.2	1.0	55.0	0.0	0.2	49.0	0.0	45.0	37.0	8.0	0.0	52.5
5/26/2014	61.0	1.0	1.1	1.0	54.0	0.0	0.1	48.0	0.0	45.0	37.0	8.0	0.0	52.0
5/27/2014	61.0	2.0	1.0	0.9	52.0	0.0	0.1	52.0	0.0	45.0	37.0	8.0	0.0	52.5
5/28/2014	57.0	2.0	1.0	0.9	51.0	0.0	0.1	53.0	0.0	44.0	36.0	8.0	0.0	51.3
5/29/2014	56.0	1.0	0.9	0.9	52.0	0.0	0.3	52.0	0.0	45.0	37.0	8.0	0.0	51.3
5/30/2014	61.0	1.0	0.7	0.9	53.0	0.0	0.3	52.0	0.0	44.0	36.0	8.0	0.0	52.5
5/31/2014	64.0	1.0	0.7	0.9	52.0	0.0	0.3	50.0	0.0	44.0	36.0	8.0	0.0	52.5
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6/1/2014	61.0	1.0	0.7	0.9	51.0	0.0	0.3	49.0	0.0	44.0	36.0	8.0	0.0	51.3
6/2/2014	60.0	1.0	0.9	0.9	51.0	0.0	0.3	49.0	0.0	42.0	35.0	7.0	0.0	50.5
6/3/2014	60.0	1.0	1.1	0.9	54.0	0.0	0.3	49.0	0.0	42.0	35.0	7.0	0.0	51.3
6/4/2014	60.0	1.0	0.9	0.9	56.0	0.0	0.3	50.0	0.0	43.0	35.0	8.0	0.0	52.3
6/5/2014	63.0	1.0	0.7	0.8	56.0	0.0	0.2	49.0	0.0	42.0	34.0	8.0	0.0	52.5
6/6/2014	66.0	2.0	0.7	0.8	56.0	0.0	0.2	49.0	0.0	42.0	34.0	8.0	0.0	53.3
6/7/2014	66.0	1.0	0.8	0.8	56.0	0.0	0.2	51.0	0.0	40.0	33.0	7.0	0.0	53.3
6/8/2014	66.0	1.0	0.7	0.9	57.0	0.0	0.4	51.0	0.0	41.0	33.0	8.0	0.0	53.8
6/9/2014	66.0	1.0	0.7	0.9	59.0	0.0	0.2	51.0	0.0	40.0	32.0	8.0	0.0	54.0
6/10/2014	66.0	1.0	0.8	1.0	59.0	0.0	0.1	51.0	0.0	40.0	32.0	8.0	0.0	54.0
6/11/2014	66.0	1.0	0.8	1.1	60.0	0.0	0.2	51.0	0.0	40.0	32.0	8.0	0.0	54.3
6/12/2014	69.0	2.0	0.8	1.1	61.0	0.0	0.1	51.0	0.0	39.0	32.0	7.0	0.0	55.0
6/13/2014	71.0	1.0	0.8	1.1	61.0	0.0	0.0	53.0	0.0	39.0	32.0	7.0	0.0	56.0
6/14/2014	71.0	1.0	0.8	1.0	61.0	0.0	0.0	53.0	0.0	39.0	32.0	7.0	0.0	56.0
6/15/2014	71.0	1.0	0.8	1.0	62.0	0.0	0.0	55.0	0.0	40.0	32.0	8.0	0.0	57.0
6/16/2014	71.0	2.0	0.9	1.0	64.0	0.0	0.0	55.0	0.0	39.0	32.0	7.0	0.0	57.3
6/17/2014	70.0	1.0	0.9	1.0	66.0	0.0	0.0	55.0	0.0	39.0	32.0	7.0	0.0	57.5
6/18/2014	70.0	1.0	1.0	0.9	66.0	0.0	0.1	55.0	0.0	40.0	32.0	8.0	0.0	57.8
6/19/2014	71.0	2.0	0.9	0.9	67.0	0.0	0.1	56.0	0.0	40.0	32.0	8.0	0.0	58.5
6/20/2014	72.0	1.0	1.0	0.9	68.0	0.0	0.1	57.0	0.0	41.0	34.0	7.0	0.0	59.5
6/21/2014	72.0	1.0	1.0	1.0	67.0	0.0	0.2	58.0	0.0	38.0	30.0	8.0	0.0	58.8
6/22/2014	71.0	1.0	0.9	1.0	68.0	0.0	0.1	59.0	0.0	45.0	37.0	7.0	1.0	60.8
6/23/2014	70.0	2.0	0.9	1.1	68.0	0.0	0.1	59.0	0.0	37.0	27.0	8.0	2.0	58.5
6/24/2014	70.0	1.0	0.8	1.1	62.0	0.0	0.0	55.0	0.0	43.0	36.0	7.0	0.0	57.5
6/25/2014	73.0	1.0	0.7	1.1	62.0	0.0	0.0	56.0	0.0	45.0	38.0	7.0	0.0	59.0
6/26/2014	73.0	1.0	0.7	1.0	60.0	0.0	0.0	57.0	0.0	42.0	34.0	8.0	0.0	58.0
6/27/2014	77.0	2.0	0.7	1.0	59.0	0.0	0.0	56.0	0.0	42.0	34.0	8.0	0.0	58.5
6/28/2014	79.0	1.0	0.7	1.0	60.0	0.0	0.1	56.0	0.0	43.0	35.0	8.0	0.0	59.5
6/29/2014	78.0	1.0	0.8	1.0	61.0	0.0	0.0	56.0	0.0	43.0	35.0	8.0	0.0	59.5
6/30/2014	78.0	1.0	0.9	1.0	62.0	0.0	0.0	54.0	0.0	43.0	35.0	8.0	0.0	59.3
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7/1/2014	78.0	1.0	0.9	0.9	63.0	0.0	0.0	55.0	0.0	43.0	35.0	8.0	0.0	59.8
7/2/2014	78.0	2.0	0.9	1.0	64.0	0.0	0.0	54.0	0.0	43.0	35.0	8.0	0.0	59.8
7/3/2014	78.0	1.0	1.0	1.0	65.0	0.0	0.0	54.0	0.0	42.0	34.0	8.0	0.0	59.8
7/4/2014	78.0	1.0	1.0	1.0	66.0	0.0	0.0	55.0	0.0	42.0	34.0	8.0	0.0	60.3
7/5/2014	78.0	1.0	1.0	1.1	65.0	0.0	0.0	56.0	0.0	42.0	34.0	8.0	0.0	60.3
7/6/2014	79.0	1.0	1.0	1.1	66.0	0.0	0.0	59.0	0.0	41.0	33.0	8.0	0.0	61.3
7/7/2014	80.0	2.0	1.1	1.1	66.0	0.0	0.0	61.0	0.0	41.0	33.0	8.0	0.0	62.0
7/8/2014	81.0	1.0	1.2	1.0	66.0	0.0	0.0	62.0	0.0	42.0	34.0	8.0	0.0	62.8
7/9/2014	83.0	1.0	1.2	1.1	67.0	0.0	0.1	63.0	0.0	44.0	36.0	8.0	0.0	64.3
7/10/2014	83.0	1.0	1.1	1.1	67.0	0.0	0.0	63.0	0.0	46.0	38.0	8.0	0.0	64.8
7/11/2014	82.0	2.0	1.0	1.2	67.0	0.0	0.0	62.0	0.0	47.0	39.0	8.0	0.0	64.5
7/12/2014	83.0	1.0	0.9	1.2	68.0	0.0	0.0	63.0	0.0	46.0	38.0	8.0	0.0	65.0
7/13/2014	84.0	1.0	0.8	1.2	68.0	0.0	0.0	64.0	0.0	47.0	39.0	8.0	0.0	65.8
7/14/2014	84.0	1.0	0.9	1.2	69.0	0.0	0.2	63.0	0.0	46.0	38.0	8.0	0.0	65.5
7/15/2014	83.0	1.0	0.9	1.2	69.0	0.0	0.2	63.0	0.0	46.0	39.0	7.0	0.0	65.3
7/16/2014	83.0	2.0	1.0	1.2	69.0	0.0	0.1	65.0	0.0	48.0	40.0	8.0	0.0	66.3
7/17/2014	83.0	2.0	1.0	1.2	69.0	0.0	0.0	64.0	0.0	48.0	40.0	8.0	0.0	66.0
7/18/2014	83.0	1.0	1.0	1.2	68.0	0.0	0.0	65.0	0.0	48.0	40.0	8.0	0.0	66.0
7/19/2014	83.0	1.0	1.0	1.2	68.0	0.0	0.0	64.0	0.0	49.0	41.0	8.0	0.0	66.0
7/20/2014	83.0	1.0	1.0	1.2	69.0	0.0	0.0	64.0	0.0	47.0	40.0	7.0	0.0	65.8
7/21/2014	83.0	1.0	1.0	1.1	69.0	0.0	0.0	63.0	0.0	48.0	32.0	16.0	0.0	65.8
7/22/2014	84.0	1.0	1.1	1.1	69.0	0.0	0.1	65.0	0.0	45.0	25.0	20.0	0.0	65.8
7/23/2014	83.0	1.0	1.0	1.1	70.0	0.0	0.1	66.0	0.0	50.0	30.0	20.0	0.0	67.3
7/24/2014	83.0	1.0	1.0	1.1	70.0	0.0	0.0	65.0	0.0	46.0	26.0	20.0	0.0	66.0
7/25/2014	83.0	1.0	1.0	1.1	69.0	0.0	1.0	65.0	0.0	48.0	28.0	20.0	0.0	66.3
7/26/2014	83.0	1.0	0.9	1.1	69.0	0.0	4.7	68.0	0.0	47.0	27.0	20.0	0.0	66.8
7/27/2014	83.0	1.0	0.9	1.1	68.0	0.0	4.8	70.0	0.0	47.0	27.0	20.0	0.0	67.0
7/28/2014	85.0	1.0	1.0	1.0	69.0	0.0	5.2	69.0	0.0	45.0	25.0	20.0	0.0	67.0
7/29/2014	85.0	1.0	1.1	1.1	69.0	0.0	11.7	76.0	0.0	48.0	28.0	20.0	0.0	69.5
7/30/2014	85.0	1.0	1.1	1.0	67.0	0.0	9.9	80.0	0.0	49.0	29.0	20.0	0.0	70.3
7/31/2014	85.0	2.0	1.2	1.0	67.0	0.0	3.0	76.0	0.0	52.0	40.0	11.0	1.0	70.0

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8/1/2014	86.0	2.0	1.2	1.0	68.0	0.0	0.9	71.0	0.0	55.0	47.0	8.0	0.0	70.0
8/2/2014	85.0	1.0	1.2	1.0	68.0	0.0	1.0	70.0	0.0	57.0	47.0	8.0	2.0	70.0
8/3/2014	85.0	2.0	1.5	1.1	71.0	0.0	0.9	74.0	0.0	60.0	47.0	8.0	5.0	72.5
8/4/2014	84.0	2.0	1.9	1.2	72.0	0.0	0.2	73.0	0.0	65.0	47.0	8.0	10.0	73.5
8/5/2014	86.0	1.0	1.8	1.2	72.0	0.0	0.1	69.0	0.0	67.0	47.0	8.0	12.0	73.5
8/6/2014	76.0	1.0	1.7	1.3	72.0	0.0	0.1	72.0	0.0	68.0	46.0	8.0	14.0	72.0
8/7/2014	78.0	1.0	1.6	1.3	72.0	0.0	0.1	72.0	0.0	74.0	47.0	8.0	19.0	74.0
8/8/2014	86.0	1.0	1.5	1.3	71.0	0.0	0.0	71.0	0.0	74.0	47.0	8.0	19.0	75.5
8/9/2014	85.0	1.0	1.4	1.3	69.0	0.0	0.0	70.0	0.0	74.0	47.0	8.0	19.0	74.5
8/10/2014	85.0	1.0	1.4	1.3	64.0	0.0	0.0	69.0	0.0	80.0	47.0	8.0	25.0	74.5
8/11/2014	86.0	1.0	1.3	1.3	64.0	0.0	0.1	70.0	0.0	76.0	43.0	8.0	25.0	74.0
8/12/2014	85.0	1.0	1.4	1.4	67.0	0.0	0.1	70.0	0.0	75.0	46.0	8.0	21.0	74.3
8/13/2014	85.0	1.0	1.4	1.4	67.0	0.0	0.0	68.0	0.0	73.0	46.0	8.0	19.0	73.3
8/14/2014	85.0	1.0	1.3	1.4	68.0	0.0	0.0	66.0	0.0	73.0	46.0	8.0	19.0	73.0
8/15/2014	78.0	1.0	1.2	1.4	68.0	0.0	0.1	65.0	0.0	72.0	46.0	8.0	18.0	70.8
8/16/2014	75.0	1.0	1.2	1.4	67.0	0.0	0.0	65.0	0.0	73.0	46.0	8.0	19.0	70.0
8/17/2014	75.0	1.0	1.1	1.4	66.0	0.0	0.0	65.0	0.0	82.0	46.0	8.0	28.0	72.0
8/18/2014	75.0	1.0	1.1	1.4	64.0	0.0	0.0	65.0	0.0	79.0	46.0	8.0	25.0	70.8
8/19/2014	75.0	1.0	1.0	1.4	61.0	0.0	0.1	65.0	0.0	77.0	45.0	8.0	24.0	69.5
8/20/2014	75.0	1.0	1.0	1.4	59.0	0.0	0.0	65.0	0.0	71.0	46.0	8.0	17.0	67.5
8/21/2014	67.0	1.0	1.0	1.4	63.0	0.0	0.0	62.0	0.0	69.0	46.0	8.0	15.0	65.3
8/22/2014	62.0	1.0	1.0	1.4	63.0	0.0	0.0	62.0	0.0	76.0	47.0	8.0	21.0	65.8
8/23/2014	65.0	1.0	1.1	1.4	63.0	0.0	0.1	60.0	0.0	70.0	47.0	8.0	15.0	64.5
8/24/2014	63.0	1.0	1.1	1.3	62.0	0.0	0.1	59.0	0.0	66.0	47.0	8.0	11.0	62.5
8/25/2014	63.0	1.0	1.1	1.2	59.0	0.0	0.0	56.0	0.0	64.0	47.0	7.0	10.0	60.5
8/26/2014	62.0	2.0	1.1	1.2	56.0	0.0	0.1	56.0	0.0	61.0	47.0	7.0	7.0	58.8
8/27/2014	62.0	1.0	1.1	1.1	55.0	0.0	0.0	55.0	0.0	62.0	47.0	8.0	7.0	58.5
8/28/2014	62.0	1.0	1.1	1.1	54.0	0.0	0.0	55.0	0.0	61.0	46.0	8.0	7.0	58.0
8/29/2014	65.0	2.0	1.1	1.1	53.0	0.0	0.0	54.0	0.0	57.0	47.0	8.0	2.0	57.3
8/30/2014	63.0	1.0	1.1	1.3	52.0	0.0	0.0	52.0	0.0	54.0	47.0	7.0	0.0	55.3
8/31/2014	62.0	1.0	1.1	1.3	52.0	0.0	0.0	50.0	0.0	52.0	45.0	7.0	0.0	54.0
Notes:	These measurements are not on the main channel of the Owens River, therefore highlighted columns are not included in average calculations.													

Flow Gaging Station / Date	Below River Intake	Blackrock Ditch Return	Goose Lake Return	Billy Lake Return	Mazourka Canyon Road	Locust Ditch Return	Georges Ditch Return	Reinhackle Springs	Alabama Gates Return	At Pumpback Station	Pump Station	Langeman n Gate to Delta	Weir to Delta	In Channel Average Flow
9/1/2014	65.0	1.0	1.1	1.4	53.0	0.0	0.0	48.0	0.0	52.0	44.0	8.0	0.0	54.5
9/2/2014	63.0	1.0	1.1	1.4	53.0	0.0	0.0	46.0	0.0	50.0	43.0	7.0	0.0	53.0
9/3/2014	65.0	1.0	1.0	1.4	53.0	0.0	0.0	47.0	0.0	49.0	42.0	7.0	0.0	53.5
9/4/2014	63.0	1.0	1.0	1.4	54.0	0.0	0.0	46.0	0.0	45.0	37.0	8.0	0.0	52.0
9/5/2014	62.0	2.0	1.0	1.4	55.0	0.0	0.0	46.0	0.0	49.0	40.0	8.0	1.0	53.0
9/6/2014	62.0	2.0	1.0	1.4	55.0	0.0	0.0	46.0	0.0	45.0	37.0	8.0	0.0	52.0
9/7/2014	62.0	1.0	1.0	1.4	54.0	0.0	0.0	46.0	0.0	43.0	35.0	8.0	0.0	51.3
9/8/2014	63.0	1.0	1.1	1.3	54.0	0.0	0.0	47.0	0.0	43.0	35.0	8.0	0.0	51.8
9/9/2014	64.0	1.0	1.1	1.3	54.0	0.0	0.0	48.0	0.0	43.0	35.0	8.0	0.0	52.3
9/10/2014	62.0	2.0	1.1	1.1	55.0	0.0	0.0	48.0	0.0	43.0	35.0	8.0	0.0	52.0
9/11/2014	65.0	1.0	1.1	1.0	55.0	0.0	0.0	49.0	0.0	43.0	35.0	8.0	0.0	53.0
9/12/2014	64.0	1.0	1.0	1.0	55.0	0.0	0.0	48.0	0.0	42.0	35.0	7.0	0.0	52.3
9/13/2014	62.0	2.0	0.9	1.1	55.0	0.0	0.0	48.0	0.0	44.0	36.0	8.0	0.0	52.3
9/14/2014	63.0	2.0	0.9	1.1	55.0	0.0	0.0	50.0	0.0	40.0	28.0	8.0	4.0	52.0
9/15/2014	63.0	2.0	0.9	1.1	56.0	0.0	0.0	50.0	0.0	47.0	27.0	8.0	12.0	54.0
9/16/2014	63.0	1.0	0.9	1.1	56.0	0.0	0.0	50.0	0.0	43.0	28.0	15.0	0.0	53.0
9/17/2014	63.0	1.0	0.9	1.1	53.0	0.0	0.0	49.0	0.0	43.0	29.0	14.0	0.0	52.0
9/18/2014	63.0	1.0	0.9	1.1	53.0	0.0	0.0	48.0	0.0	43.0	35.0	8.0	0.0	51.8
9/19/2014	63.0	1.0	1.0	1.1	52.0	0.0	0.0	49.0	0.0	42.0	34.0	8.0	0.0	51.5
9/20/2014	63.0	1.0	1.1	1.1	52.0	0.0	0.0	49.0	0.0	42.0	34.0	8.0	0.0	51.5
9/21/2014	63.0	1.0	1.1	1.2	53.0	0.0	0.0	50.0	0.0	41.0	33.0	8.0	0.0	51.8
9/22/2014	65.0	1.0	1.2	1.2	54.0	0.0	0.0	49.0	0.0	43.0	35.0	8.0	0.0	52.8
9/23/2014	62.0	1.0	1.2	1.2	54.0	0.0	0.0	50.0	0.0	45.0	37.0	8.0	0.0	52.8
9/24/2014	60.0	1.0	1.1	1.3	54.0	0.0	0.0	49.0	0.0	46.0	38.0	8.0	0.0	52.3
9/25/2014	59.0	1.0	1.1	1.3	52.0	0.0	0.0	47.0	0.0	47.0	39.0	8.0	0.0	51.3
9/26/2014	56.0	1.0	1.0	1.3	51.0	0.0	0.0	46.0	0.0	44.0	36.0	8.0	0.0	49.3
9/27/2014	54.0	1.0	0.9	1.3	50.0	0.0	0.0	48.0	0.0	43.0	35.0	8.0	0.0	48.8
9/28/2014	53.0	1.0	0.9	1.3	49.0	0.0	0.0	49.0	0.0	41.0	34.0	7.0	0.0	48.0
9/29/2014	53.0	1.0	1.1	1.3	48.0	0.0	0.0	49.0	0.0	42.0	35.0	7.0	0.0	48.0
9/30/2014	52.0	1.0	1.2	1.3	47.0	0.0	0.0	48.0	0.0	44.0	36.0	8.0	0.0	47.8

Notes: These measurements are not on the main channel of the Owens River, therefore highlighted columns are not included in average calculations.

3.0 LOWER OWENS RIVER WATER QUALITY DATA REVIEW

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COUNTY OF INYO
WATER DEPARTMENT

MEMORANDUM REPORT

September 25, 2014

To: MOU Parties

From: Randy Jackson, Senior County Hydrologist

Subject: Lower Owens River Water Quality Data Review

LOWER OWENS RIVER WATER QUALITY DATA REVIEW

Introduction

At the Lower Owens River Project (LORP) Summit, held July 29-31, 2014, a review was requested by the Owens Valley Committee of LORP water quality data. The purpose of this report is to satisfy that request. The data extend back in time for over twenty-five years. Data are available for as late as 2013. The data consists of thousands of measurements of a wide variety of water quality constituents. In order to review the data sources a draft list of sources was circulated to Los Angeles Department of Water and Power (LADWP), California Department of Fish and Wildlife (CDFW), and Ecosystem Sciences (ESI). Requests were made from these three parties for data and to augment a draft list with any known sources not on the draft list. A review of each data source is provided.

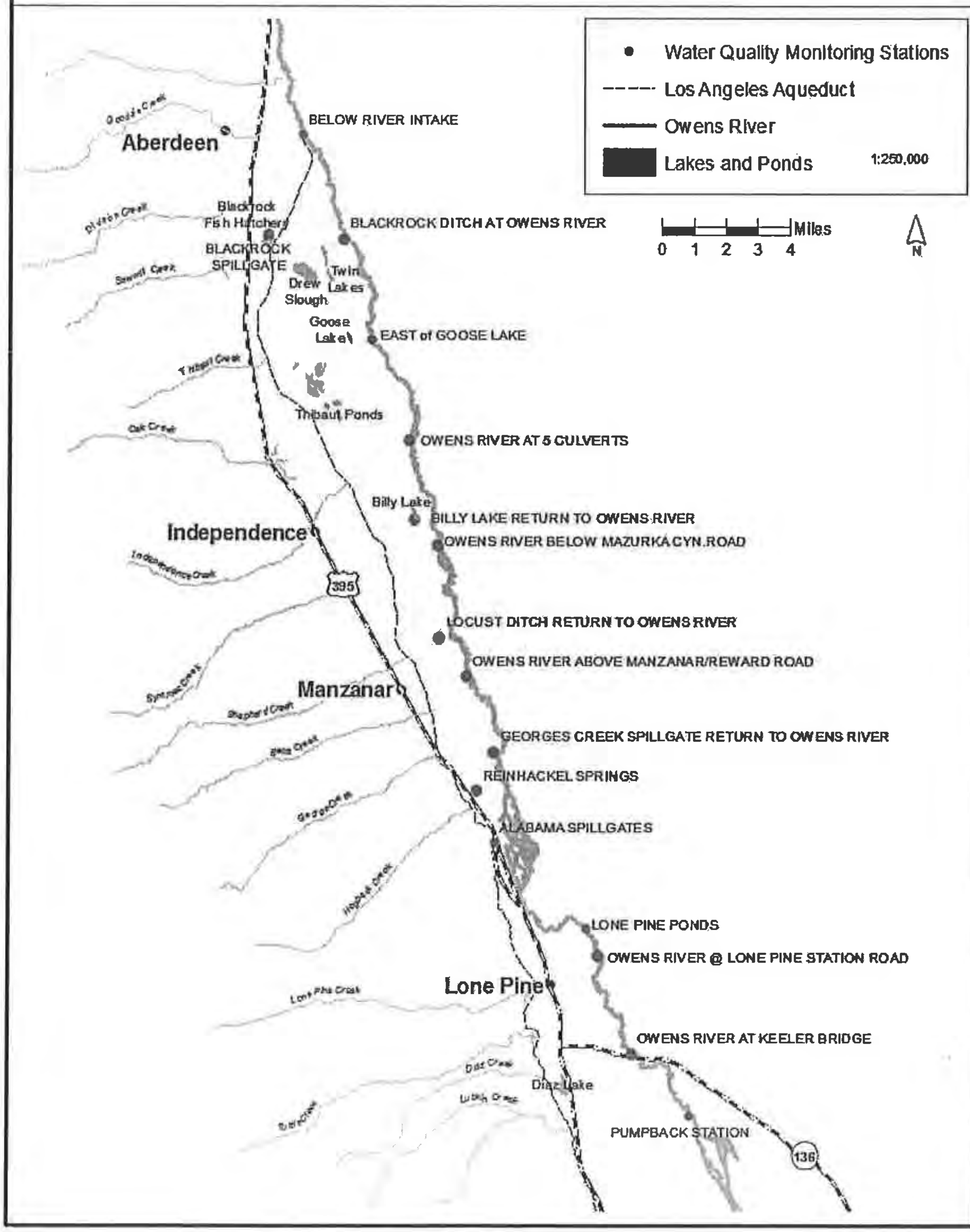
The data are divided into two time classifications relative to LORP project implementation. The classifications are: 1) data collected starting before the LORP project was implemented, including the project EIR, and 2) data collected starting after the LORP project was implemented.

A LORP water quality trends review follows the data list.

A map of the LORP is provided below.

Inyo County Water Department

Water Quality Monitoring Stations



Preproject and EIR Water Quality Data Review

The data source is listed in bold type and numbered, and a summary is provided below the source. A dissolved oxygen (DO) fact sheet is provided as Appendix B.

Prior to 1986 the Lower Owens River flows consisted of groundwater seepage and releases from spillgates on the Los Angeles Aqueduct in high runoff years. From 1927 to 1985 flows at Keeler Bridge varied from average annual flows of about 3 cfs/year to 358 cfs/year. The Lower Owens River Rewatering Project (Lower Owens River E/M Project) was initiated in 1986 by LADWP and Inyo County. In this project, approximately 18,000 acre-feet per year was to be released from Blackrock Spillgate to maintain a continuous flow from the Blackrock area to the Owens River Delta. Releases from Blackrock Spillgate to the river continued from 1986 to 1989. From Runoff Year 1989 until the LORP project was started in 2006, flows were maintained from Independence Spillgate Return (aka Billy Lake Return) just above Mazourka Canyon Road south to the Owens River Delta in response to a drought which started in 1987. From 1986 to 2006 flows at Keeler Bridge averaged approximately 11 cfs/year.

1.) D. Groenoveld and the Inyo County Water Department, 1988, Unpublished BOD for Muck in the LORP.

In December 1988 D. Groenoveld collected 15 muck samples from various locations along the LORP from Mazourka Canyon Road to the Pumpback. BOD (Biochemical Oxygen Demand) values ranged from 1,100 to 21,000 mg/kg. Ignoring the highest and lowest values, the mean BOD value is 6,910 mg/kg.

2.) D. Groenoveld and the Inyo County Water Department, 1988, Unpublished Muck Volume Data.

In 1988 D. Groenoveld and Inyo County staff collected cross section data on the Lower Owens River including organic muck depth. That data provided the basis for an estimate of organic muck in the LORP. The total estimated organic muck from Mazourka Canyon Road to Keeler Bridge was 103,700 cubic yards. The total estimated organic muck from Keeler Bridge to the Pumpback site was 19,400 cubic yards. The total estimated muck for 1988 was 123,100 cubic yards.

3.) Newspaper Reports of Fish Kills (1880-1989) Local Newspapers and other sources (Asked LADWP, ESI, CDFW). No Responses from 1880-1988. Response from CDFW-1989.

CDFW supplied an article from the Inyo Register dated 8/18/89 written by Stephen McFadden. In it is described a fish kill of more than 200,000 fish and amphibians over 20 miles of the Lower Owens River below Alabama Gates due to Los Angeles Aqueduct releases in order to prevent U.S. 395 and the Olancha area from flooding and to clear flash flood debris from the aqueduct near Olancha. Blue Gill, Carp, Bullhead and Large Mouth

Bass were reported to have been killed. An interview with Steve Parmenter, CDFG (California Department of Fish and Game) Biologist, attributes the kill to low dissolved oxygen levels due to disturbance of organic materials in the channel. Concentrations are reported as low as 0.2 mg/l of dissolved oxygen (DO). In the interview Parmenter comments on the buildup of organic materials "It has been a chronic problem because of the lack of a flushing flow" and "If It is not a stable situation, and we expect an annual kill, we would refrain from restocking it". It is not known if CDFG ever restocked the river.

4.) **1989, California Department of Fish and Game. Memorandum Report: Fish Kill Investigation, Lower Owens River. Author: Steve Parmenter. Report and field notes supplied with recollections.**

Mr. Steve Parmenter, the author of the report, supplied field notes and his recollections in an e-mail dated August 12, 2014. He reports that Fish and Game Warden Pat McLernon stated that fish kills occurred in the LORP in 1969 and 1986. One-time spot measurements of DO and temperature were made at Mazourka Canyon Road, in the Los Angeles Aqueduct, Manzanar-Reward Road, Lone Pine Ponds, Lone Pine Station Road, Alabama Gates outfall, east of Lone Pine and Keeler Bridge on 8-12-1989. Low dissolved oxygen levels were reported from below Alabama Gates to Keeler Bridge in the LORP channel (0.15-0.40 ppm). Temperatures were also recorded and ranged from 73.4 to 80.6 °F. The smell of hydrogen sulfide gas was reported east of Lone Pine. Dead carp, frogs and crayfish as well as bullhead, bass and bluegills were reported. The LADWP Daily Aqueduct Report for August 8, 1989 reports flow at Alabama Gates as 603 cubic feet per second (cfs) and this is likely the flow released from Alabama Gates.

5.) **R. Rychert, 1992 Report on bacteria analysis in the Lower Owens River. LADWP, Bishop, CA.**

In October 1992, prior to planned releases to conduct a controlled flow study, muck samples were taken to test for total coliform, fecal coliform, fecal streptococci, salmonella, and toxicity. Results show that all bacteria parameters are well below water quality standards, salmonella is absent, and the sediments are non-toxic.

6.) **LADWP, 1993. Water Quality Division Water Quality Laboratory Data Report. Supplied to ICWD in 1993.**

Water releases were made into the Lower Owens River as part of a study conducted by Inyo County and LADWP with approval of the California Department of Fish and Game in July and August of 1993. A maximum of 155 cfs was released from the Aqueduct Intake into the river channel. The peak flow was maintained for a single day. Flows were ramped up to 110 cfs in four days and to 155 cfs in 11 days. Flows were maintained above 100 cfs for six days after the peak then ramped down to 10 cfs over the next fifteen days. Total length of releases from the Intake was 36 days after which the Intake releases ceased. Supplemental flows were released from Alabama Gates resulting in peak flows of almost 70 cfs at Keeler Bridge. Samples collected along the Lower Owens River on August 5, 1993 were analyzed by LADWP's Water Quality Division Laboratories for various constituents and documented in a 14-page report. Sample locations included the Pumpback Site, Lone Pine Narrow Gauge Road, above Lone Pine Ponds, Above the Island, LAA at Alabama Gates, Reinhackle Spring Station, Manzanar-Reward Road, Mazourka Canyon Road, Five Culverts, Black Rock Ditch Return and at the LORP Intake.

Constituents measured included Total Suspended Solids, Lab Turbidity, Field Turbidity, BOD, TOC, Ammonia, Phosphate, Alkalinity, Specific Conductance, Arsenic, E. Coli, Fecal Coliform, Total Coliform, Field Dissolved Oxygen, Bromodicloromethane, Bromoform, Chloroform, Dibromochloromethane, Total Trihalomethane, Nitrate, Nitrite, HPC count, Hydrogen Sulfide, Field Temperature, Field pH, Field Total Alkalinity, general appearance value, odor value and Field Turbidity. DO was recorded as 0.00 mg/l from Lone Pine Ponds to the Pumpback Site. Above the Island, a value of 0.80 mg/l was recorded. Temperatures recorded varied from 74.6 to 76.8 °F and flows during the LADWP sampling on August 5, 1993 were approximately 36 to 45 cfs from Manzanar-Reward Road to the Pumpback Site.

7). Jackson, R. 1994. Lower Owens River Planning Study: Transient Water Quality in the Lower Owens River during the Planning Study Flow Releases in July and August of 1993. Inyo County Water Department. Bishop, California.

Water releases were made into the Lower Owens River as part of a study conducted by Inyo County and LADWP with approval of the California Department of Fish and Game in July and August of 1993. A maximum of 155 cfs was released from the Aqueduct Intake into the river channel. The peak flow was maintained for a single day. Flows were ramped up to 110 cfs in four days and to 155 cfs in 11 days. Flows were maintained above 100 cfs for six days after the peak then ramped down to 10 cfs over the next fifteen days. Total length of releases from the Intake was 36 days after which the Intake releases ceased. Supplemental flows were released from Alabama Gates resulting in peak flows of almost 70 cfs at Keeler Bridge. Field measurements were taken of DO, Turbidity, pH, electrical conductivity and temperature at the LAA intake, East of Goose Lake, Five Culverts, Mazourka Canyon Road, Manzanar-Reward Road, Reinhackle Spring, Lone Pine Ponds, Lone Pine Narrow Gage Road and Keeler Bridge. Measurements were taken daily from July 6, 1993 to August 23, 1993. A fish kill occurred from Mazourka Canyon Road to the Pumpback site of at least thousands of fish. The kill was most intense from Manzanar-Reward Road to the Pumpback Site. DO concentrations remained below 1 mg/l for multiple days (up to 25 days) below Manzanar-Reward Road. Values as low as 0.2 mg/l were measured for 4 days at Lone Pine Station Road. Peak flows of 91, 81, 70, 72 and 67 cfs occurred at Mazourka Canyon Road, Manzanar-Reward Road, Reinhackle Spring Station, Lone Pine Station Road and Keeler Bridge respectively. Water temperatures varied from 64-80 °F with a mean of about 72 °F from Manzanar-Reward Road to Keeler Bridge.

Organic anaerobic muck (sediment) deposits on the LORP bed containing hydrogen sulfide and ammonia probably have a surface aerobic layer which was probably scoured by the flow study discharges which created a high benthic oxygen demand depleting dissolved oxygen in the water and releasing hydrogen sulfide and ammonia. Low DO caused a fish kill extending from Mazourka Canyon Road to the Pumpback location. At relatively low discharge rates, below approximately 30 cfs, this scouring apparently did not occur.

8). Jackson, R., 1996, Lower Owens River Planning Study: Water Quality in the Lower Owens River Enhancenment\ Mitigation Project, May 1995 through June 1996. Inyo County Water Department. Bishop California.

LORP elementary baseline water quality data were documented in the LORP Enhancement/Mitigation Project in 1995 and 1996 calendar years. During this time, flow was maintained from Mazourka Canyon Road to the proposed Pumback Site and flows at Keeler Bridge varied from 5 to about 30 cfs. Field measurements were taken of DO, Turbidity, pH, electrical conductivity (EC) and temperature at the Mazourka Canyon Road, Reinhackle Spring, Lone Pine Ponds, Lone Pine Narrow Gage Road, Keeler Bridge and the Proposed Pumpback Station. Measurements were made weekly or biweekly from May 1995 through June 1996. Temperatures over the year varied from 34°F to 74°F. All locations below Reinhackle Spring experienced DO concentrations of near or below 2 mg/l for varying durations. The lowest DO measured was 0.48 mg/l at Lone Pine Station Road. Table 1 contains a summary of DO measured. The saturation concentration of DO in freshwater is dependent on temperature, pressure and salinity. Higher temperatures result in lower DO's, lower atmospheric pressure reduces DO and higher salinity reduces DO. Winter time water temperatures result in higher concentrations of DO.

Table 1 Maximum, Minimum and Mean of DO (mg/l) Measured at Stations Along the Lower Owens River.

LOCATION	MAXIMUM	MINIMUM	MEAN
MAZOURKA CANYON RD	10.2	4.5	7.27
REINHACKLE SPRING	8.5	2.5	5.48
LONE PINE PONDS	6.2	1.2	3.93
LONE PINE STATION ROAD	6.2	0.48	3.61
KEELER BRIDGE	7.2	1.61	4.39
PUMPBACK STATION	7.5	1.53	5.07

9.) Jackson, R., 1997. Lower Owens River Planning Study: Water Quality in Selected Off-River Lakes and One On-River Pond in the Lower Owens River Enhancement/Mitigation Project, July 1996 through June 1997. Inyo County Water Department. Bishop, California.

DO, Turbidity, EC, temperature and pH were measured at Lone Pine Ponds which is an on-river pond. The approximate depth of sampling was 4 feet. Sampling was done as soundings, taking DO and temperature at 1-foot intervals. EC, pH and Turbidity were taken at the 1 foot depth and at the 3 foot depth once a Kemmerer Sampler was available. Measurements were made monthly or bimonthly from July 1996 to June 1997. Lone Pine Ponds were found to have low DO concentrations in summer. DO remained at or below the 1 mg/l concentration for several months with a minimum DO at the surface of 0.68 mg/l. Surface temperatures of Lone Pine Pond varied from 43°F to 73°F over the year.

10.) Jackson, R. , 1999. Comprehensive Water Quality Sampling (Jackson, 1999, unpublished data).

In March and August of 1999, Inyo County personnel sampled the LORP for 123 constituents and water quality parameters, including various compounds, physical properties and organic compounds. Samples were collected from eight locations along the Owens River. Elevated levels of the following parameters were observed: manganese, chloride, fluoride, and orthophosphates. The results did not indicate water quality problems related to coliform bacteria, pesticides, ammonia, total nitrogen, sulfates, and various organic compounds. No exceedances of quantitative Basin Plan water quality objectives were found, with the exception of DO.

11.) Jackson, R., 1999. Unpublished Muck Data

In December 1999 Inyo County collected several organic sediment samples for laboratory analysis. Each sediment sample was analyzed for total organic carbon (TOC), sulfides, ammonia, arsenic, lead, silver, zinc, mercury, tannins and lignins, volatile dissolved solids, dissolved methane, and total suspended solids. The channel sediments can be classified as silty clay to silty loam.

TOC values ranged from 550 mg/kg at Mazourka Canyon Road to 7,660 mg/kg at Keeler Bridge. Sulfides ranged from 27 mg/kg at Mazourka Canyon road to 119 mg/kg at the Pumpback station site. Concentrations of ammonia ranged from 2 mg/kg at Mazourka Canyon Road to 38 mg/kg at Lone Pine Ponds. Lead, silver and mercury were not detected in sediment samples. Zinc was detected at low concentrations. Tannins and lignins were detected in all samples ranging from 3.2 ug/g at Mazourka Canyon Road to 29 ug/g at Lone Pine Station Road. Volatile dissolved solids (VDS) were detected in each sediment sample from 1.5 percent at Mazourka Canyon Road to 30.2 percent at Lone Pine Ponds. Arsenic was detected in all the sediment samples with a maximum concentration of 6.8 mg/kg. Dissolved methane was detected in all sediment samples ranging from 76 ug/kg at Manzanar-Reward Road to 18,000 ug/kg at Lone Pine Ponds.

12.) LADWP, 2001, unpublished Water Quality Data.

LADWP released water from the Alabama Spillgates from August 15 to 27, 2001 while the Aqueduct was being cleaned. A flow of 24 cfs was estimated to have been maintained for several days. Water quality measurements were taken at the Alabama Spillgates, Lone Pine Ponds, Lone Pine Station Road, Keeler Bridge and below Keeler Bridge and included temperature, DO, EC, Turbidity and pH. The increased flows in the LORP apparently did not affect DO levels or the other measured parameters. DO levels were 1 to 4 mg/l with most measurements less than 2 mg/l along the river from Lone Pine Ponds to below Keeler Bridge.

13.) Jackson, R., 2001. Water quality monitoring conducted during beaver dam removal on the Lower Owens River Enhancement/Mitigation Project on August 1st and 2nd, 2001, Memorandum to LADWP. Inyo County Water Department. Bishop, California.

DO, Turbidity, EC, temperature and pH were measured at sites immediately above and below beaver dams before and after removal by a helicopter operated clamshell on August 1-2, 2001. Some transient short term changes of Turbidity and DO concentration of no significance were noted at one location. Overall beaver dam removal operations conducted over two days had no significant effect on water quality in the Lower Owens River. The lowest DO measured during the removal was at Lone Pine Station Road where a value of 1.4 mg/l was taken at a 71.6 °F water temperature.

14.) Ecosystem Sciences, Technical Memorandum #7. No date. Water Quality in the Lower Owens River: Existing and Future Conditions

The data from Jackson, 1996 number (8) above are presented. A water quality model, QUAL2E was used to predict future conditions at 40 cfs. The model predicted DO of 2.5-6.1 mg/l and temperatures of 71-80°F from the intake to 55 miles down the channel (62 mile total length). The model prediction, in general was for improvement in DO over the reaches modeled.

15.) LADWP, 2004, Final Environmental Impact Report and Environmental Impact Statement Lower Owens River Project.

The Final EIR for the LORP lists as a Class 1 Impact (Class 1 Impacts are significant and unavoidable) water quality in the LORP project. The EIR states "Based on the available data and analytic tools, it appears that the proposed 40-cfs baseflow and seasonal habitat flows could degrade water quality and adversely affect fish due to the depletion of oxygen and the possible increase in hydrogen sulfide and ammonia. These impacts are only expected to occur along the wetted reach of the river where organic sediment deposits are present, affecting about 37 channel miles of the 62-mile length of the river. It is anticipated that water quality conditions will improve under the 40-cfs baseflow over time, but may be subject to periodic disturbance by seasonal habitat flows of up to 200 cfs. The time required to stabilize water quality under the baseflow and seasonal habitat flows is unknown."

Water Quality in the LORP is covered in section 4.4 of the EIR. It summarizes many of the sources listed above.

Post Project Implementation-Water Quality Data Review

The data source is listed in bold type and numbered and a summary is provided below the source. When a report has a summary and conclusions section it is labeled and repeated below the report listing.

From 1986 to 2006 flows at Keeler Bridge averaged approximately 11 cfs/year and releases were made from Independence Spillgate southward under the Lower Owens River Rewatering E/M project from 1989 to 2006. Beginning in mid-December 2006 flows were gradually ramped up from 0 cfs to 40 cfs in Late January, 2007 at the LORP Intake. Flows at Keeler Bridge and the Pumpback Site reached 40 cfs or greater by February 20, 2007.

16.) Jackson, R., 2008, Lower Owens River Project EIR Water Quality Monitoring Data. Collected During Base Flow Establishment (2006-2008)-and the First Habitat Flow in 2008.

The ramp up to baseflows of approximately 40 cfs took place in January and February of 2007 when water temperatures varied from near freezing to about 45 °F. The first habitat flow was released in February, 2008. Peak habitat flow intake releases occurred on February 21, 2008 of 210 cfs daily average flow. LORP water temperatures were about 45°F.

A monitoring plan to fulfill the final LORP EIR requirements was completed in early 2006 (Jackson, 2006). A copy of the plan is attached as Appendix A to this memorandum report. It was compiled to determine if fish refuge creation was warranted at spillgate return locations and provide background data for management decisions during the establishing of the 40 cfs base flows and for three habitat flow releases. Spot measurements were made at Mazourka Canyon Road, Georges Spillgate Return, Manzanar-Reward Road, Reinhackle Springs and Keeler Bridge. Continuous recorders were located at Manzanar-Reward Road and Keeler Bridge and set to make measurements at two-hour intervals. Parameters measured included DO, pH, Temperature, EC, Turbidity by spot measurement and continuously and ammonia, hydrogen sulfide and tannins and lignins as spot measurements with test kits. Prior to flow release, background data at 3 days per week was to be taken. Then 1-5 days per week depending on conditions until the 40 cfs baseflow was established throughout the river and 1-5 days per week for six months thereafter. During habitat flows the same measurements were to be made for two weeks and up to two weeks after the habitat flows for the first three habitat flows at a frequency of 1-5 days per week depending on conditions.

Water quality and fish conditions thresholds were documented in the monitoring plan. They included 1.5 mg/l DO and a downward trend in the data (later changed to 1.0 mg/l and a downward trend), 0.030 mg/l hydrogen sulfide and the acute criterion (one-hour average concentration) for Non-Salmonoids for ammonia. Fish stress behavior was an additional threshold. These thresholds were the point at which fish refuge creation by releases from spillgates was thought to be warranted.

SUMMARY AND CONCLUSIONS-BASE FLOWS

Three of the monitoring stations (Manzanar-Reward Road, Reinhackle Spring Station and Keeler Bridge) experienced dissolved oxygen levels below the 1.0 mg/l concentration during warm weather periods after the 40 cfs baseflows had been established. Other water quality parameters measured were not a problem. Fish stress was not observed at any of these stations at any time. It is likely that after habitat flow release during warm weather periods, similar concentrations of DO will be experienced.

MAZOURKA CANYON ROAD-HABITAT FLOWS

Water quality data were collected manually at Mazourka Canyon Road during habitat flow releases. No water quality thresholds were exceeded during habitat flows at this location. No fish stress was observed during habitat flows at this location. Slightly elevated levels of tannins and lignins, Turbidity and electrical conductivity were noticed as habitat flows passed this water quality station. Maximum average daily flow was 174 cfs during habitat flow releases on 2-23-08.

MANZANAR-REWARD ROAD-HABITAT FLOWS

Water quality data were collected manually and by continuous recorder at Manzanar-Reward Road during habitat flow releases. The continuous recorder was set to read every two hours. Water quality thresholds were not exceeded at any time during habitat flows at this location. No fish stress was observed at any time during habitat flows at this location. Slightly elevated levels of tannins and lignins, Turbidity and electrical conductivity were noticed as habitat flows passed this water quality station. Slightly decreased levels of pH were noticed. A moderate drop in DO (a drop of approximately 2.5 mg/l) was also measured as habitat flows passed this water quality station. Maximum average daily flow was 164 cfs during habitat flow releases on 2-24-08.

REINHACKLE SPRING STATION-HABITAT FLOWS

Water quality data were collected manually at the Reinhackle Spring Station along the Lower Owens River during habitat flow releases. Water quality thresholds were not exceeded at any time during habitat flows at this location. No fish stress was observed at any time during habitat flows. Slightly elevated levels of tannins and lignins, Turbidity and EC were measured as habitat flows passed this water quality station, as well as slightly decreased levels of pH. A moderate drop in DO (a drop of approximately 4 mg/l) was also measured as habitat flows passed this water quality station. Maximum average daily flow was 171 cfs during habitat flow releases on 2-25-08.

KEELER BRIDGE-HABITAT FLOWS

Water quality data were collected manually and by continuous recorder at Keeler Bridge during habitat flow releases. The continuous recorder was set to read every two hours. Water quality thresholds were not exceeded at any time during habitat flows. No fish stress was observed at any time during habitat flows. Slightly elevated levels of EC, Turbidity and tannins and lignins were noticed as habitat flows passed this water quality station. A very slight decrease in pH was noticed. A considerable drop in DO (a drop of approximately 6 mg/l) was also noticed as habitat flows passed this water quality station. Maximum average daily flow was 223 cfs during habitat flow releases on 2-29-08.

SUMMARY AND CONCLUSIONS-HABITAT FLOWS

Three of the monitoring stations (Manzanar-Reward Road, Reinhackle Spring Station and Keeler Bridge) experienced drops in DO levels as the habitat flows passed these stations. Some of the stations experienced slight elevations of other water quality parameters as well as some slight declines in others. Fish stress was not observed at any of the four water quality stations at any time during habitat flows. Release of the first habitat flows during cold weather, when ambient dissolved oxygen concentrations in the water were high and water temperatures were low, prevented DO levels from dropping to levels of concern. Based on what was observed during the first habitat flow release, it was recognized that when habitat flows are released later in the year, that dissolved oxygen levels could decline to levels of concern (at or below 1.0 mg/l).

17.) 2008, Ecosystem Sciences, Water Quality Data taken by Ecosystem Sciences in LORP 2008 Annual Report.

A water quality data report from Ecosystem Sciences (ESI) is included in the 2008 LORP Annual Report. Manual water quality data was measured from the LAA Intake to the Pumpback Station at twelve locations during the first habitat flow release in February of 2008. These data are not the same data as discussed in (16) above, but are an independent data set. Water quality parameters recorded included odor, color, visibility, dissolved oxygen, temperature, conductivity and salinity. Sites were sampled once a day eight to eleven times during the seasonal habitat flow. The purpose of the ESI water quality monitoring was to keep project managers informed of current conditions. The lowest DO concentration was 2.82 mg/l at Keeler Bridge on March 1, 2008 when the flow was recorded at 218 cfs.

18.) Jackson, R., 2009, Lower Owens River Project Water Quality Monitoring Data Collected during the Spring 2009 habitat Flow.

Habitat flows of 104 cfs were released from the Intake on May 27, 2009. LORP water temperatures were about 67°F. Water quality data was collected according to the 2006 plan described in (16), above.

SUMMARY AND CONCLUSIONS-HABITAT FLOWS

Three of the monitoring stations (Manzanar-Reward Road, Reinhackle Spring Station and Keeler Bridge) experienced slight drops in DO levels as the habitat flows passed these stations. Some of the stations experienced slight elevations of other water quality parameters. None of the water quality thresholds were reached. Fish stress was not observed at any of the four water quality stations at any time during habitat flows. It is possible, based on what was observed during the 2009 spring habitat flow release, that when larger habitat flows are released in warmer weather with higher ambient water temperatures after the April Owens Valley runoff forecast becomes available, that dissolved oxygen levels could decline to levels of concern (at or below 1.0 mg/l) as the peak of habitat flows pass the lower three monitoring stations (Manzanar-Reward Road, Reinhackle Station and Keeler Bridge) in the Lower Owens River.

19.) Jackson, R., 2010, Lower Owens River Project EIR Water Quality Monitoring Data Collected During the Summer 2010 Habitat Flow.

Habitat flows of 192 cfs were released from the Intake June 30, 2010. LORP water temperatures were about 70-75°F. Water quality data was collected according to the 2006 plan described in (16), above.

SUMMARY AND CONCLUSIONS

All four of the primary monitoring stations (Mazourka Canyon Road, Manzanar-Reward Road, Reinhackle Spring Station and Keeler Bridge) experienced substantial drops in DO levels as the habitat flows passed these stations in summer of 2010. Changes in other water quality parameters were also experienced. Water quality thresholds were reached at Manzanar-Reward Road and Reinhackle Springs. Fish stress was observed at Manzanar-Reward Road, Georges Spillgate Return Pond (where hydrogen sulfide was detected for two days) and Reinhackle Springs. Fish kills were reported from below Manzanar-Reward Road and at Reinhackle Springs. From the observed fish kill it was estimated that the kill magnitude was minor and about several hundred fish.

In 2008 habitat flows were released in February 2008 and continued downriver into early March, 2008. Both ambient air and water temperatures were colder in 2008 than in May and June of 2009 when the 2009 habitat flows were released. June and July 2010 habitat flows were released during the warmest water temperatures yet experienced during habitat flow releases. Daily average peak flows at the intake were 210, 104 cfs, and 192 cfs in the habitat flows of 2008, 2009 and 2010 respectively. Approximate ambient water temperature and dissolved oxygen levels as well as peak flows at water quality stations are shown for habitat flows in 2008, 2009 and 2010 in Table 2. Dissolved Oxygen level declines experienced are also shown in Table 2.

Table 2 - Habitat Flow Dissolved Oxygen Comparison 2008, 2009 and 2010.

Location	2008 Q_p cfs	2009 Q_p cfs	2010 Q_p cfs	2008 T_A F	2009 T_A F	2010 T_A F	2008 Ambient DO mg/l	2009 Ambient DO mg/l	2010 Ambient DO mg/l	2008 Delta DO mg/l	2009 Delta DO mg/l	2010 Delta DO mg/l
Manzanar-Reward	164	84	120 (e)	48	67	72	9.0	4.2	3.8	2.5	1.5	3.3
Reinhackle Spring	171	89	116	48	64	72	9.0	4.0	2.8	4.0	1.5	2.6
Keeler Bridge	223	65	75	48	66	72	8.0	5.0	4.7	6.0	1.0	3.6

Q_p-peak flow in cfs, T_A F- Ambient water temperature in F (water temperature before and during peak flows), Ambient DO – the measured DO in mg/l before the habitat flow reached the location. Delta DO – Decrease in DO in mg/l when the peak flow passed the location from the ambient DO. (e)-estimate

Based on water quality data acquired in 2008, 2009 and 2010 three options for the continuation of release of habitat flows are suggested. Option 1: Continue releases as scheduled and planned and accept the water quality and fish effects experienced (2010 habitat flow water quality data). If there are significant changes in tule distribution that allow higher peak flows to reach Mazourka Canyon Road and southward, water quality and fish effects may be considerably worsened compared to the 2010 experience. Option 2: Release habitat flows during colder weather to minimize water quality degradation. (2008 habitat flow water quality data) Option 3: Release lower peak flows to minimize water quality degradation (2009 habitat flow water quality data).

Water Quality Monitoring has been completed for first three habitat flow releases and the EIR requirement for water quality monitoring during habitat flows has been completed.

20.) LADWP, 2006-2013, Water Quality Data collected in response to Lahontan requirements (Unpublished Data).

Contains water quality data which includes various elements, mineral compounds, nutrients, physical properties, dissolved oxygen, temperature, pH, TDS, TSS, Turbidity and organic compounds. Samples were collected from the LAA, Mazourka Canyon Road, Lone Pine Station Road, Keeler Bridge and the Pumback station from 2006 to 2013 on various schedules to comply with Lahontan requirements. Lowest dissolved oxygen at Lone Pine Station Road was measured on 7-10-07 at 1.41 mg/l, 76.1 °F, 44 cfs. Additional data was collected upstream and downstream from the Intake, Keeler Bridge and Pumpback Station construction sites in 2006 in response to Lahontan requirements before project flows were established. The parameters measured included DO, pH, EC, Turbidity and temperature.

21.) Jackson, R., 2012, Lower Owens River Project Water Quality Monitoring Data Collected During the Spring 2012 Habitat Flow.

Habitat flows of 89 cfs were released from the Intake June 1, 2012. LORP water temperatures were about 64-72°F. DO and temperature were the measurements taken at Mazourka Canyon Road, Manzanar-Reward Road and Reinhackle Spring Station.

SUMMARY AND CONCLUSIONS

All three of the primary monitoring stations (Mazourka Canyon Road DO drop of 2 mg/l, Manzanar-Reward Road DO drop of 1 mg/l, Reinhackle Spring Station DO drop of 0.4 mg/l) experienced slight and insignificant drops in DO levels as the habitat flows passed these stations in Spring of 2012 No fish stress was observed at any location. This lack of fish stress is attributable to the relatively low water temperatures and low maximum flows that occurred in 2012.

Based on water quality data acquired in 2012, release of habitat flows during these flow and temperature conditions successfully minimizes water quality degradation at the peak flows released in 2012 from the intake.

22.) Jackson, R. , 2013, Lower Owens River Project Water Quality Monitoring Data Collected During the Spring 2013 Flow Releases from Alabama Gates-with additional data collected from above and below Alabama Gates Following a Flow Release From the Aqueduct in Late July 2013.

Releases occurred from Alabama Gates during two periods. The first was planned as part of the LORP seasonal habitat flow, and was an unplanned release due to a need to dispose of storm runoff during aqueduct repairs. On May 29, 2013 a 30 cfs flow was released from Alabama Gates when water temperatures in the LORP were 61 to 68°F. This release resulted in a 56 cfs flow at the Pumpback. DO and temperature were the measurements taken at Lone Pine Ponds, Lone Pine Station Road, and Keeler Bridge.

In 2013, a release was made from the Alabama Gates for Los Angeles Aqueduct maintenance purposes. This release occurred in late July and moved down the LORP to the Pumpback in early August, 2013. An estimated 111 cfs was released from Alabama Gates on July 23, 2014 and approximately 93 cfs reached the Pumpback Station on July 29, 2014. Water temperatures were measured ranging from 68.4°F to 74.7°F from Alabama Gates to the Pumpback. DO and temperature were the measurements taken at Reinhackle Spring, Lone Pine Ponds, Lone Pine Station Road, Keeler Bridge and at the Pumpback Station.

SUMMARY AND CONCLUSIONS

Two of the primary monitoring stations (Lone Pine Ponds and Lone Pine Station Road) experienced declines in dissolved oxygen levels as the flows released from Alabama Gates passed these stations in Spring of 2013. No fish stress was observed at any location. This lack of fish stress is attributable to the relatively low water temperatures and low maximum flows that occurred during the planned spring flows. Biochemical oxygen demand of the water which drained from the wet area below the Alabama Gates, following release from Alabama Gates is thought to be the reason for the oxygen decline.

Based on water quality data acquired in 2013, release of habitat flows during colder weather successfully minimizes water quality degradation at the peak flows released in 2013 from the Alabama Gates for the short duration of release.

SUMMARY-FLOW RELEASE FROM ALABAMA GATES

Manual water quality monitoring was conducted in response to a flow release from Alabama Gates in late July 2013. Monitoring was conducted for three days at five sites along the Lower Owens River. Among these five sites was a site located at Reinhackle Springs above the Alabama Gates.

The stations monitored below Alabama Gates show a trend of recovering dissolved oxygen concentrations and slightly lowering temperature. Dissolved oxygen concentrations increased above those at Reinhackle Spring Station for all stations by August 1, 2013. At the Pumpback Station, DO increased from 0.47 mg/l to 2.04 mg/l from 7/30/2013 to 8//1/2013. During this same period DO increased from 0.45 to 1.68

mg/l, 0.78 to 2.35mg/l, and 0.9 to 2.82 mg/l at Lone Pine Ponds, Lone Pine Station Road and Keeler Bridge respectively.

The results of a fish kill were observed at the Pumpback Station where several hundred dead fish were observed. Fish stress was observed for two of the three days of monitoring at this location. By August 1, 2013 no fish stress was observed.

23.) LADWP, 2013, Unpublished Water Quality Data related to a fish kill at the Pumpback station.

Water quality data consisting of temperature, DO and Turbidity were collected in response to the releases from Alabama Gates described in (22). DO concentrations varied from 0.15 mg/l -0.25 mg/l from below Alabama Gates to Lone Pine Station Road for two days on July 24, 2013 and July 25, 2013. Keeler Bridge remained above 1.57 mg/l. Minimum DO concentrations were experienced at Lone Pine Station Road and Lone Pine Ponds. Temperatures varied from 72.5 to 75.3°F.

24.) CDFW, 2013, California Department of Fish and Wildlife Unpublished Water Quality Data related to a fish kill at the Pumpback Station.

Water quality data consisting of temperature, DO, EC, alkalinity and pH were taken at Manzanar-Reward Road, Alabama Gates Spillway, Lone Pine Narrow Gage Road, Keeler Bridge and the Pumback Station on July 31, 2013. A measurement of the same parameters was taken at Keeler Bridge only on July 30, 2013. D O concentrations of 0.5 mg/l -4.6 mg/l were measured from Manzanar-Reward Road to the Pumback station. The Pumpback station DO concentration was 0.5 mg/l. Keeler Bridge remained at or above 1.0 mg/l. Temperatures varied from 71-77 °F.

25.) Lone Pine Tribe (Matt Hayes) and Larry Freilich, 2013, Unpublished Water Quality Data related to a fish kill at the Pumpback Station.

Water quality data consisting of DO, temperature, Turbidity, pH and EC were taken from various places including Diaz Lake, Lone Pine Ponds, Lone Pine Station Road, near Alabama Gates, Keeler Bridge, the Pumpback Station and the East end of Substation Road. Not all parameters were measured at each of the above stations and the measurements were made at various places from 7/26/2013 to 7/29/2013. DO at the Pumpback was measured as 0.4 mg/l and 0.71mg/l at 11:27 and 13:00 on 7/29/2013. DO at Lone Pine Station Road was measured at 0.35 mg/l on 7/29/2013. Water temperatures varied from about 70-75°F.

Water Quality Trends

In-situ DO concentration is the constituent common to the majority of the data available. DO is necessary to maintain aerobic conditions in surface water and is considered a primary indicator of the suitability of surface water to support aquatic life. Very low DO is the primary cause of fish kills documented in the LORP. A dissolved oxygen fact sheet is provided in Appendix B. Baseflow and Habitat flow

DO trends in the LORP are presented below with supporting data source number (1-25) in parenthesis.

Baseflow

Baseflows vary at each measurement location. At Reinhackle Spring Station Baseflows range between 40-80 cfs with higher flows released in spring and summer to maintain 40 cfs at the Pumpback. Generally the baseflow DO trend in the LORP has been upward from pre-project conditions to project implementation. Prior to project implementation in 1993, flows as low as approximately 30 cfs caused DO declines and relatively large fish kills over a considerable distance in the LORP from Mazourka Canyon Road to the Pumpback (6) (7). In 1993, DO as low as 0.0 mg/l was measured. DO at Lone Pine Station Road was measured as low as 0.48 mg/l prior to project implementation under normal flow conditions in 1995-96 in the Lower Owens River Enhancement/Mitigation Project (5-30 cfs)(8).

During baseflow implementation in 2007, DO dropped to minimum concentrations below 1 mg/l in the first warm weather in spring and summer for a relatively short duration, although no fish stress was observed (16) (20). DO declines were expected as documented in the EIR. In the post-implementation time period (2007-2013), baseflow DO conditions have improved from the initial very short term drop in spring-summer 2007 and been relatively stable based on the DO and temperature data (16) (20). DO levels, which dipped to lows initially in 2007 warm weather, are typically above 1 mg/l at Lone Pine Station Road and all other locations even with warm summer time water temperatures in the period 2007-2013. Since project baseflows have been implemented and maintained, there has not been a fish kill at baseflow discharges. The fishery has been reported in good condition in 2013.

Habitat Flows

Generally, the DO trend during seasonal habitat flows has been upward from pre-project conditions to project implementation. The July and August 1993 flows experienced at Keeler Bridge were approximately 67 cfs maximum when water temperatures were 66-80°F. Peak flows experienced at Mazourka Canyon Road, Manzanar-Reward Road, Reinhackle Spring Station and Lone Pine Station Road were 91 cfs, 81 cfs, 70 cfs, and 67 cfs respectively. An extensive fish kill from Mazourka Canyon Road to the Pumpback location was experienced with DO measurements as low as 0.0 mg/l and fish mortality in the thousands. DO was below 1 mg/l for as long as 25 days in some locations (6)(7).

Only two relatively high flows since project implementation have caused low enough DO to result in minor fish kills. These occurred in 2010 during the seasonal habitat flow (and after two habitat flow releases during the preceding years) and 2013 following an emergency release from Alabama Gates (after 5 annual habitat flow releases. Both the 2010 and 2013 fish kills were caused by relatively high water temperatures (in the mid 70's °F) and peak flows above 90 cfs at the location of kills. The 2013 releases from Alabama Gates likely flushed high biochemical oxygen demand water from the wet area below the Alabama Gates and above the river.

In 2010, habitat flows were released from the intake (maximum daily flow of 192 cfs) in June and continuing down the LORP in July during relatively warm water temperatures of 74-76°F. Maximum daily flows were 125, 116, 116, 75 and 78 cfs at Mazourka Canyon Road, Manzanar -Reward Road, Reinhackle Spring Station, Keeler Bridge and the Pumpback, respectively. Fish kills were reported from below Manzanar-Reward Road and at Reinhackle Springs Station. DO was measured below 1 mg/l for up to six days at Manzanar-Reward Road and 11 days at Reinhackle Spring Station. The lowest DO measured was 0.14 mg/l. The fish kill in 2010 was localized, of less duration, and of less intensity compared to the event in 1993 (19).

In 2013, a release occurred from the Alabama Gates for Los Angeles Aqueduct maintenance purposes. This release occurred in late July and moved down the LORP to the Pumpback in early August, 2013. An estimated 111 cfs was released from Alabama Gates on July 23, 2014 and approximately 93 cfs reached the Pumpback Station on July 29, 2014. Water temperatures were measured ranging from 68.4°F to 74.7°F from Alabama Gates to the Pumpback. A kill of several hundred fish occurred at the Pumpback Station. The lowest DO concentrations varied from 0.15 mg/l to 0.47 mg/l from Alabama Gates to the Pumpback Station. DO was below 1 mg/l at the Pumpback Station for about 2 days. The fish kill in 2013 was localized, of less duration and of less intensity compared to the event in 1993 (22).

Habitat flows and other releases cause declines in DO concentrations from Mazourka Canyon Road to the Pumpback Station. Habitat flow releases in 2008, 2009, 2012 and 2013 did not result in declines of a magnitude to cause fish kills because releases were made during relatively cooler water temperatures or flows were of reduced discharge or a combination of both. When flows are high enough and water temperatures are warm enough, habitat flows can result in fish kills in the LORP due to low DO. This condition was anticipated in the 2004 Final EIR for the LORP.

The Final EIR for the LORP lists as a Class 1 Impact (Class 1 Impacts are significant and unavoidable) water quality in the LORP project. The EIR states "Based on the available data and analytic tools, it appears that the proposed 40-cfs baseflow and seasonal habitat flows could degrade water quality and adversely affect fish due to the depletion of oxygen and the possible increase in hydrogen sulfide and ammonia. These impacts are only expected to occur along the wetted reach of the river where organic sediment deposits are present, affecting about 37 channel miles of the 62-mile length of the river. It is anticipated that water quality conditions will improve under the 40-cfs baseflow over time, but may be subject to periodic disturbance by seasonal habitat flows of up to 200 cfs. The time required stabilizing water quality under the baseflow and seasonal habitat flows is unknown."

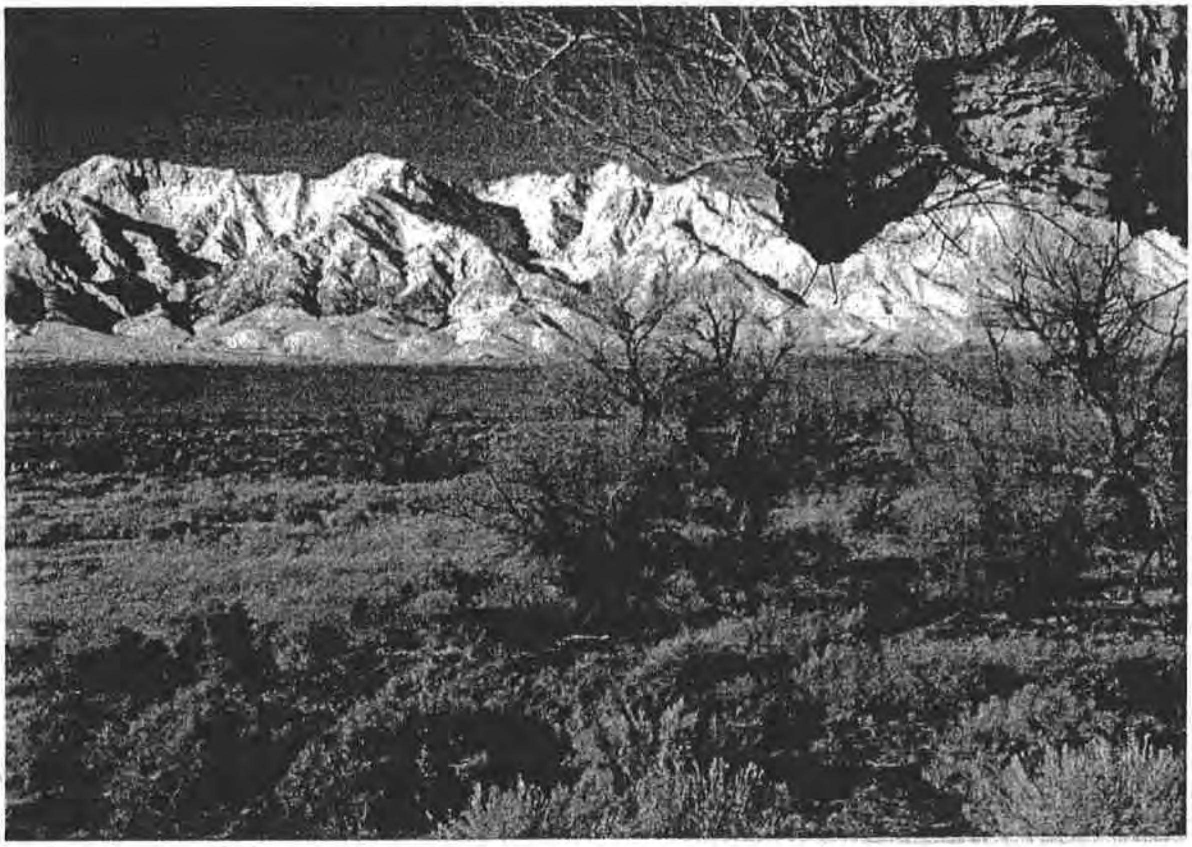
References

Jackson, R., 2006, Lower Owens River Project Water Quality Monitoring Plan to Fulfill the Final EIR Requirements. Inyo County Water Department.

APPENDIX A: LOWER OWENS RIVER PROJECT WATER QUALITY MONITORING PLAN TO FULFILL THE FINAL EIR REQUIREMENTS

DRAFT

LOWER OWENS RIVER PROJECT WATER QUALITY MONITORING PLAN TO FULFILL THE FINAL EIR REQUIREMENTS



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January 9, 2006

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Water Quality Monitoring

INTRODUCTION

The Lower Owens River Final Environmental Impact Report (EIR) (LADWP-Los Angeles Department of Water and Power, 2004) outlines a two-phase rewatering schedule for establishing 40 cubic foot per second (cfs) base-flows in the Lower Owens River Channel. In addition, the EIR describes seasonal habitat flows of up to 200 cfs. The principal water quality concern related to rewatering of the Lower Owens River relates to re-suspension of bottom sediments in the currently wetted reach from Mazourka Canyon Road to the pump station. Anaerobic organic bottom sediments, when mobilized by flows having sufficient velocity, consume dissolved oxygen in the water column and release hydrogen sulfide and ammonia. These water quality conditions can result in fish kills and objectionable odors.

This water quality monitoring plan is designed to collect the data necessary to determine if fish refuge creation is warranted in Phase 1 and 2 of establishing the 40 cfs baseflow. General water quality river conditions will also be monitored for up to 6 months after the 40 cfs baseflow has been established. Additional data will also be collected, to describe general river water quality conditions during the habitat flow release, for up to two weeks duration and for up to two weeks after the seasonal habitat flows are released. The seasonal habitat flow water quality monitoring is scheduled for the first three seasonal habitat flows only.

QUALITY OBJECTIVES AND CRITERIA

Data Quality Objectives

This water quality monitoring program is designed to provide the data necessary to determine if fish refuge creation is warranted in Phase 1 and 2 of establishing the 40 cfs baseflow. Additional data will also be collected to describe general river conditions after establishment of baseflows and during and after habitat flow release. The principal use of the water quality data is for management decisions and input into the adaptive management process. Data of management quality for the uses described is the objective.

Measurement Quality Objectives

Measurement quality objectives (MQOs) are the acceptance thresholds or goals for data collected for the project based on the individual Data Quality Indicators. The MQOs are used to determine whether the quality of data collected are acceptable for use in answering project questions, testing hypothesis, or making decisions. Where defined, the MQOs and the methodologies for ensuring collection of data of the necessary quality for the water quality monitoring task are described in Table 1.

Table 1. Measurement Quality Objectives for Water Quality Monitoring

Data Quality Indicators	MQO / Methodology
Precision – measure of agreement between or among repeated samples Bias – systematic or persistent distortion in a measurement process that causes errors in one direction Accuracy – degree of agreement of a measurement within a known or true value	• Water quality parameters will be measured in duplicate when questionable data is encountered. • Standard sample collection and measurement procedures will be implemented. (Standard Measurement Procedures supplied by kit and equipment manufacturers)
Representativeness – degree to which data reflect a characteristic of an environmental condition	• The Sample Process Design described below includes multiple sample locations along the river.
Comparability – confidence with which one data set can be compared to another	• The same sample locations will be used during each sample year. • Standard sample collection and measurement procedures will be implemented. • Data will be recorded on project-specific field forms. • Data sheets will be reviewed prior to database entry.
Completeness – portion of valid data out of total data	• Equipment maintenance and calibration procedures will be followed. • Standard sample collection and measurement procedures will be implemented.
Measurement Range and Sensitivity – capability of method or instrument to discriminate measurements to a specific degree within a specified range	• The Sample Process Design described below notes applicable ranges and sensitivities for field instruments.

SAMPLING PROCESS DESIGN

The 1993 flow study in the Lower Owens River demonstrated that increased flows above a certain threshold (approximately 30 cfs) mobilized organic sediments in the river channel, which caused water quality degradation and fish kills (Jackson, 1994). The LORP water quality monitoring program is, therefore, designed to provide an early warning of declines in water quality during initiatial flow releases to allow for creation of fish refuges in limited areas around three spillgates via releases of higher quality water from those spillgates. Results from the monitoring will also be used to track the water quality conditions over the long-term. Water quality data will be incorporated into the annual report to be presented to the Technical Group (LADWP, LORP Final EIR, 2004, Page 2-3 and 2-4).

Water quality monitoring will be conducted as shown in Table 2. The locations of the monitoring stations are described in Table 3 and are shown on a map in Appendix A. Two of the stations, Manzanar Reward Road and Keeler Bridge, will be equipped with continuous water-quality monitoring recorders. Water quality parameters to be measured and the measurement range and sensitivity of the instrument or test kit to be used are shown in Table 4. A list of the instruments and test kits is shown in Table 1 in Appendix B.

Table 2. Summary of Water Quality Monitoring Frequency

Phase	Duration	Monitoring Frequency
Prior to, During and After Baseflow Establishment		
1 month prior to Phase 1	1 month	3 days per week
Phase 1	From first flow releases to establishment of low flows (approximately 3 - 17 cfs) throughout the river	1 to 2 days per week (depending on conditions)
Phase 2	After completion of construction of pump station until 40 cfs baseflow is established throughout the river	1 to 5 days per week (depending on conditions)
Post-Phase 2	6 months starting at the end of Phase 2	1 to 5 days per week (depending on conditions) for 6 months after 40-cfs baseflow has been established
Seasonal Habitat Flows (first three releases in excess of 40 cfs)		
During Seasonal Habitat Flows	Up to 14 days	5 days per week
After Seasonal Habitat Flows	Up to 14 days	1 to 5 days per week (as needed) for up to 2 weeks

Table 3. Water Quality Monitoring Stations

Water Quality Monitoring Station	Distance downstream from River Intake (miles)	Linked Spillgate for Releasing Higher Quality Water to Create Fish Refuge	Equipment
Mazourka Canyon Road[1]	24.1	Independence	Spot Measurement
Independence Spillgate return[2]	23.6	Independence	Spot Measurement
Manzanar Reward Road[1]	32.9	Georges	Continuous Recorder
Georges Spillgate return[2]	36.9	Georges	Spot Measurement
Reinhackle Springs[1]	39.2	Alabama	Spot Measurement
Alabama Spillgate return[2]	44.2	Alabama	Spot Measurement
Keeler Bridge[3]	56.4	None	Continuous Recorder

1 Primary monitoring stations for use in initial determination of whether spillgate releases are needed to create fish refuge
2 Secondary monitoring stations to be used in monitoring during spillgate releases to create fish refuge
3 The Keeler Bridge Station is for water quality tracking purposes only, and is not linked to a spillgate; therefore, water quality thresholds for spillgate releases to create fish refuge do not apply to Keeler Bridge.

Table 4. Summary of Water Quality Parameters

Parameter	Minimum Range of Instrument Measurement	Minimum Sensitivity of Instrument Measurement
Electrical Conductivity	0-100 mS/cm	0.001 mS/cm
Dissolved Oxygen	0 – 50 mg/L	0.01 mg/L
pH	0 – 14 pH units	0.01 pH units
Turbidity	0 – 100 NTU	0.1 NTU
Temperature	-5 – 50 degrees C	0.01 degree C
Ammonia	0 – 2.5 mg/L NH_3-N	0.1 mg/L
Hydrogen Sulfide	0 – 5.0 mg/L	0.01 mg/L
Tannins and Lignins	0 – 15 mg/L	0.5 mg/L

If it is determined that a water quality threshold or fish condition identified in Table 5 has been exceeded at a monitoring station, water will be released to the river through the spillgate linked to that monitoring station to create a refuge for fish in the spillgate channel and at the confluence with the river below the spillgate channel. If monitoring indicates that the trend in water quality is deteriorating 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, water quality monitoring for dissolved oxygen, hydrogen sulfide, ammonia, and fish conditions by spot measurements will be conducted in the river below the spillgate channel (Table 3). Monitoring below spillgate channels will be in addition to the water quality monitoring at the four primary monitoring stations. Water quality monitoring below spillgate channels will cease when thresholds are reached and a trend in water quality improvement is noted as explained below.

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.

Table 5. Water Quality and Fish Condition Thresholds

Constituent or Observation	Threshold
Dissolved oxygen	1.5 mg/l and downward trend in data
Hydrogen sulfide	0.030 mg/l
Ammonia	Acute Criterion (one-hour average concentration) for Non-Salmonids (pH dependent)*
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.

Source: LADWP, LORP Final EIR, 2004.
* Reference to criterion maximum concentration described in EPA, 1999-See Appendix D.

SAMPLING METHODS

Water quality measurements include:

- Continuous recording equipment
- Spot measurements taken by portable multi-parameter water quality probe instrument
- Spot measurements taken by individual constituent test kits

Continuous recorders installed in fixed casings will be located as close to mid-stream as practicable. Grab samples for constituent test kits will be taken mid-stream, six inch-depth, and facing upstream using a 500-milliliter beaker. All samples will be analyzed in the field. Spot measurements will be taken by placing the portable probe mid-stream in the channel, approximately 6 inches from the water surface, with the probe facing upstream. Field measurements will be taken and recorded on field data sheets (Appendix A). Continuous recorders will be downloaded every two weeks or more frequently, if necessary.

Field Equipment

The following equipment will be used for the water quality monitoring program.

- Two continuous recording, fixed, multi-parameter water quality instruments with probes for dissolved oxygen, pH, turbidity, temperature, and electrical conductivity at Mazanar Reward Road and Keeler Bridge.
- One portable, multi-parameter water quality instrument for spot measurements at other locations along the river reach at which continuous recorders are not

installed to measure dissolved oxygen, pH, turbidity, temperature, and electrical conductivity.

- Maintenance and calibration materials for the above field instruments and test kits for operation of up to three years at the frequency provided in Table 2.
- A laptop computer compatible with the field equipment to facilitate data retrieval. In addition, a 20-amp-hour 12 volt battery and appropriate instrument-dedicated water quality software.
- 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 2.
- Two perforated casings driven into the river bottom just downstream of Keeler Bridge and just upstream of Manzanar Reward Road with locking caps.
- Instrument and test kit documentation notebooks dedicated to individual instruments and test kits that will contain information on calibration, service and performance of instruments and test kits.

If one of the continuous-recording water quality instruments fails, monitoring at that location will be conducted with portable equipment until the unit can be repaired or replaced. Maintenance materials will be on hand for up to 3 years of operation, according to the frequency of measurements described in Table 2. If the portable, multi-parameter water quality instrument fails, it will temporarily be replaced by borrowed meters from LADWP or California Department of Fish and Game until repairs can be made.

Disposal of Residual Materials

Test kit reagents and samples will be returned to LADWP or ICWD facilities for disposal. Samples with reagents will not be discarded in the field.

Sample Documentation

Field notebooks will be maintained for each of the multi-parameter water quality instruments documenting calibrations, downloads and instrument problems. A field notebook will be used for independent constituent test kits. In addition, measurements will be recorded on field data sheets (Appendix A).

At a minimum, the following information will be recorded during the collection of each sample or data download:

- Measurement location and description including sketch, if necessary
- Date and time of measurement collection or Data Download
- Data file name of download

- Field observations and details related to analysis or integrity of measurements (e.g., weather conditions, noticeable odors, colors, etc.)
- Preliminary sample descriptions (e.g. clear water with strong ammonia-like odor)
- Personnel taking the measurement

Photographs will be taken at the sampling locations and at other areas of interest in the sampling area. These photographs will serve to verify information entered in the field instrument and test kit notebooks. For each photograph taken, the following information will be written in the notebook or recorded in a separate field photography log:

- Time, date, location and weather conditions
- Description of the subject photographed
- Name of the photographer

QUALITY CONTROL

Quality control (QC) activities for the water quality monitoring task will consist of the following:

- All instrument standard operating procedures, service recommendations, calibration protocols, and test kit instructions as supplied by the manufacturer will be followed.
- Field personnel will check each measurement made at the location and time of measurement. If the measurement is suspect in any way, additional measurements will be made in an effort to confirm or reject the original measurement. If measurements continue to be suspect after duplicate measurement, suspect measurements will be identified using a flag variable. None of the measurements will be culled from the data. The field personnel will enter explanation for all flagged data in a comments section. Field personnel will review the day's field form in the field at the end of the day to ensure that they are complete, legible, accurate, and in standard format.
- Office personnel will enter the date of data entry, data, and any QC flag variables into spreadsheets such as MS Excel or data bases such as Access. The name of the person entering the data and the date will be recorded on the original field form. The person entering the data will be responsible for reviewing and correcting any data transcription errors.

INSTRUMENT/EQUIPMENT AND SUPPLIES/CONSUMABLES

Instrument/Equipment Testing, Inspection, and Maintenance

A routine preventative maintenance program will be conducted to minimize risk of instrument failure and other system malfunctions per the instructions provided by the manufacturer. Testing, inspection, and maintenance activities will be documented in the notebook dedicated to each instrument or test kit type.

Instrument/Equipment and Calibration and Frequency

Water quality field instruments will be calibrated and serviced according to manufacturer's instructions at frequencies outlined in these instructions. Calibration and service activities will be documented in the notebook dedicated to each instrument.

Inspection/Acceptance of Supplies and Consumables

All equipment and supplies will be inspected each day prior to use.

PERSONNEL TIME

An estimate of personnel time and vehicle mileage is provided in Appendix C. It is impossible to present a final staffing plan at this time since Inyo County and Los Angeles Department of Water and Power have not yet agreed upon a work distribution. Time from at least two people will be needed. These two people would consist of a field person and an office person. Staffing arrangements will be made well in advance of flow releases.

TRAINING AND CERTIFICATION

Staff will receive sufficient training to safely, effectively, and efficiently perform water quality sampling. Field personnel will be trained on the use of equipment and field test kits and data recording. There are no specific educational requirements.

DATA MANAGEMENT

All field forms and data downloads will have a chain of custody form attached or on the back of the form. A copy of the completed field forms and downloads will be retained by field personnel. The chain of custody forms will be filled out by each person handling the documents and downloads until they reach a designee at LADWP. All completed field forms and downloads will be submitted to LADWP offices in Bishop either in person or by mail after each sampling day. If the field forms and downloads are mailed, the sender will retain a duplicate copy, or certified/registered mail will be used.

All original field forms will receive a document control number added by office personnel and will be filed and retained at LADWP offices in Bishop. Downloads will reside on the project server at LADWP.

Office personnel will enter the data into spreadsheets or databases such as MS Excel or Access, and the electronic data will be stored on the project server. The name of the person entering the data will be recorded on the original field form. The office person entering the data will be responsible for reviewing and correcting any data transcription errors. (If data entry is conducted outside of LADWP offices, the spreadsheet will be e-mailed or otherwise transmitted in electronic format to LADWP offices for storage on the project server.)

FIELD VARIANCES

As conditions in the field vary, it may become necessary to implement modifications to the water quality sampling and possibly the water quality thresholds in Table 5 presented in this plan. Prior water quality data on the Lower Owens River contained in or referenced in the EIR may also be used to justify these variances as well as the data collected for one month prior to Phase I flow releases. When appropriate, the Inyo County Water Department and Los Angeles Department of Water and Power will be notified and approval obtained before implementing the changes. Modifications to the approved plan will be recorded on field data forms and/or notebooks associated with each instrument or test kit type.

REFERENCES

Los Angeles Department of Water and Power, 2004, Final Environmental Impact Report for the Lower Owens River Project, Inyo County, California.

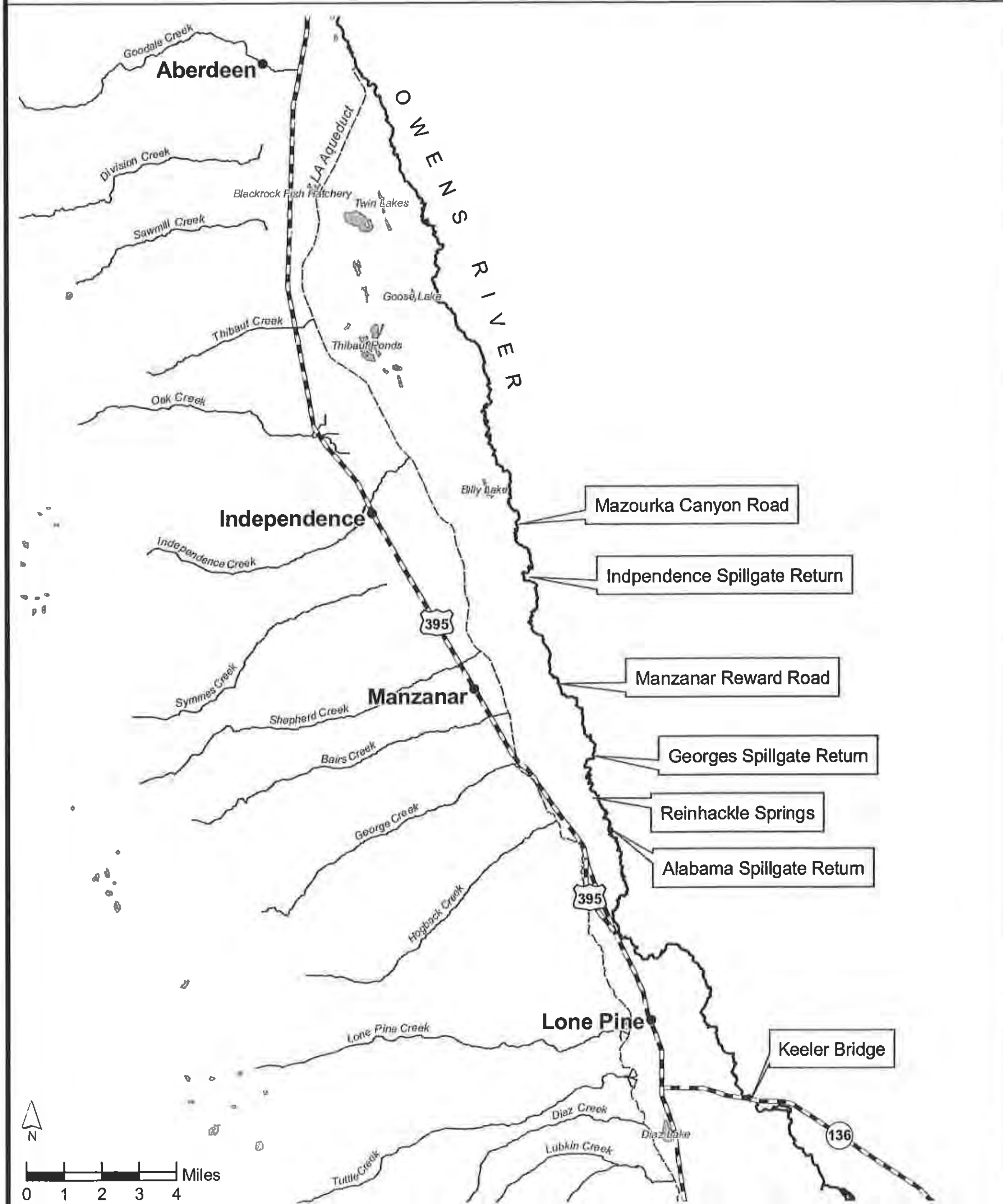
Jackson, R., 1994, Lower Owens River Planning Study: Transient Water Quality in the Lower Owens River during Planning Study Flow Releases in July and August of 1993. Inyo County Water Department, Bishop, California.

EPA, 1999, 1999 Update of Ambient Water Quality Criteria for Ammonia, EPA-822-R-99-014, December 1999.

APPENDIX A

Inyo County Water Department

Water Quality Monitoring Stations



16 Dec 2005

projects/lorpmap/lorp water quality monitoring stations.mxd

FORM 1: CHAIN OF CUSTODY SHEET-LOWER OWENS RIVER PROJECT – EIR RELATED WATER QUALITY MONITORING.

Sampler or Data Custody Person, Date and Time Received	Data Transfer Location	Comments	Signature

FORM 2: FIELD WATER QUALITY DATA SHEET-LOWER OWENS RIVER PROJECT – EIR RELATED WATER QUALITY MONITORING.

Date:____________________ **Field Document No.** _______________________

Location	Time	Staff Gage or Q	D.O.	Turbi dity	Ph	EC	Temp	Ammonia	Hydrogen Sulfide	Tannins and Lignins	Comments
UNITS		cfs or feet	mg/l	NTU		Ms/ cm	C	mg/l	mg/l	Mg/l	
Mazourka Canyon Rd.											
Independence Spillgate Return											
Manzanar Reward Rd.											
Georges Spillgate Return											
Reinhackle Springs											
Alabama Spillgate Return											
Keeler Bridge											

FORM 3: FIELD DATA SHEET- FISH AND AQUATIC LIFE OBSERVATIONS-LOWER OWENS RIVER PROJECT – EIR RELATED WATER QUALITY MONITORING.

Date:____________________ **Field Document No. :**________________________

Location	Time	Staff Gage or Q (cfs or feet)	Aquatic Life	Behavior	Comments
Mazourka Canyon Rd.					
Independence Spillgate Return					
Manzanar Reward Rd.					
Georges Spillgate Return					
Reinhackle Springs					
Alabama Spillgate Return					
Keeler Bridge					

APPENDIX B

TABLE 1. INVENTORY OF WATER QUALITY EQUIPMENT

TYPE OF EQUIPMENT	MAKE AND MODEL
CONTINUOUS RECORDER	HYDROLAB Data Sonde 4a-probes for pH, EC, Temp, D.O. and Turbidity-HYDROLAB SURVEYOR-download and programming instrument.
CONTINUOUS RECORDER	On Order- similar to above-Data Sonde Only
SPOT MEASUREMENT MULTI-PARAMETER PROBE	HYDROLAB QUANTA-LADWP instrument-LADWP may order an additional instrument
HYDROGEN SULFIDE TEST KIT	HACH Model HS-C #25378-00 Hydrogen Sulfide Test Kit, HACH Model HS-WR on order
AMMONIA TEST KIT	HACH NI-8 Test Kit #224100 Ammonia as N test kit
TANNINS AND LIGNINS TEST KIT	HACH TA-3 Tannin and Lignin Test Kit #193701

APPENDIX C

DRAFT

TABLE 1. ESTIMATE OF PERSONNEL HOURS AND MILEAGE FOR THE LORP EIR WATER QUALITY MONITORING

Time Period	Monitoring Frequency	Hours per day	Duration	Total Hours Min	Total Hours Max
BASEFLOWS					
1 month prior to Phase 1	3 days per week	8.0	1 month	96	96
Phase 1	1 to 2 days per week (depending on conditions)	8.0	5 months	160	320
Phase 2	1 to 5 days per week (depending on conditions) during the	8.0	6 months + 10 days	272	1040
	period when spillgates may be operated (see above)				
Post-Phase 2	1 to 5 days per week (dpending on conditions) for 6 months	8.0	6 months	192	960
	after 40-cfs base flow has been established				
SEASONAL HABITAT	(first three releases in excess of 40 cfs)				
During Seasonal Habitat Flows	5 days per week-maximum 2 weeks duration	8.0	2 weeks	240	240
After Seasonal Habitat Flows	1 to 5 days per week (as needed) for up to 2 weeks	8.0	2 weeks	48	240
EIR MONITORING					
TOTALS				**1008**	**2896**
ADDITIONAL TASKS					
Logistics	5% of total EIR plan hours			50	145
Data Input and Transfer	5% of total EIR plan hours			50	145
Contingency	10% of the total EIR plan hours			101	290
TOTALS				**202**	**579**
		min. trips	max. trips	min. mileage	max. mileage
Truck Milage	estimate of trips from Bishop -120 miles per trip	**126**	**362**	**15120**	**43440**
				Minimum Total	Maximum Total
				Hours	Hours
TOTALS				**1210**	**3475**

REFERENCES:
1. LORP EIR

TABLE 2. SUMMARY TABLE

PERSONNEL HOURS MIN	1008
PERSONNEL HOURS MAX	2896
ADDITIONAL TASKS MIN	202
ADDITIONAL TASKS MAX	579
MILAGE MIN	15120
MILAGE MAX	43440

APPENDIX D

THE NATIONAL CRITERION FOR AMMONIA IN FRESH WATER

use of Mazourka Canyon Road pH values

Table 1. The one-hour average concentration of total ammonia nitrogen (in mg N/L) Where Non-Salmonoid Fish are present.

Calculated Using equation on page 83, 1999 Update of Ambient Water Quality Criteria for Ammonia , EPA-822-R-99-014, DECEMBER 1999

[illegible]	M1	M2	[illegible]
6.50	0.067841411	48.76025	48.83
6.60	0.081906641	46.76168	46.84
6.70	0.098054703	44.46717	44.57
6.80	0.116261682	41.88009	42.00
6.90	0.136376113	39.02198	39.16
7.00	0.158103799	35.93464	36.09
7.10	0.181011489	32.67963	32.86
7.20	0.204553644	29.33447	29.54
7.30	0.228120666	25.98577	26.21
7.40	0.251100394	22.72053	22.97
7.50	0.272940144	19.61726	19.89
7.60	0.293196386	16.739	17.03
7.70	0.311563371	14.1292	14.44
7.80	0.327878566	11.81093	12.14
7.90	0.342108735	9.788929	10.13
8.00	0.354323845	8.053254	8.41
8.10	0.364666428	6.583651	6.95
8.20	0.373322336	5.353712	5.73
8.30	0.380496435	4.334326	4.71
8.40	0.386394567	3.496246	3.88
8.50	0.391211555	2.811789	3.20
8.60	0.39512427	2.255822	2.65
8.70	0.398288473	1.806212	2.20
8.80	0.400838235	1.44391	1.84
8.90	0.402886967	1.152801	1.56
9.00	0.404529319	0.919435	1.32
9.10	0.405843458	0.732706	1.14
9.20	0.406893416	0.583515	0.99
9.30	0.407731308	0.464457	0.87

APPENDIX B: DISSOLVED OXYGEN FACT SHEET

(Please Note that the section entitled "What are Acceptable Ranges?" does not apply to the LORP)

Dissolved Oxygen Fact Sheet

What is Dissolved Oxygen?

It is the amount of oxygen dissolved in water.

Why is it Important?

Most aquatic organisms need oxygen to survive and grow.

- Some species require high DO such as trout and stoneflies.
- Other species do not require high DO, like catfish, worms and dragonflies.

If there is not enough oxygen in the water the following may happen:

- Death of adults and juveniles,
- Reduction in growth,
- Failure of eggs/larvae to survive,
- Change in species present.

How it is Measured?

Measuring DO
Color production: DO chemical test kit for field work with freshwater
Winkler titration method: This method is valid for ocean water and fresh water, but not highly alkaline water.
DO Meter: electrical conductance based on a chemical reaction.

See IP-3.1.1(DO) in this folder for more information.

Reporting DO

- **Dissolved oxygen concentration** is reported in units of mg/l, or milligrams per liter (mg/l is also referred to as parts per million (ppm) because a liter is 1000 grams of fresh water, and a milligram is a millionth of that).
- **Percent saturation** is reported in units of percent. Oxygen dissolves in water to saturation, a value typical of a given temperature. Percent saturation tells us what part of the holding capacity is actually taken.

What Affects the Concentration in Water?

1. Physical Factors affecting saturation (**Temperature, salinity, etc.)**
2. **DO Sources (inputs)**
3. **DO Sinks (outputs)**

1. Physical Factors

Temperature

As temperature increases, less oxygen can be dissolved in water. When water holds all the DO it can at a given temperature, it is said to be 100 percent saturated with oxygen. Water can be supersaturated with oxygen under certain conditions (e.g. when algae are growing rapidly and producing oxygen more quickly than it can be used up or released to the atmosphere). The following table shows the concentration of dissolved oxygen that is equivalent to the 100 percent saturation for the noted temperature (and normal barometric pressure). Note: these values are for fresh water only!

Temperature degC	DO (mg/l)	Temperature degC	DO (mg/l)
0	14.6	16	9.9
1	14.2	17	9.7
2	13.8	18	9.6
3	13.5	19	9.3
4	13.1	20	9.1
5	12.8	21	8.9
6	12.5	22	8.7
7	12.1	23	8.6
8	11.8	24	8.4
9	11.6	25	8.3
10	11.3	26	8.1
11	11.0	27	8.0
12	10.8	28	7.8
13	10.5	29	7.7
14	10.3	30	7.6
15	10.1	31	7.5

Other Physical Factors

- Altitude: Water holds less oxygen at higher altitudes.
- Salinity/Mineral content: As salinity or mineral content increases, dissolved oxygen decreases.

2. DO Sources

Oxygen is added to water by:

Re-aeration: Oxygen from air is dissolved in water at its surface, mostly through turbulence. Examples of this include:

Water tumbling over rocks (rapids, waterfalls, riffles)
Wave action

Photosynthesis (during daylight) Plants produce oxygen when they photosynthesize. DO is generally highest in the late afternoon, and lowest in the early morning hours before sunrise.

3 DO Sinks

Dissolved oxygen is used in two major ways:

Respiration: Aquatic organisms breathe and use oxygen.

Large amounts of O_2 are consumed by algae and aquatic plants at night (where large masses of plants are present).

Large amounts are consumed by decomposing bacteria (when there are large amounts of dead material to be decomposed, there will be significant numbers of bacteria). Examples:

Dead organic matter (i.e. Algae)
Sewage
Yard Clippings - yard waste
Oil and grease

Chemical Oxidation:

Some materials are oxidized naturally (without involvement of microorganisms) and this chemical process utilizes oxygen. Oxygen uptake through chemical oxidation is very marginal compared to biological uptake (i.e., respiration).

What are generally the biggest causes of low DO?

- Increases in water temperature
- Algal blooms
- Human waste
- Animal waste - from feedlots, dairies, etc.

What are Acceptable Ranges?

- The following table gives specific DO values for the survival of different species:

NOTE: DOES NOT APPLY TO THE LORP.

Biologic effects of decreasing dissolved oxygen (DO) Levels on salmonids, non-salmonids fish, and aquatic invertebrates	Dissolved oxygen (mg L^{-1})	
	Instream	Intergravel
I. Salmonid waters		
A. Embryo and larval stages		
No production impairment	11	8
Slight production impairment	9	6
Moderate production impairment	8	5
Severe production impairment	7	4
Limit to avoid acute mortality	6	3
B. Other life stages		
No production impairment	8	
Slight production Impairment	6	
Moderate production impairment	5	
Severe production impairment	4	
Limit to avoid acute mortality	3	
II. Non-Salmonid waters		
A. Early Life stages		
No production impairment	6.5	
Slight production impairment	5.5	
Moderate production impairment	5	
Severe production impairment	4.5	
Limit to avoid acute mortality	4	
B. Other life stages		
No production impairment	6	
Slight production impairment	5	
Moderate production impairment	4	
Severe production impairment	3.5	
Limit to avoid acute mortality	3	
III. Invertebrates		
No production impairment	8	
Some production impairment	5	
Limit	4	

What are the Water Quality Objectives?

- The water quality objectives for dissolved oxygen vary from region to region. Check with the Regional Water Quality Control Board in your area. Water quality objectives are included in their Basin Plan. For waters that support coldwater fishes, the objective requires that the dissolved oxygen concentration shall not fall below 6 to 8 mg/l (depending on the region of California). For waters that support warm water fishes, the objective requires that the dissolved oxygen concentration shall not fall below 5 to 6 mg/l (depending on the region of California). Some Regional Water Boards describe objectives in terms of percent saturation. For example, the dissolved oxygen shall not fall below 80% saturation.

- For ocean waters, the dissolved oxygen concentration shall not be depressed more than 10 percent from that which occurs naturally.

Sources and Resources

This Fact Sheet is implemented by the Clean Water Team (CWT), the Citizen Monitoring Program of the California State Water Resources Control Board. This fact sheet has been revised by CWT from an original document authored by Gwen Starrett, former State Coordinator for Citizen Monitoring. Please contact your Regional CWT Coordinator for further information and technical support.

For an electronic copy, to find many more CWT guidance documents, or to find the contact information for your Regional CWT Coordinator, visit our website at www.swrcb.ca.gov/nps/volunteer.html

If you wish to cite this FS in other texts you can use "CWT 2004" and reference it as follows:
"Clean Water Team (CWT) 2004. Dissolved Oxygen Fact Sheet, FS-3.1.1.0(DO). in: The Clean Water Team Guidance Compendium for Watershed Monitoring and Assessment, Version 2.0. Division of Water Quality, California State Water Resources Control Board (SWRCB), Sacramento, CA."

4.0 LAND MANAGEMENT

4.1 Land Management Summary

The 2014 Lower Owens River Project (LORP) land management monitoring efforts continued with monitoring utilization across all leases, range trend monitoring on two of the leases inside the LORP management area, rare plant monitoring, and streamside monitoring for woody establishment. Irrigated pasture evaluations will be conducted again in 2016. The LORP area is currently experiencing its third year of extreme drought. Effects from this are a decreased forage production in the uplands and decreased availability of irrigation water. Despite the drought, ranch lessees were able to keep their utilization levels within the allowable use levels in 2013-14. Range trend results indicate that in most areas where plant communities are dependent on groundwater to some degree, trends have either remained static or only slightly decreased. 2014 marks the sixth year of examining the effects of excluding rare plants from livestock grazing. Results indicated a decline of plant populations in ungrazed sites. Streamside monitoring results again showed light use by livestock and elk, high survivorship, and continued growth of young tree willows monitored since 2012. However, sustained high summer flows continue to negatively impact approximately one third of the juvenile trees monitored.

Pasture utilization for leases within the LORP was below the allowable levels of use established for both riparian (up to 40%) and upland (up to 65%) areas except the Islands and Lone Pine leases. Use on the Blackrock Lease was lower than most other leases in the project area remaining well below all grazing standards. The Twin Lakes Lease had a prescribed burn on the riparian sections of the Lower Blackrock Riparian and Upper Blackrock fields in 2013 the burned area recovered well and use was below allowable utilization. The Islands Lease has started to show signs of stressed meadow vegetation and aquatic vegetation spreading due to prolonged inundation from flow augmentations for the LORP project. Use on the Thibaut Lease in the Thibaut Field was below the allowable upland standard. The Lone Pine Lease has recovered well from the 2013 fire, the only major loss was to mature willow trees.

All irrigated pastures were monitored in 2013. Pastures that scored 80% or below were checked in 2014, including pastures in the Islands, Lone Pine, and Delta Leases. Many leases rated below the 80% minimum irrigated pasture score and reflect a below normal precipitation year. All irrigated pastures in the LORP will be evaluated again in 2016.

2014 marks the sixth year collecting rare plant trend plot data for *Sidalcea covillei* (Owens Valley Checkerbloom), and *Calochortus excavatus* (Inyo County Star Tulip) for the LORP. The objective of the study was to determine the effects of grazing exclusion on Owens Valley checkerbloom. Results show an increase in numbers over time in grazed sites and a decrease in numbers over time in ungrazed sites. However, external factors during a given year may be confounding the results of the study. Because of this, it is recommended to continue this study for one more year. Additional data will be useful to further illustrate trends of Owens Valley checkerbloom and Inyo County star tulip within the LORP area.

Streamside Monitoring continued this year with sampling of juvenile tree heights, survivorship, and browsing by livestock and wildlife.

4.2 Introduction

The land use component of this report is composed of project elements related to livestock grazing management. Under the land management program, the intensity, location, and duration of grazing is managed through the establishment of riparian pastures, forage utilization rates, and prescribed grazing periods (described in Section 2.8.1.3 and 2.8.2 LORP EIR 2004). Other actions include the monitoring and protection of rare plant populations, establishment of off-river watering sources (to reduce use of the river and off-river ponds for livestock watering) and the monitoring of utilization and rangeland trend on the leases. In 2010, an additional monitoring component (Streamside Monitoring) was added to note woody establishment that may be occurring in the LORP following project implementation.

Grazing management plans developed for the ranch leases in the LORP modified grazing practices in riparian and upland areas on seven LADWP leases in order to support the 40 LORP goals as described in the LORP EIR (2007). The seven leases within the LORP planning area are: Intake, Twin Lakes, Blackrock, Thibaut, Islands, Lone Pine, and the Delta. LORP-related land use activities and monitoring that took place in 2014 are presented by lease in Section 4.9, LORP Ranch Leases.

4.2.1 Utilization

The *Lower Owens River Monitoring Adaptive Management and Reporting Plan* (Ecosystem Sciences 2008), developed as part of the LORP Plan, 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. Grazing utilization standards identify the maximum amount of biomass that can be removed by grazing animals during specified grazing periods. LADWP has developed height-weight relationship curves for native grass and grass-like forage species in the Owens Valley using locally-collected plants. These height-weight curves are used to relate the percent of plant height removed with the percent of biomass removed by grazing animals. Land managers can use these data to document the percent of biomass removed by grazing animals and determine whether or not grazing utilization standards are being exceeded. The calculation of utilization (by transect and pasture) is based on a weighted average. Therefore, species that only comprise a small part of available forage contribute proportionally less to the overall use value than more abundant species. Utilization data collected on a seasonal basis (mid- and end-points of a grazing period) 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.

4.2.2 Riparian and Upland Utilization Rates and Grazing Periods

Under the *Lower Owens River Monitoring Adaptive Management and Reporting Plan* (Ecosystem Sciences, 2008), livestock are allowed to graze in riparian pastures during the grazing periods prescribed for each lease (see Sections 2.8.2.1 through

2.8.2.7 LORP EIR 2004). Livestock are to be removed from riparian pastures when the utilization rate reaches 40% or at the end of the grazing period, whichever occurs first. The beginning and ending dates of the lease-specific grazing periods may vary from year-to-year depending on conditions such as climate and weather, but the duration remains approximately the same. The grazing periods and utilization rates are designed to facilitate the establishment of riparian shrubs and trees.

In upland pastures, the maximum utilization allowed on herbaceous vegetation is 65% annually if grazing occurs only during the plant dormancy period. Once 65% is reached, all pastures must receive 60 continuous days of rest for the area during the plant “active growth period” to allow seed set between June and September. If livestock graze in upland pastures during the active growth period (that period when plants are “active” in putting on green growth and seed), maximum allowable utilization on herbaceous vegetation is 50%. The utilization rates and grazing periods for upland pastures are designed to sustain livestock grazing and productive wildlife through efficient use of forage. Riparian pastures may also contain upland habitat. If significant amounts of upland vegetation occur within a riparian pasture or field, upland grazing utilization standards 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. Typically riparian utilization rate of 40% is reached before 65% use in the uplands occurs. Because of this pattern, utilization is not quantitatively sampled in adjacent upland areas, but use is assessed based on professional judgment. If utilization appears greater than 50% then utilization estimates using height weight curves will be implemented on the upland areas in the riparian field.

4.2.3 Utilization Monitoring

Monitoring methodologies are fully described in Section 4.6.2 of the *Lower Owens River Monitoring Adaptive Management and Reporting Plan* (Ecosystem Sciences, 2008).

Utilization is compliance monitoring and involves determining whether the utilization guidelines set forth in the grazing plans are being adhered to. Similar to precipitation data, utilization data alone cannot be used to assess ecological condition or trend. Utilization data is used to assist in interpreting changes in vegetative and soil attributes collected from other trend monitoring methods.

These standards are not expected to be met precisely every year because of the influence of annual climatic variation, livestock distribution, and the inherent variability associated with techniques for estimating utilization. Rather, these levels should be reached over an average of several years. If utilization levels are consistently 10% above or below desired limits during this period, then adjustments should be implemented (Holecheck and Galt, 2000; Smith et al., 2007).

Utilization monitoring is conducted annually. Permanent utilization transects have been established in upland and riparian areas of pastures within the LORP planning area. An emphasis has been placed on establishing utilization monitoring sites within riparian management areas. Each monitoring site is visited prior to any grazing in order to collect ungrazed plant heights for the season. Sites are visited again mid-way through the grazing period (mid-season) and again at the conclusion of the grazing period (end-of-season).

All of the end-of-season utilization data are presented in table format in Section 4.10 results of land use by lease.

4.3 Range Trend

4.3.1 Overview of Monitoring and Assessment Program

A description of monitoring methods, data compilation, and analysis techniques can be found in the 2008 LORP Monitoring, Adaptive Management and Reporting Plan. More detailed discussion of the Range Trend methods and considerations for interpretation can be found in previous LORP Annual Monitoring reports. Descriptions of the range trend monitoring sites and their locations on the leases can be found in the individual lease monitoring narratives in previous LORP Annual Monitoring Reports. Nested frequency and shrub cover data are presented for each lease and are presented as range trend transect data tables for each sampling transect and sampling year in previous reports. In this year's report, Range Trend data for leases monitored are found in the Appendices as a pdf file. Major departures from historic ranges of variability will be discussed at the lease level in the following sections.

Range trend monitoring for 2014 involves the quantitative sampling of the following attributes: nested frequency of all plant species and line intercept sampling for shrub canopy cover. Photo documentation of the site conditions is included as part of range trend monitoring.

Because frequency data is sensitive to plant densities and dispersion, frequency is an effective method for monitoring and documenting changes in plant communities (Mueller-Dombois and Ellenberg, 1974; Smith et al., 1986; Elzinga, Salzer et al., 1988; BLM 1996; Heywood and DeBacker, 2007). For this reason, frequency data is the primary means for evaluating trend at a given site. Based on recommendations for evaluating differences between summed nested frequency plots (Smith et al., 1987 and Mueller-Dombois and Ellenberg, 1974), a Chi-Square analysis with a Yate's correction factor was used to determine significant differences between years. The 2014 results were compared to all sampling events during the baseline period to determine if results in 2014 were ecologically significant or remained within the typical range of variability observed for that particular site.

The ecological site on the LORP where the majority of land management monitoring transects are located is the Moist Floodplain ecological site (MLRA 29-20). The site describes axial-stream floodplains. Moist Floodplain sites are dominated by *Distichlis spicata* (saltgrass), plant symbol DISP and to a lesser extent *Sporobolus airoides* (alkali sacaton), plant symbol SPAI and *Leymus triticoides* (creeping wildrye), plant symbol LETR5. Only 10% of the total plant community is expected to be composed of shrubs and the remaining 10% forbs. This ecological site does not include actual river or stream banks. Stream bank information is available from the Rapid Assessment Survey (RAS) reports and the Streamside Monitoring Report.

Saline Meadow ecological sites (MLRA 29-2) are the second most commonly encountered ecological sites on the LORP range trend sites. These sites are located on fan, stream, lacustrine terraces, and may also be found on axial stream banks. Potential plant community groups are 80% perennial grass with a larger presence of alkali sacaton than Moist Floodplain sites. Shrubs and trees comprise up to 15% of the community while forbs are only 5% of the community at potential. Saline Bottom (MLRA 29-7) and Sodic Fan (MLRA 29-5) ecological sites were also associated with several range trend sites. These are more xeric stream and lacustrine terrace sites. Saline Bottom ecological sites still maintain up to 65% perennial grasses, the majority of which is alkali sacaton, while shrubs compose up to 25% of the plant community, and forbs occupy the remaining 10%. Sodic Fan ecological sites are 70% shrubs, primarily *Atriplex torreyi* (Nevada saltbush), plant symbol ATTO, with a minor component of alkali sacaton of up to 25% and 5% forbs.

During the pre-project period, a range of environmental conditions were encountered including “unfavorable” growing years when precipitation in the southern Owens Valley was less than 50% of the 1970-2009 average, “normal” years, when precipitation was 50-150% of average, and “favorable” conditions when precipitation was greater than 150% of average. Many of the monitoring sites responded differently to the variable precipitation conditions during the baseline period. This provided the Watershed Resources staff an opportunity to sample across a broad amplitude of ecological conditions for these sites, which contributed to a robust baseline dataset. Data from the Lone Pine rain gauges are used to determine the growing conditions for each sampling year on the Islands, Lone Pine, and Delta Leases. Precipitation data from Independence are used for the Thibaut and Blackrock Leases, and data from the Intake are used for the Intake, Twin Lakes, and the northern portion of the Blackrock Leases.

Adaptive management recommended that a modified range trend schedule was implemented beginning 2012. This schedule will ensure that there will be some monitoring across the landscape annually, increasing the probability of documenting the influence of significant changes in climate or management on the various ecological sites in the LORP area.

Land Management Table 1. Revised Range Trend Monitoring Schedule for the LORP

2012	2013	2014	2015	2016	2017
Twin Lakes	Blackrock	Thibaut	Intake	Blackrock	Thibaut
Lone Pine	Delta	Islands	Twin Lakes	Delta	Islands
	Intake Lease		Lone Pine		

4.4 Irrigated Pastures

Monitoring of irrigated pastures consisted of Irrigated Pasture Condition Scoring following protocols developed by the (NRCS, 2001). Irrigated pastures that score 80% or greater are considered to be in good to excellent condition. If a pasture rates below 80%, changes to pasture management will be implemented.

All irrigated pastures were monitored in 2013. Pastures that scored 80% or below were checked in 2014. The results of the monitoring are presented in a table format by lease in Section 4.9. Irrigated pasture condition scoring for all pastures will take place again in 2016.

4.5 Fencing

No new fence construction occurred within the LORP project boundaries in 2014. Some repairs did occur along with general maintenance.

4.6 Rare Plants

The LORP EIR identified approximately 44 miles of new fencing to be built in the project area to improve grazing management and help meet the LORP goals. The new fencing consisted of riparian pastures, upland pastures, riparian exclosures, rare plant exclosures, and rare plant management areas. New rare plant exclosures were constructed on Blackrock Lease and Thibaut Lease (see sections 2.8.1.4, 2.8.2.2, and 2.8.2.3 of the Final LORP EIR June 23, 2004). Fence construction began in September 2006 and was completed in February 2009 with the total fence miles constructed being approximately 50 miles. The Blackrock Lease has two 0.25-acre rare plant exclosures built in the Robinson and Little Robinson Pastures and two riparian exclosures were constructed in the White Meadow Riparian and Wrinkle Riparian Fields. The rare plant exclosures were designed to evaluate the effect of grazing on *Sidalcea covillei* (Owens Valley checkerbloom, plant symbol SICO2) and *Calochortus excavatus* (Inyo County star-tulip, plant symbol CAEX2).

Within the LORP there are 15 trend plots within four rare plant populations on two separate ranch leases, Blackrock and Thibaut. Target species are Owens Valley checkerbloom and Inyo County star-tulip. Owens Valley checkerbloom is a state endangered species, endemic to the Owens Valley that occurs in alkali meadows. Inyo County Star Tulip is not State or federally listed but is considered a California Species of Special Concern (CSSC) and rare in its range. A mesic species, Inyo County star-tulip occurs in alkali meadows and seeps, transitioning into chenopode scrubland.

The plots have been monitored for six years to evaluate population trends. As designed, if trends are static or suggest that grazing is beneficial, the exclosure fencing will be removed. In contrast, if trends in data support that exclosures are needed to protect these populations of Owens Valley checkerbloom and Inyo County star-tulip, then LADWP will construct additional exclosures (or a practical variation thereof) and monitoring will continue as needed (see Section 6.6 LORP Annual Monitoring Report 2009).

4.6.1 Rare Plant Monitoring Methods

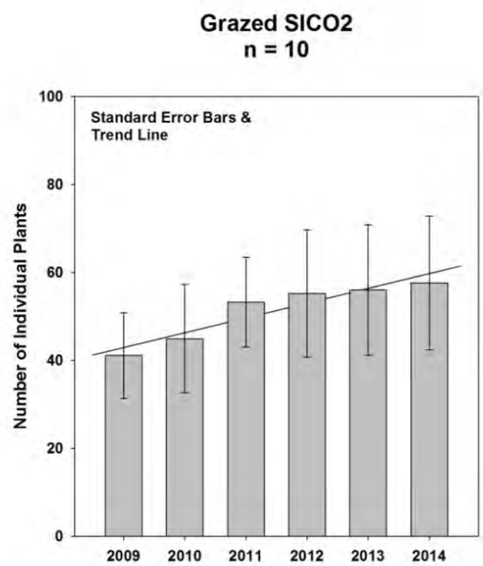
The LORP rare plant trend plots were established inside and outside of exclosures to measure change between grazed and ungrazed plots. Plots are permanently located by driving a piece of rebar into the center of the plot and taking a GPS point of the location. Plots can then be relocated using a hand-held GPS unit and a metal detector. Two 50-meter measuring tapes are used to delineate the plot into four sections with a diameter of 7.24 meters (3.62 meter radius) for a total plot size that is 1/100 of an acre. Target species are flagged with a pin flag to aid in accurately identifying all individuals within the plot. Photos are taken in all cardinal directions depicting the plot area containing flagged plants. One measuring tape is then attached to the rebar in the center of the plot to record the distance of individuals within a radius of 3.62 meters. A compass is used to record the bearing of individuals from the center of the plot. By measuring the distance and bearing from the center of the plot, individual plants can then be accurately measured overtime. Data on recruitment, persistence, phenology and if the plants are grazed, are collected. General observational notes on site condition and other environmental factors are also recorded.

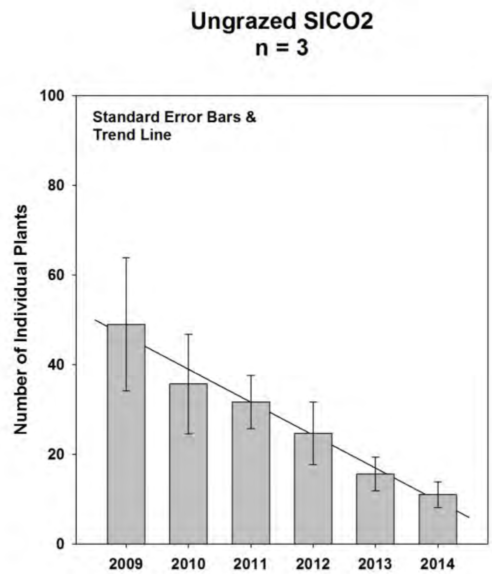
2014 marks the sixth year collecting trend plot data within the LORP. Data was compiled into a comprehensive database to analyze population trend over time.

4.6.2 Rare Plant Summary

Monitoring Results

A two-way repeated measures ANOVA was performed to determine if there is a measurable difference in population trend overtime between grazed and ungrazed trend plots. Results of the test show that there is no statistically significant difference between grazed and ungrazed sites (F=1.07, P=0.32) but that there is an effect of different levels of grazing depending on the year (F=3.30, P=0.01). Visually depicting the data showed an increasing trend over time in grazed sites and a decreasing trend over time in ungrazed sites (Figures 1-2). Additionally, external factors during a given year may be confounding results for the individual trend plots. Looking specifically at individual plots, we were able to formulate ideas on trend for Owens Valley checkerbloom. Because of generally low numbers of Inyo County star-tulip within the plots and size of the trend plot a statistical analysis was not performed on Inyo County star-tulip.





***Total plants for all sites**

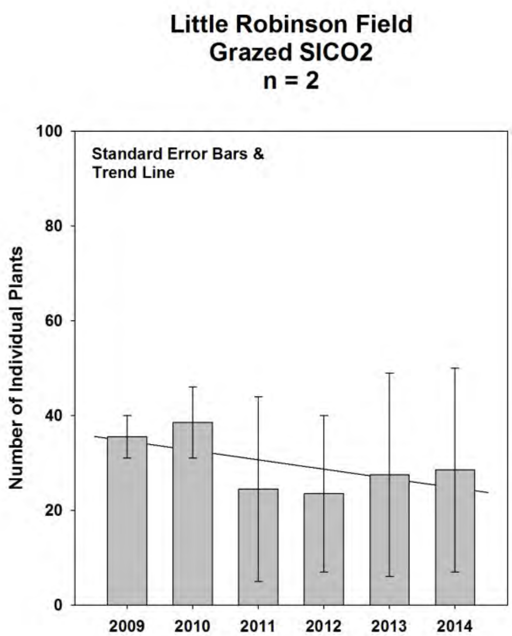
Land Mgmt Figure 1. All Age Classes Combined   **Land Mgmt Figure 2. All Age Classes Combined**

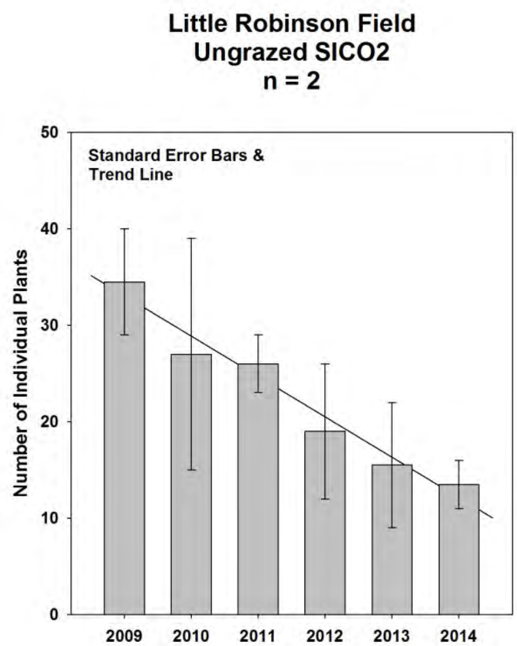
Little Robinson Pasture, Blackrock Lease

This pasture contains an Owens Valley checkerbloom population. Trend plots Little Robinson 1EX and Little Robinson 2EX occur within an exclosure; trend plots Little Robinson 1C and Little Robinson 2C are adjacent to the exclosure and are grazed. Trend in the grazed plots are static while the trend in the ungrazed plots is decreasing (Figures 3-4).

This site illustrates the effect of different types of grazing for a given year. Factors that have additionally influenced these plots are inundation of trend plots due to stock water diversions and a nutrient tub within a trend plot site. Looking at the figures and raw data table, Little Robinson 2C has been inundated 4 of the 5 years of this study. Additionally, a nutrient tub, which provides supplement for livestock, was placed within the plot sometime in 2011 and was removed after the 2012 monitoring season. Based on observational data, the inundation of the site is favoring mesic, wetland species, such as sedge, Baltic rush, and creeping wildrye, which may be outcompeting Owens Valley checkerbloom. The nutrient tub placement may have had an effect due to the density of cattle congregating within the plot, compacting the soil and potentially overgrazing the monitoring site. By removing the nutrient tub in 2012, it appears that the trend may be increasing as observed in Figure 3. Little Robinson 1EX and 2EX may be experiencing the same issues from inundation.

These confounding environmental factors make it difficult to isolate the grazing effect on this rare plant population. However, because both grazed and ungrazed plots have been inundated at some time during this study and trend is slightly decreasing in the ungrazed plots, we may be able to deduce that some level of grazing is beneficial.





***Total plants, all age classes combined**

Land Mgmt Figure 3. Grazed, Little Robinson Field **Land Mgmt Figure 4. Ungrazed, Little Robinson Field**

Land Management Table 1. Rare Plant Raw Data

Plot Number	Year	Species	Seedling	Juvenile	Mature	Total
Little Robinson 1C (Grazed)	2009	Owens Valley checkerbloom	0	12	28	40
	2010		1	0	45	46
	2011		16	11	17	44
	2012		12	0	28	40
	2013		36	0	13	49
	2014		19	0	31	50
Little Robinson 2C (Grazed)	2009*	Owens Valley checkerbloom	0	12	19	31
	2010*		3	0	28	31
	2011*		4	1	0	5
	2012^		0	0	7	7
	2013*		5	0	1	6
	2014		1	0	6	7
Little Robinson 1EX (Ungrazed)	2009	Owens Valley checkerbloom	0	0	40	40
	2010		0	0	39	39
	2011		0	0	29	29
	2012		3	0	23	26
	2013*		13	0	9	22
	2014		3	0	8	11
Little Robinson 2EX (Ungrazed)	2009	Owens Valley checkerbloom	0	6	23	29
	2010		0	0	15	15
	2011		8	0	15	23
	2012		1	0	11	12
	2013*		6	0	3	9
	2014		0	0	16	16

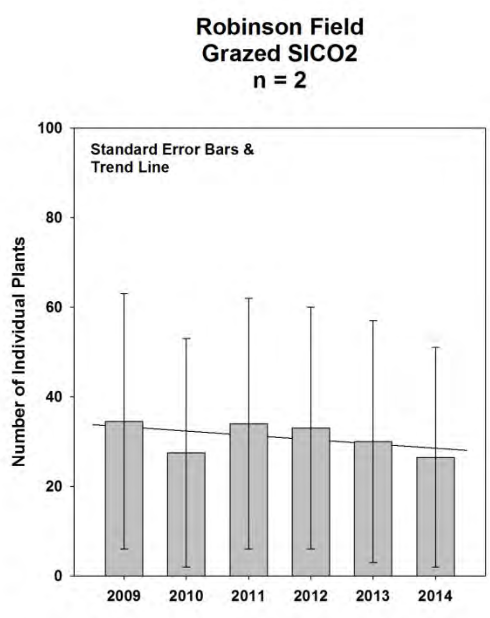
**Plot inundated*
^Nutrient tub in plot

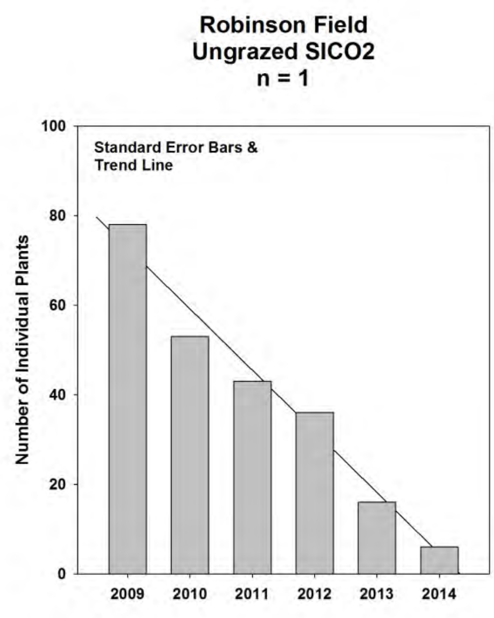
Robinson Field, Blackrock Lease

This pasture contains an Owens Valley checkerbloom population and an Inyo County star-tulip population. Trend plots Robinson 1EX and Robinson 2EX occur within an exclosure containing both Owens Valley checkerbloom and Inyo County star-tulip. Two Owens Valley checkerbloom trend plots (Robinson 1C and Robinson 2C) along with one Inyo County star-tulip trend plot (Robinson 3C) are outside the exclosure within the same pasture. Trend in the grazed plots are static while trend in the ungrazed site is decreasing (Figures 5-6).

This site is possibly another example of the effect of different types of grazing for a given year. The exclosure for the ungrazed plot was left open in 2011 only to be discovered during the 2012 monitoring season. Observational data suggests that the exclosed site is becoming overgrown and decadent. Treating 2009 as baseline, or pre-exclosure conditions, the precipitous decline may be attributed to the lack of grazing (i.e. disturbance). This may explain the decrease in trend for the ungrazed plot.

Because trend is static in the grazed plots and decreasing in the ungrazed plot, it appears that grazing is maintaining the population.





***Total plants, all age classes combined**

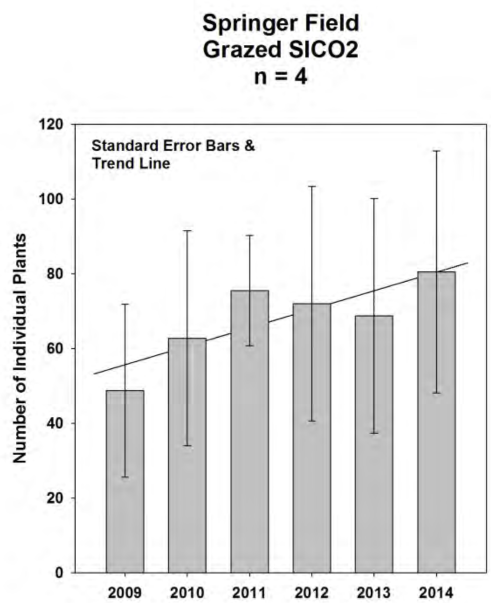
Land Mgmt Figure 5. Grazed, Robinson Field **Land Mgmt Figure 6. Ungrazed, Robinson Field**

Land Management Table 2. Rare Plant Raw Data

Plot Number	Year	Species	Seedling	Juvenile	Mature	Total
Robinson 1C (Grazed)	2009	Inyo County star-tulip	0	0	12	12
	2010		0	0	38	38
	2011		0	0	30	30
	2012		0	0	2	2
	2013		1	0	2	3
	2014		10	0	23	26
Robinson 1C (Grazed)	2009	Owens Valley checkerbloom	0	0	6	6
	2010		0	0	2	2
	2011		4	0	2	6
	2012		1	0	5	6
	2013		1	0	2	3
	2014		0	0	2	2
Robinson 2C (Grazed)	2009	Inyo County star-tulip	0	0	0	0
	2010		0	0	2	2
	2011		0	0	6	6
	2012		0	0	1	1
	2013		0	0	0	0
	2014		0	0	2	2
Robinson 2C (Grazed)	2009	Owens Valley checkerbloom	0	4	59	63
	2010		1	0	52	53
	2011		22	6	34	62
	2012		12	0	48	60
	2013		7	0	50	57
	2014		11	0	91	101
Robinson 3C (Grazed)	2009	Inyo County star-tulip	0	0	1	1
	2010		0	0	11	11
	2011		0	0	18	18
	2012		0	0	13	13
	2013		0	0	13	13
	2014		7	0	11	18
Robinson 1EX (Ungrazed)	2009	Inyo County star-tulip	0	0	2	2
	2010		0	0	11	11
	2011		0	0	2	2
	2012*		0	0	0	0
	2013		0	0	0	0
	2014		0	0	0	0
Robinson 1EX (Ungrazed)	2009	Owens Valley checkerbloom	0	43	35	78
	2010		17	0	36	53
	2011		13	8	22	43
	2012*		13	0	23	36
	2013		7	0	9	16
	2014		2	0	8	10
Robinson 2EX (Ungrazed)	2009	Inyo County star-tulip	0	0	23	23
	2010		2	0	23	25
	2011		0	1	30	31
	2012*		0	0	1	1
	2013		5	0	20	25
	2014		5	0	29	24
**Gate open – Exclosure grazed*						

Springer Pasture, Blackrock Lease

This pasture contains an Owens Valley checkerbloom population with four trend plots; Springer 1C, Springer 2C, Springer 1EXC, and Springer 2EXC, all of which are grazed. Trend across all plots is static (Figure 7). This pasture is consistently grazed year round by both cattle and horses and receives irrigation water from Stevens Ditch. Because of the consistent grazing regime and that trend has remained static to slightly increasing, it appears that the level of grazing is not negatively effecting the Owens Valley checkerbloom population.



***Total plants, all age classes combined**

Land Management Figure 7. Grazed, Springer Field

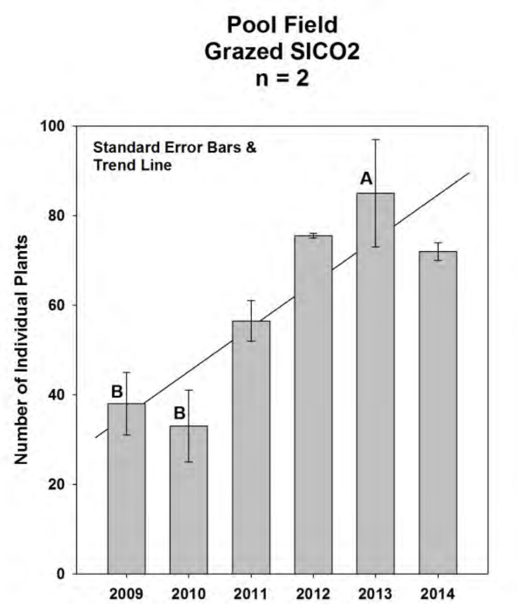
Land Management Table 3. Rare Plant Raw Data

Plot Number	Year	Species	Seedling	Juvenile	Mature	Total
Springer 1C (Grazed)	2009	Owens Valley checkerbloom	0	74	31	115
	2010		15	0	131	146
	2011		9	31	9	108
	2012		41	0	119	160
	2013		28	0	128	156
	2014		17	0	143	160
Springer 2C (Grazed)	2009	Owens Valley checkerbloom	0	13	24	37
	2010		3	0	49	52
	2011		7	17	33	57
	2012		27	0	44	71
	2013		7	0	59	66
	2014		11	0	91	101
Springer 1EXC (Grazed)	2009	Owens Valley checkerbloom	0	2	5	7
	2010		0	0	16	16
	2011		6	44	42	92
	2012		6	0	10	16
	2013		1	0	8	9
	2014		2	0	8	10
Springer 2EXC (Grazed)	2009	Owens Valley checkerbloom	0	23	13	36
	2010		0	0	37	37
	2011		3	13	29	45
	2012		17	0	24	41
	2013		15	0	29	44
	2014		15	0	36	51

Thibaut Pasture, Thibaut Lease

This pasture contains an Owens Valley checkerbloom and Inyo County star tulip population. Trend for both Pool Field 1 and Pool Field 4 are increasing (Figure 8). An ANOVA test revealed that the positive trend observed is statistically significant, P = .008. The trend is significantly different between years 2010 and 2013, P = .002, and 2009 and 2013, P = .003.

The plots are located within the Rare Plant Management Area and are grazed by horses and mules, which are excluded from grazing from March 1 to September 30. This is to allow the rare plants to complete their life cycle (see section 2.8.2.3 of Final LORP EIR June 23, 2004). Because plant numbers are increasing over time it appears that Owens Valley checkerbloom favors some level of seasonal grazing. The positive trend may also be attributed to the irrigation regime from an irrigation/stock water ditch located between the trend plots. No actual data has been collected on soil moisture at the plots but observational data does not indicate that the plots have ever been inundated or drying out and that the management regime of the ditch has remained consistent.



***Total plants, all age classes combined**

Land Management. Figure 8. Grazed Pool Field

Land Management Table 4. Raw Data

Plot Number	Year	Species	Seedling	Juvenile	Mature	Total
Pool Field 1C (Grazed)	2009	Owens Valley checkerbloom	N/A	N/A	N/A	N/A
	2010		1	0	24	25
	2011		15	5	32	52
	2012		34	0	42	76
	2013		45	0	52	97
	2014		35	0	35	70
Pool Field 1C (Grazed)	2009	Inyo County star-tulip	N/A	N/A	N/A	N/A
	2010		0	0	12	12
	2011		0	0	4	4
	2012		2	0	7	9
	2013		4	0	8	12
	2014		24	0	25	49
Pool Field 4C (Grazed)	2009	Owens Valley checkerbloom	N/A	N/A	N/A	N/A
	2010		3	0	38	41
	2011		9	12	40	61
	2012		31	0	44	75
	2013		28	0	45	73
	2014		22	0	52	74
Pool Field 4C (Grazed)	2009	Inyo County star-tulip	N/A	N/A	N/A	N/A
	2010		0	0	4	4
	2011		0	0	2	2
	2012		0	0	1	1
	2013		0	0	3	3
	2014		1	0	4	5

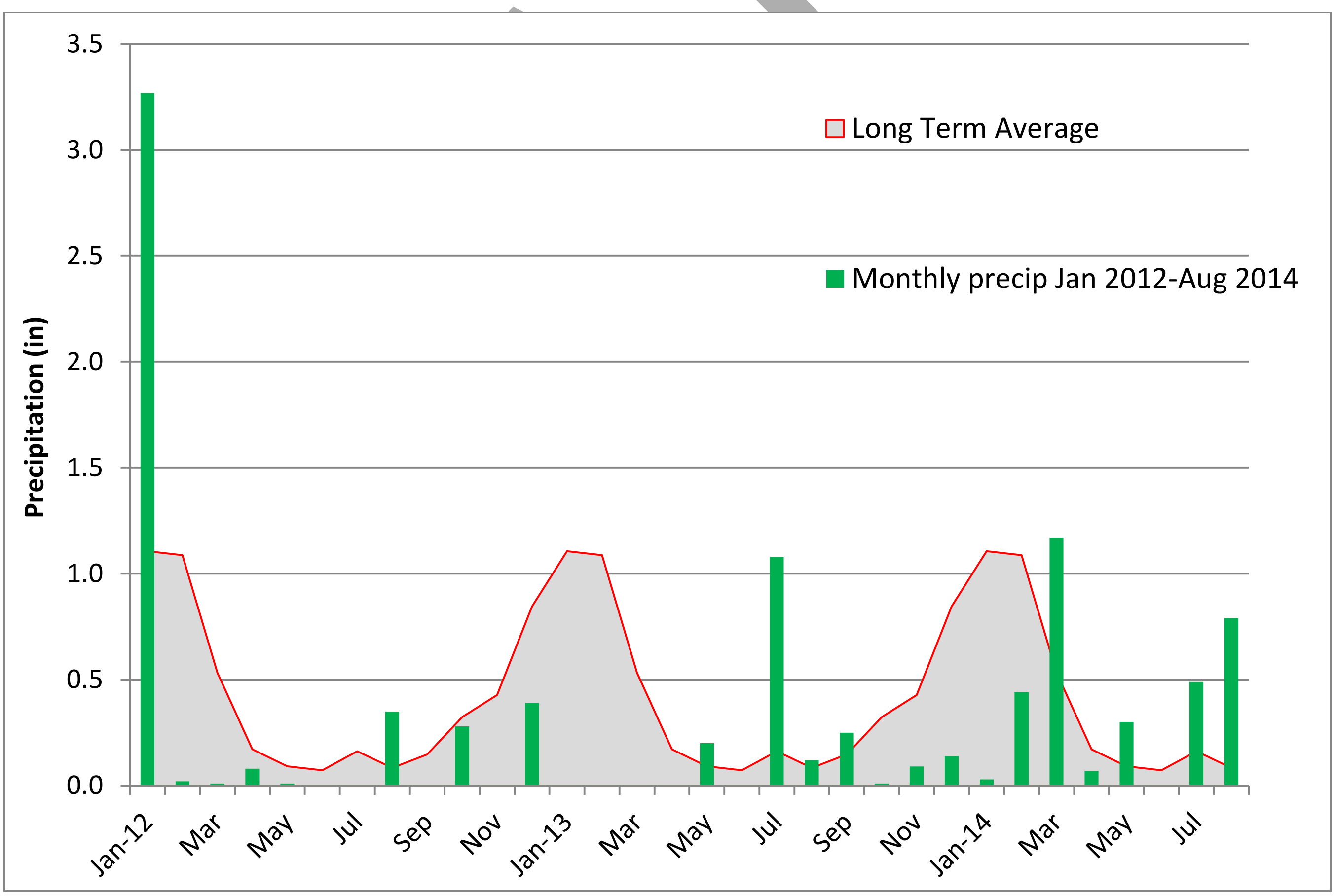
4.6.3 Rare Plant Conclusions/Recommendations

The objective of the project was to monitor impacts of grazing exclusion on Owens Valley checkerbloom. Based on 6 years of data, the trend in excluded plots appears to be decreasing across all sites. Using the Pool Field and Springer pastures as an example, some level of disturbance, grazing (per the LORP EIR grazing prescriptions) and improved irrigation water management, may contribute to maintaining stable populations of Owens Valley checkerbloom and Inyo County star tulip.

It is recommended to continue this study for one more year, particularly because the Robinson exclosure was left open in 2011. Additional data will be useful to further illustrate trends of Owens Valley checkerbloom and Inyo County star tulip within the LORP area.

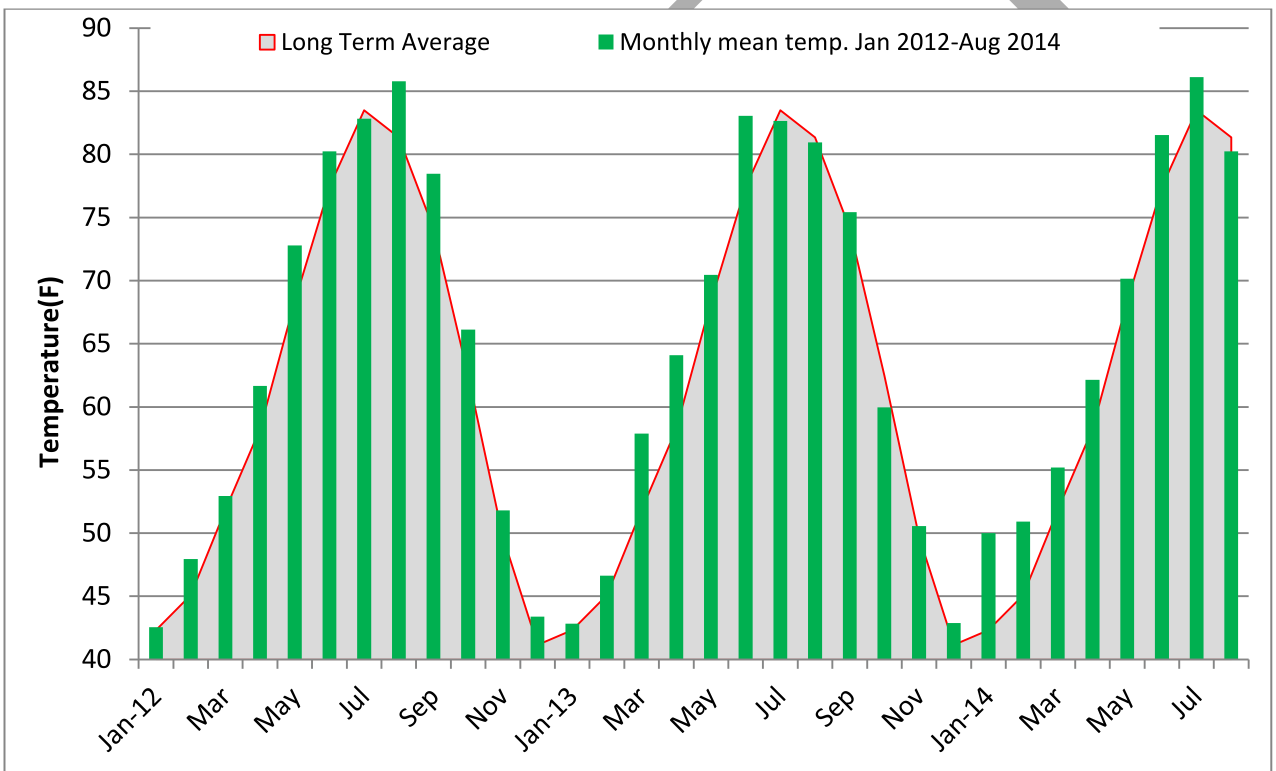
4.7 Discussion Range Trends in 2014

Range Trend transects on the Thibaut and Islands lease were read in August along with transects located in the former ‘dry reach’ from Two Culverts upstream to the southern section of the Twin Lakes lease. These included floodplain transects on the Thibaut Lease.



Land Management Figure 9. January 2012 thru August 2014 monthly precipitation data from the Intake with long-term monthly average (1991-2014).

2014 is the third year where precipitation remains well below average, particularly during the mid- and late winter periods (Figure 9). Mean monthly temperatures have typically remained at or above average for the same period (Figure 10). The winter and spring in 2014 was unseasonably warm which facilitated early growth of both cool and warm season grasses. This early break in plant dormancy helped to offset some of the impacts associated with the drought by extending the growing season of key forage plants. Effects from the drought vary depending upon location. With regards to the two leases sampled inside the LORP project area, trends remain stable on the moist floodplain sites where water tables remain high due to steady baseflows on the Lower Owens River throughout the year. Off-river Saline Meadow locations are beginning to show impacts from the drought with declining densities of perennial grasses. The post burn areas (moist floodplains) on the Islands Lease have resulted in an increase in perennial grasses and continued suppression of woody species. Continued significant declines of Nevada saltbush along multiple locations on the former dry reach of the Lower Owens are a result of the rising water table as the river continues to aggrade.



Land Management Figure 10. January 2012 thru August 2014 mean monthly temperature data from Independence compared to long term mean monthly temperatures (1991-2014).

4.7.1 Impacts of Early Season Grazing on a Moist Floodplain

In order to better understand the impacts of livestock grazing during the onset of the growing *season upon subsequent regrowth of key forage grasses, a small experiment was conducted on* a moist floodplain ecological site on the Lone Pine Lease between May 2014 and September 2014. Four plots, 10 ft x 5 ft were selected on a moist floodplain meadow exhibiting fairly homogenous conditions concerning vigor, micro-topography, moisture availability, and species composition. Three plots were selected on the west side of the Lower Owens River and one plot was selected on the east side of the river. On May 20, 2014 all four plots were clipped to a 5-inch stubble height which is equivalent to approximately 35-40% use if the area was grazed by livestock. The plots were then staked at each corner and their locations were recorded using a GPS unit. Plots were clipped and weighed 115 days later in September. Three $0.25m^2$ quadrats were randomly placed inside each of the four plots clipped in May and three quadrats were placed in conjunction at random locations adjacent to each plot, totaling 12 clipped quadrats for the treatment and 12 clipped quadrats for the control. Current years above ground biomass were then dried and weighed. LADWP tested whether biomass removal in May would result in an overall decrease in biomass production at the end of the growing season when compared to the control which did not experience biomass removal in May. A one-sided Student's t-test was used to evaluate and results showed there was no difference in production between the control and clipped plots at the end of the growing season for salt grass(t=0.0, p=0.5) and for alkali sacaton (t=-0.61, p=0.28). It is concluded that early season moderate use followed by three months of rest will have very little or no influence on overall annual production on moist floodplain meadows.

Plot	Treatment	Control
LP_DISP_1	(CLIPPED)	OUT
	35.3g	23g
	33.2g	36.1g
	44.3g	38.3g
LP_DISP_2	34.8g	35.0g
	31.8g	53.9g
	42.3g	36.5g
LP_DISP_3	40.8g	44.3g
	23.1g	40.4g
	49.0g	27.1g
Mean	**37.17g**	**37.12g**
LP_SPAI_1	50.9g	68.9g
	44.0g	49.5g
	65.5g	57.6g
Mean	**53.5g**	**58.7g**

4.8 Streamside Monitoring for Woody Species

In response to adaptive management recommendations by the MOU consultants, LADWP implemented a streamside monitoring program in 2010. The objective of the monitoring effort was to document establishment of woody vegetation in the riparian corridor of the LORP, browsing activity, and streamside conditions that were being missed in other monitoring activities. This streamside monitoring effort was to be conducted twice a year for the first 3 years (if needed) to establish baseline conditions, and then once annually at 3-year intervals until the completion of all project monitoring in 2022. Scheduling has since changed where monitoring continues annually instead of every three years and additional sites demonstrating high numbers of juvenile tree willows are included while sites with low numbers of willows are dropped. Monitoring was designed to be completed in the spring and late summer/early fall to correspond with livestock rotation. The complete streamside monitoring protocol can be found in Land Management Appendix 4 in the *2010 Final Lower Owens River Project Annual Report*.

From 2010 to 2012, a count and classification (juvenile, mature, decadent, dead) of inundated 'in channel' trees at base flow level from the transect edge, across to the other side of the river was incorporated into the protocol. The objective for this was to track survivability of older pre-LORP trees which colonized the bottom of the channel prior to the return or augmentation of flows throughout the LORP. These existing trees presently serve as the primary seed source for tree establishment. In 2013, counting of the in channel trees was discontinued because of the low degree of repeatability caused by poor cross channel visibility. With the availability of new aerial imagery collected in the summer of 2014, trends for in-channel trees will be compared by examining changes between 2009 imagery and the 2014 imagery. This imagery is currently being processed and results will be reported in 2015.

A refined classification of browsing was integrated into the protocol in 2012. Previously, a tree was recorded as browsed or not. Research has demonstrated that juvenile riparian trees can typically withstand light leader browsing (<30%) before overall growth of the tree becomes suppressed (Guillet and Bergstrom, 2006; Lucas et. al., 2004; Conroy and Svejcar, 1991; Shaw, 1992; Platts, personal communication, 2012). Changes to the protocol evaluated browsing intensity as either no leaders browsed (0%), less than 25% leaders browsed, or greater than 25% of leaders browsed for trees less than 6 feet in stature. Browsing levels were further divided into trees less than 6 feet and trees greater than 6 feet based on the idea that trees that exceed 6 feet will be able to grow to their natural heights because they will have grown above the browse line. To monitor highlining of mature trees greater than 6 feet, the same classes of leader use were applied to leaders below the browse line which was typically less than 6 feet. The final modification to the streamside monitoring for woody species regeneration was the elimination of belt transects for assessing woody riparian establishment and survivability on the LORP. The criteria used to eliminate plots were those which had no seedling or juvenile willow or cottonwood trees. The only plots that remained were plots with more than one seedling or juvenile tree and all plots inside of the livestock grazing/browsing exclosures. This resulted in 12 original plots remaining and 20 were eliminated. Using results from previous RAS surveys that identified locations with woody recruitment, additional locations were surveyed for their potential as long-term study plots for the project. All plots located within grazing exclosures were sampled in 2013 but were not revisited in 2014 because of time constraints and the knowledge that there were no juvenile trees present in the exclosures. In the fall of 2013, the Streamside Monitoring project incorporated an additional metric of sampling: the height of all woody riparian species which are less than 6 feet tall and then making note of tree taller than 6 feet. Heights will be sampled in the fall.

The Streamside Monitoring study examines the interactions between the combined browsing of elk and livestock and interaction of elk alone on woody riparian juvenile and mature trees. In this study a juvenile tree is defined as a tree >1 year and a

<3-inch DBH (Diameter at Breast Height), with the exception of coyote willow which in this project is considered to be a shrub willow. The distinction between trees used solely by elk versus elk and cattle combined is done by sampling plots in May immediately after most livestock have left the river and revisiting the same sites again in late September, allowing for a 4-5 month period when only Tule Elk are present on the river. Livestock exclosures are also used, to a lesser extent, to make similar spatial comparisons on the few exclosure sites which support tree willows. The exclosures also serve to examine what, if any, impacts the removal of livestock may have on willow and cottonwood recruitment. Thus far there is no evidence indicating that the removal of livestock will increase the frequency of recruitment events. The study also examines intensity of highlining or browsing accessible leaders by large ungulates on mature trees. There are several avian species which require the lower branches of mature riparian tree species for nesting. This study will also look at long-term trends over time as it relates to the survivability of tree willows both in the belt transect along the stream bank and inside the channel.

The biological definition of recruitment refers to seedlings that have germinated this year (germinants). This growth stage of a plant is usually its most vulnerable and is prone to high mortality (Leck, M. et. al., 2008). What is more useful for assessing long-term condition of the Lower Owens River with regard to woody riparian trees would be the examination of recruitment sites over subsequent years and shifting the focus to the survivorship of seedlings identified from the first recruitment event. Cooper used the concept of establishment defined as the survivorship of seedlings after three growing seasons (Cooper et. al, 1999).

It is important to point out that all sites in this study which contain willows were not randomly selected. These locations were intentionally chosen because of their potential to provide a greater understanding: 1) of willow survivability over time, 2) riparian tree susceptibility to different levels of browsing/highlining, and 3) what influences livestock, beaver, and elk may play upon young willow stands during the dormant and growing season. The following results cannot be extrapolated to represent conditions typical to the entire 124 miles of riverbank which comprises the Lower Owens River.

In 2014, thirteen plots were sampled, both in the spring and in the fall. Because of time constraints, monitoring focused only on those sites which would provide the most information which translated to sites with at least 10 juvenile trees. Thirteen plots were sampled, beginning in the north on the Twin Lakes Lease (TWN_5A, TWN_4A), Blackrock Lease (BLK_10B, BLK_13B, BLK_14B, BLK_15A, BLK_17B, BLK_8A, BLK_9B, BLK18A) Thibaut Lease (THIB_2A), and the Island Lease (ISL_4B, ISL_5B). Two plots were subsequently dropped in the fall because the large majority of the juvenile trees had grown above six feet and were expected to survive over the long-term. These sights may be revisited in the future. The two plots were ISL_5b and BLK_13b. The following section in the 2014 LORP Annual Report presents summarized results of eleven combined transects. Detailed descriptions of individual plots and associated maps can be found in the 2013 LORP Annual Monitoring Report.

Land Management Table 5. Density counts for plots with greater than 10 juvenile tree willows

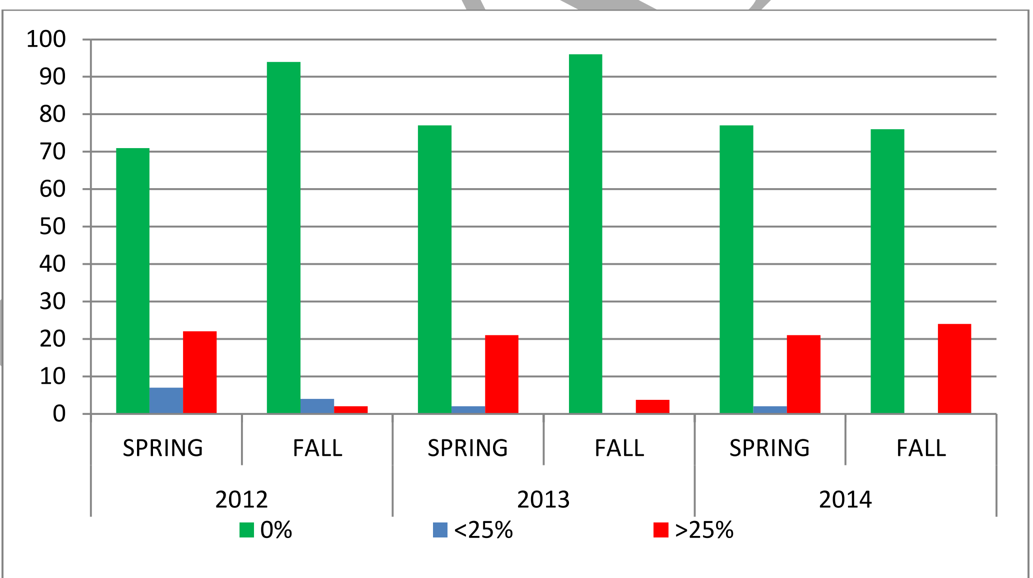
Density counts for plots with greater than 10 juvenile tree willows, 2012-2014				
PLOT	**Age Class**	**2012**	**2013**	**2014**
BLK_10B	Juvenile	29	27	22
	Seedling	1		
BLK_14B	Juvenile	174	249	156
	Seedling	1		
BLK_15A	Juvenile	59	76	65
	Seedling	2		
BLK_17B	Juvenile	74	44	32
BLK_8A	Juvenile	13	13	3
BLK_9B	Juvenile	21	39	21
	Seedling	2		
ISL_4B	Juvenile	35	30	24
THIB_2A	Juvenile	34	29	19
TWN_4A	Juvenile	43	38	40
BLK_18A	Juvenile		518	550
TWN_5A	Juvenile		230	176
			1,293	**1,108**

The total juvenile tree willow density for the eleven plots declined from 1,293 individuals in 2013 to 1,108 in 2014, a difference of 185 trees (Table 5). This decline was offset by an increase in juvenile tree height across all transects, with a mean increase of 13 cm across all eleven transects and a mean increase in total height from 61 cm to 74 cm (Table 6). Under natural conditions there is an expected reduction in juvenile tree densities in exchange for an increase in tree height and volumes.

Land Management Table 6. 2013-14 Mean Juvenile Tree Willow Heights

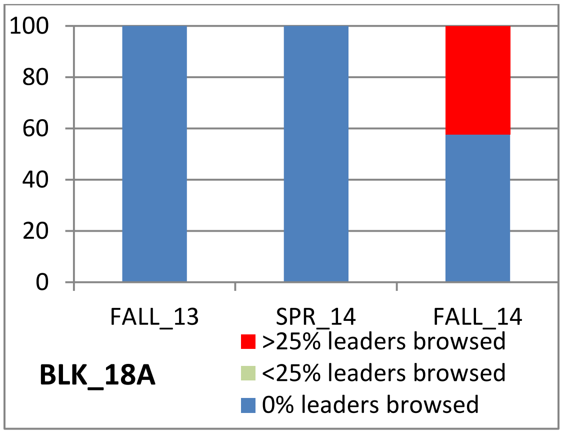
2013 and 2014 mean juvenile tree willow heights			
	2013 Mean Juvenile Ht (cm)	2014 Mean Juvenile Ht (cm)	Difference in mean ht. b/w 2013-14
BLK_10B	109	150	41
BLK_14B	74	86	12
BLK_15A	66	89	23
BLK_17B	77	93	16
BLK_18A	38	45	7
BLK_8A	84	188	104
BLK_9B	64	121	57
ISL_4B	57	71	14
THIB_2A	99	220	121
TWN_4A	88	112	24
TWN_5A	81	98	17
Average	61	74	13

Browsing of leaders averaged across all eleven transects exhibited similar patterns to the two prior years, with the exception of an increase in fall use for this year. This jump in heavy browsing in the fall is attributed to BLK_18A where elk had browsed approximately 42% of the 550 juvenile trees observed on the site in the fall of 2014.



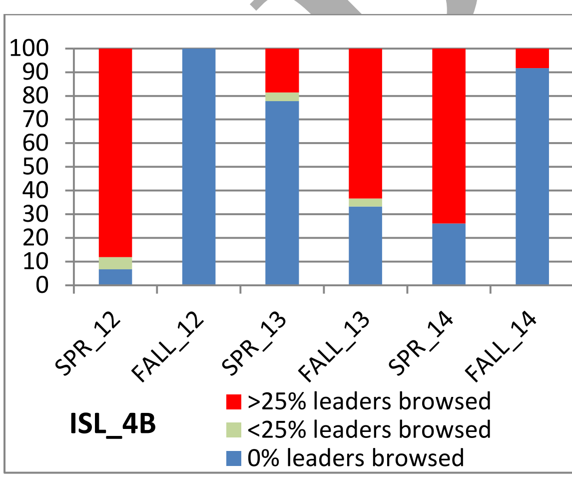
Land Management Figure 11. Percent tree willow use browsed leader class across all eleven transects for spring and fall from 2012 to 2014.

When use is examined at the transect level, browsing intensity varied considerably across the eleven sites. No use or use at a minimal level for both Spring and Summer occurred on seven sites (BLK_15A, BLK_8A, BLK_17B, BLK_9B, BLK_10B, THIB_2A, and BLK_15A). Browsing during the summer (elk) in 2014 was nominal across ten of the eleven sites. BLK_18A was browsed at fairly high levels by tule elk approximately a week prior to sampling in September, 2014 in the figure below. The same site was grazed heavily by livestock in February 2014 prior to the break of tree dormancy; however, cattle were exclusively targeting herbaceous material. Livestock were removed from the pasture in early March and sampling on the transect in May recorded no browsing of tree willows.



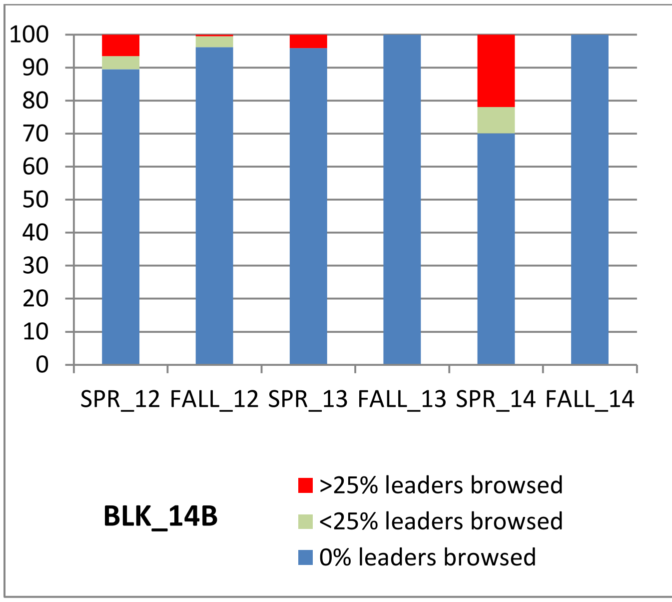
Percentage of leader class browsed, BLK_18A

Browsing of tree willows by livestock (spring use) occurred on four of the eleven transects (ISL_4B, BLK_14B, TWN_4A, and TWN_5A) with the heaviest use (74% of juvenile trees experiencing >25% browsing of leaders) occurring on the Islands lease at ISL_4B in the figure below. This site has continuously been browsed by both elk and livestock since 2012. Mean growth in juvenile tree height was 14 cm for the site. The site is open and in close proximity to the only shaded areas in a large meadow on the east side of the river.

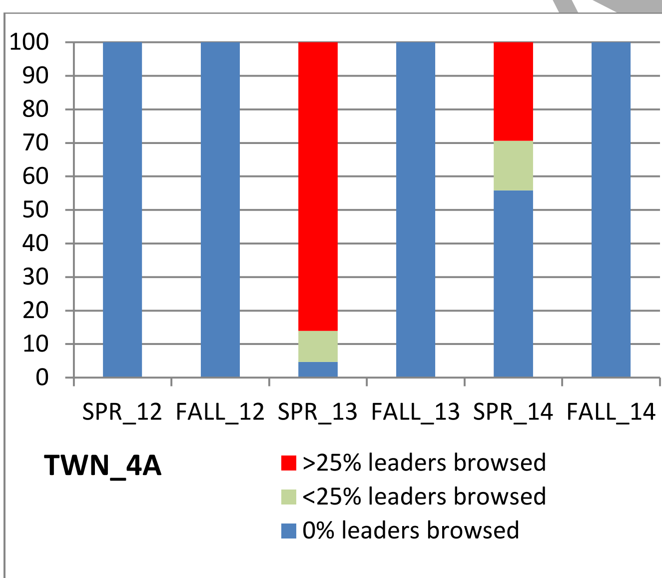


Percentage of leader class browsed, ISL_4B

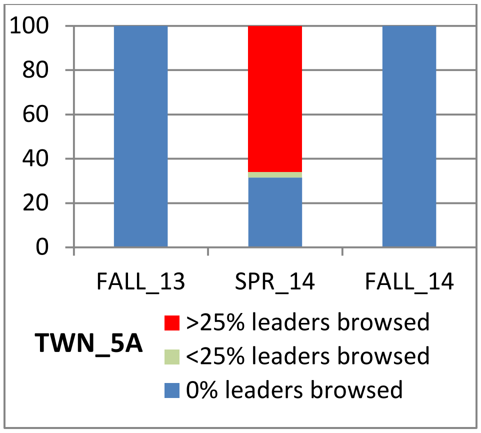
BLK_14B experienced moderate browsing (22% juvenile with >25% leader browsed) during winter, but no browsing was recorded during summer in the figure below. Two plots on the Twin Lakes lease also experienced heavy browsing, in particular site TWN_5A in the figure below. Cattle on this site and on the Islands site were in the pasture until mid-May. Both sites were examined in February and there was no use at either location.



Percentage of leader class browsed, BLK_14B



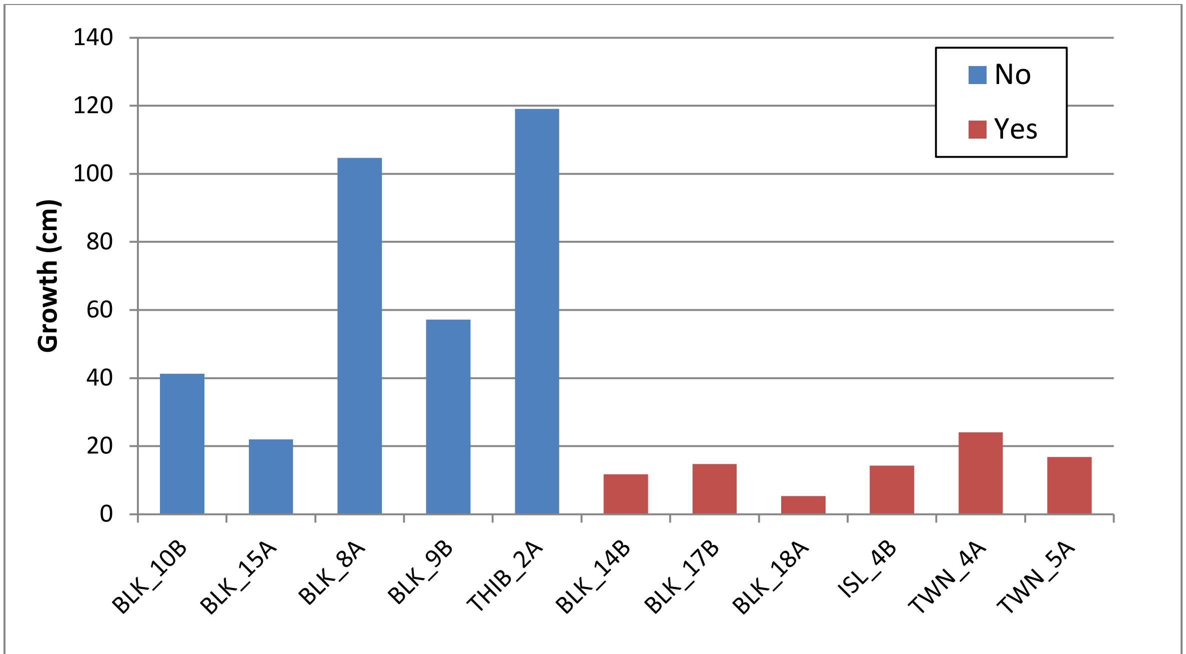
Percentage of leader class browsed, TWN_4A



Percentage of leader class browsed, TWN_5A

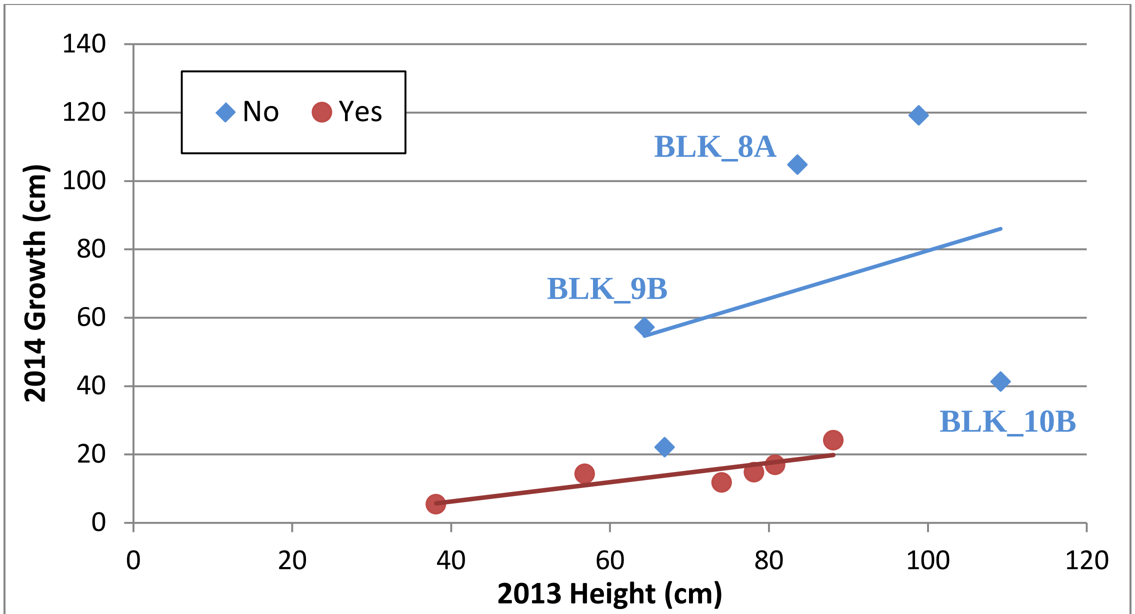
Excessive browsing can inhibit potential heights of trees and shrubs, decrease leader densities, and in some cases completely alter the species composition of riparian zones (Belsky et al, 1999; Boggs and Weaver, 1992; Green et al, 1995). Lacking successful willow recruitment, riparian systems can develop unbalanced age class distributions eventually leading to the die off of willow stands (Kauffman, 1987). Moderate spring and fall forage utilization (36%-55%) has shown to have little impact on red willow and coyote willow survivorship and the tree's ability to reach full growth potential, while heavy utilization (56%-75%) and summer long use can retard both growth and seedling densities (Shaw, 1992). The single finding common to all studies of livestock impacts on riparian areas is that no two situations are similar (Kauffman and Krueger, 1984; Kovalchik and Elmore, 1992). This known variability serves to emphasize the need for continued study of livestock impacts on the Lower Owens River. Successful stand establishment on the Owens River is thought to require browsing intensities where less than 25% of juvenile leaders are browsed annually (Platts, pers comm). Repeated browsing could slow the growth of juvenile trees to the point where further growth could be severely retarded or cease altogether. Maintaining steady growth is crucial for long term survival and the establishment of a natural woody riparian structure which will in turn support riparian wildlife.

Utilizing the juvenile tree height data collected in 2013 and 2014 combined with data quantifying browsing intensities from six sampling periods (spring & fall 2012, 2013, and 2014) on those same trees we tested whether recent heavy browsing events could negatively influence juvenile tree willow growth. A Student's t-test was used to test whether there was a significant difference in juvenile tree willow growth between two types of sites, one which was browsed heavily during past three seasons (spring and fall 2014, 2013, and 2012), and the other which was not browsed heavily during past three seasons. If a site had been browsed heavily at least once during this same period, we assigned "yes" to heavy browsing. If no heavy browsing was recorded during past three seasons, "no" was assigned to the site. The result of the t-test shows there is a significant difference in growth of juvenile tree willows between two sets of sites ($t = -2.89$, $P = 0.021$); the juvenile tree willow at the sites which have experienced heavy browsing have grown less (Figure 12). Recent heavy browsing adversely influences the juvenile tree willow growth.



Land Management Figure 12. Difference in juvenile tree willow growth between two types of sites; one which has experienced heavy browsing at least once during past three seasons (Yes – red color) and the other which has not experienced heavy browsing during past three seasons (No – blue color).

Second, we examined the same relationship in the context of tree height. The precise age of each juvenile tree willow is unknown, but must reach approximately six feet or 182 cm in height in order to be relieved from heavy browsing according to observation. At the site that has experienced heavy browsing, growth of tree willows was similar for trees with different starting height (Figure 12). At the site which has not experienced heavy browsing, on the other hand, taller trees are growing faster. Three sites (BLK8A, BLK9B, and BLK10B) had been browsed heavily during the first half of the study, but during the second half of the study no browsing has been observed. Two sites (BLK8A and BLK9B) have responded very positively to absence of recent heavy browsing. The average tree height at BLK_8A reached six feet (182 cm) during the 2014 growing seasons. BLK10B, on the other hand, has not shown a growth rate similar to the other two sites. This indicates that it may take longer than a year and a half to recover from heavy browsing.



Land Management Figure 13. Difference in juvenile tree willow growth between two types of sites; one which has experienced heavy browsing at least once during past three seasons (Yes – red color) and the other which has not experienced heavy browsing during past three seasons (No – blue color).

Juvenile trees at heavily browsed sites were shorter and not growing as much as they should. At the current rate, it may take as much as eight years to reach six feet (182 cm) in height at heavily browsed sites, if they continue to be browsed each season and are not rested. It is not clear whether trees at these sites will continue growing in the future or will stop growing; more data are needed to answer this question.

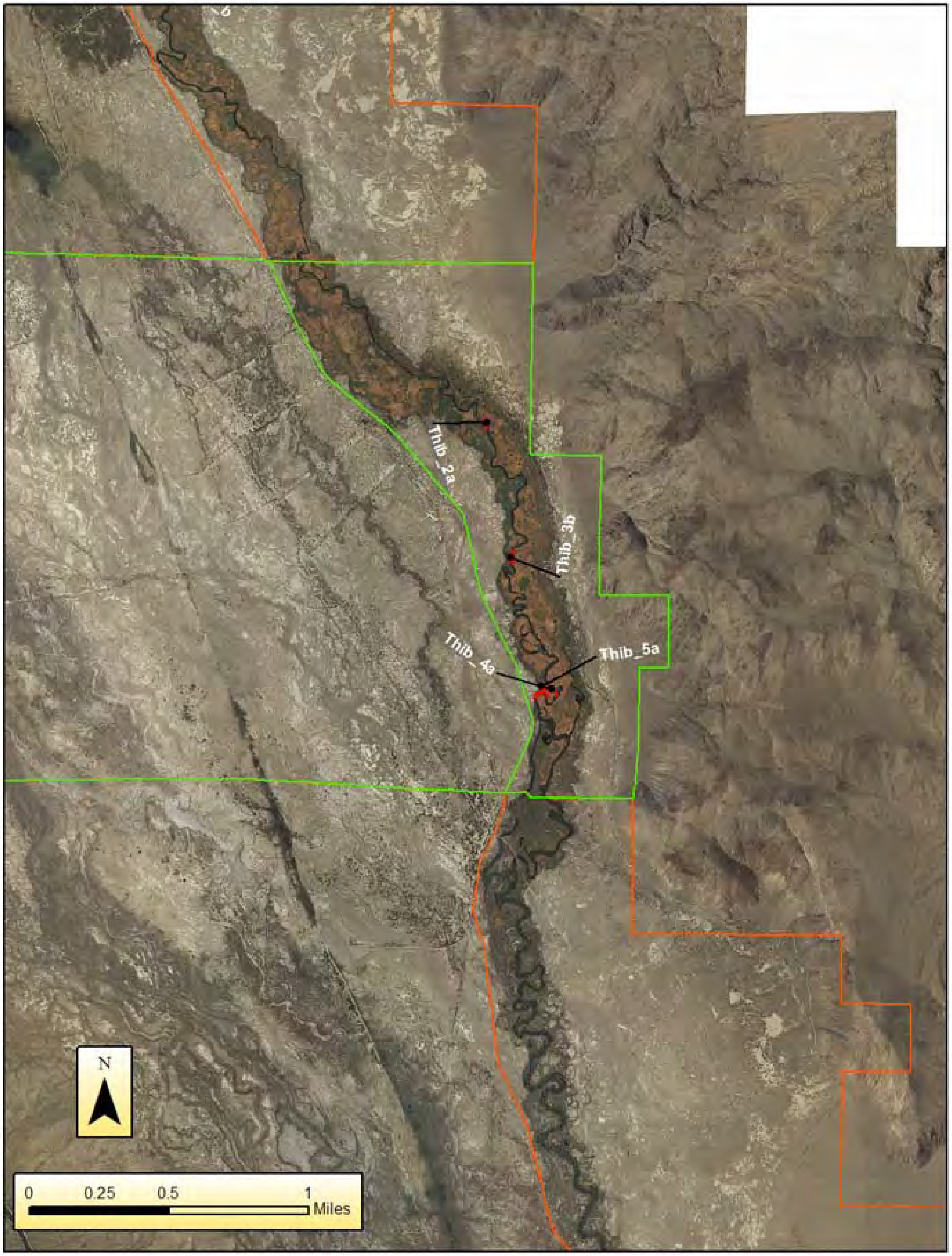
Existing data indicate juvenile tree willows are growing at heavily browsed sites but at a much slower rate than juvenile tree willows at sites with no recent browsing. Once heavy browsing stops, juvenile tree willows can start growing again at much higher rate. Young trees can maintain upward growth trajectories following a single severe browsing event if provided with at least two years of subsequent rest. Young trees experiencing repeated heavy browsing events will gain vertical heights at very slow rates, if at all, when compared to trees which have been rested from browsing for at least two years.

Continued data collection on these 11 sites will improve understanding of juvenile woody riparian growth rates and their tolerances to browsing by large ungulates. Tracking both the timing of use and grazing intensity by livestock is contributing to a deeper understanding of when young trees are targeted by elk and cattle and when they are avoided during a given season.

The following four large scale overview maps illustrate the locations of the individual streamside monitoring transects within the broader context of the LORP Project Area.

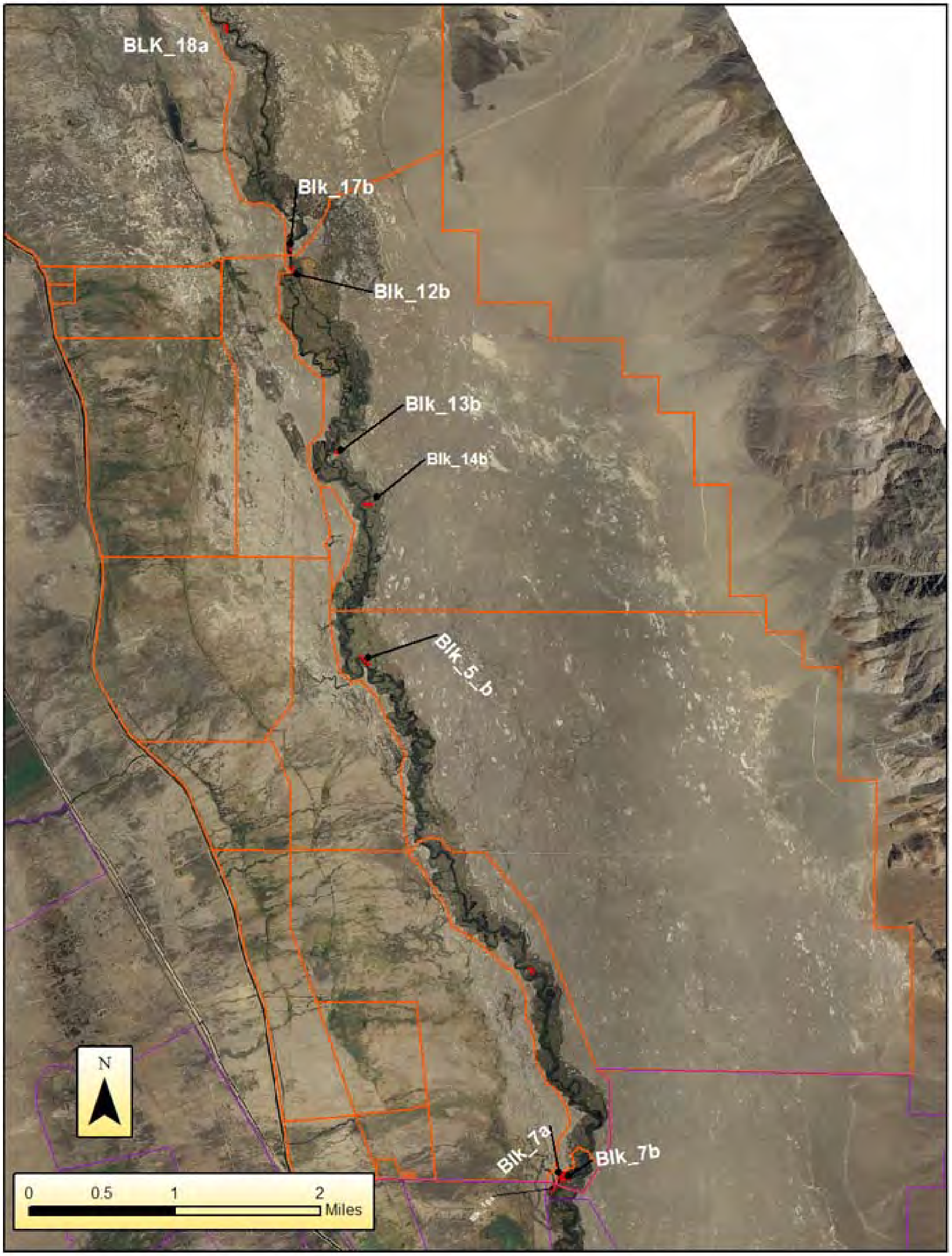
Land Management Figure 14. Twin Lakes Transects and Upper Blackrock Transects

Twin Lakes Transects (TWN_3b, TWN_4a, and TWN_5a) and Upper Blackrock Transects (BLK_1a, BLK_1b, BLK_10b, BLK_9b, and BLK_8a).



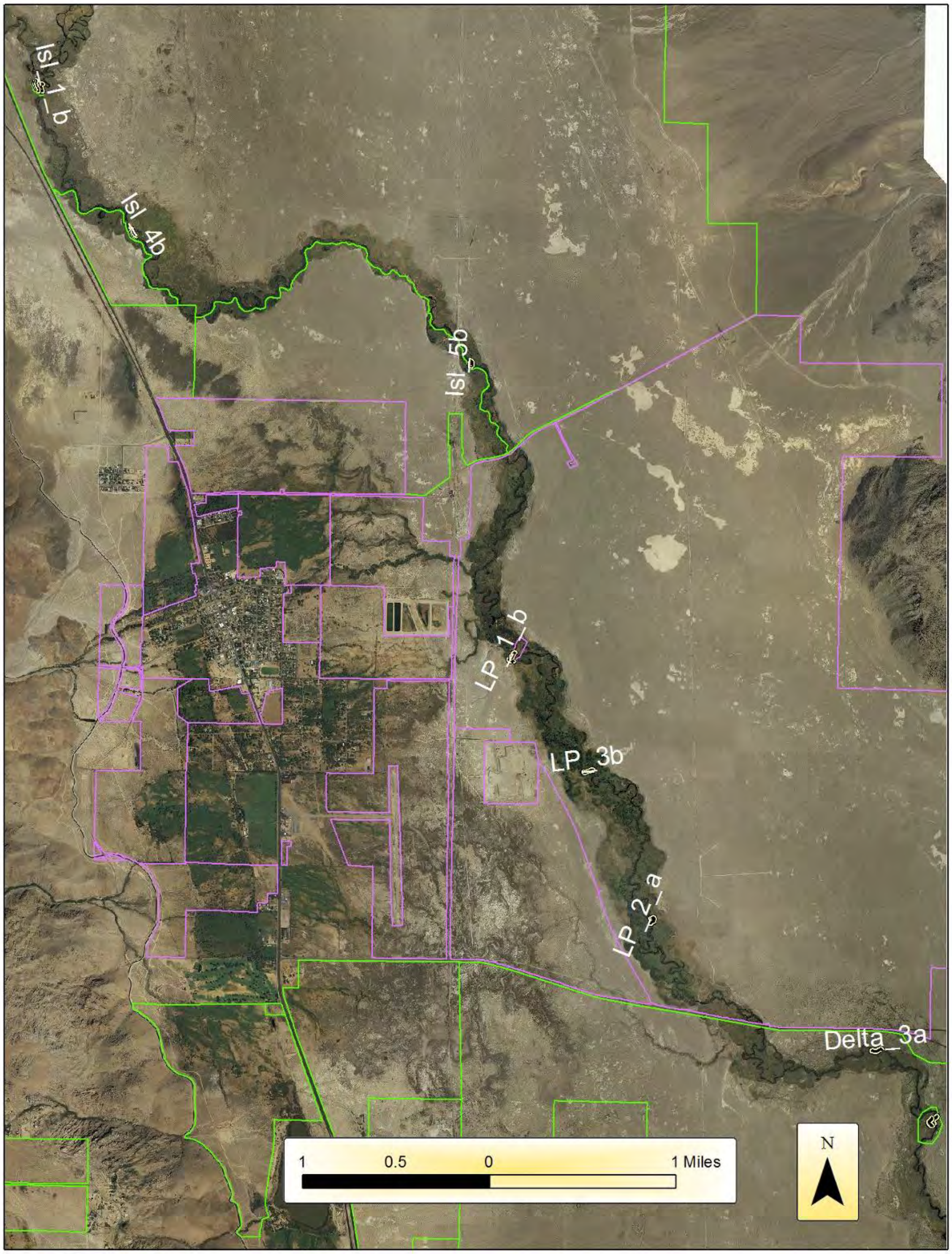
Land Management Figure 15. Thibaut Transects

Thibaut Transects (Thib_2a, Thib_3b, Thib_4a, Thib_5a).



Land Management Figure 16. Lower Blackrock Transects and Upper Island Transect

Lower Blackrock Transects (BLK_18a, BLK_17b, BLK_12b, BLK_13b, BLK_14b, BLK_5b, BLK_7a, BLK_7b) and (BLK_16a).

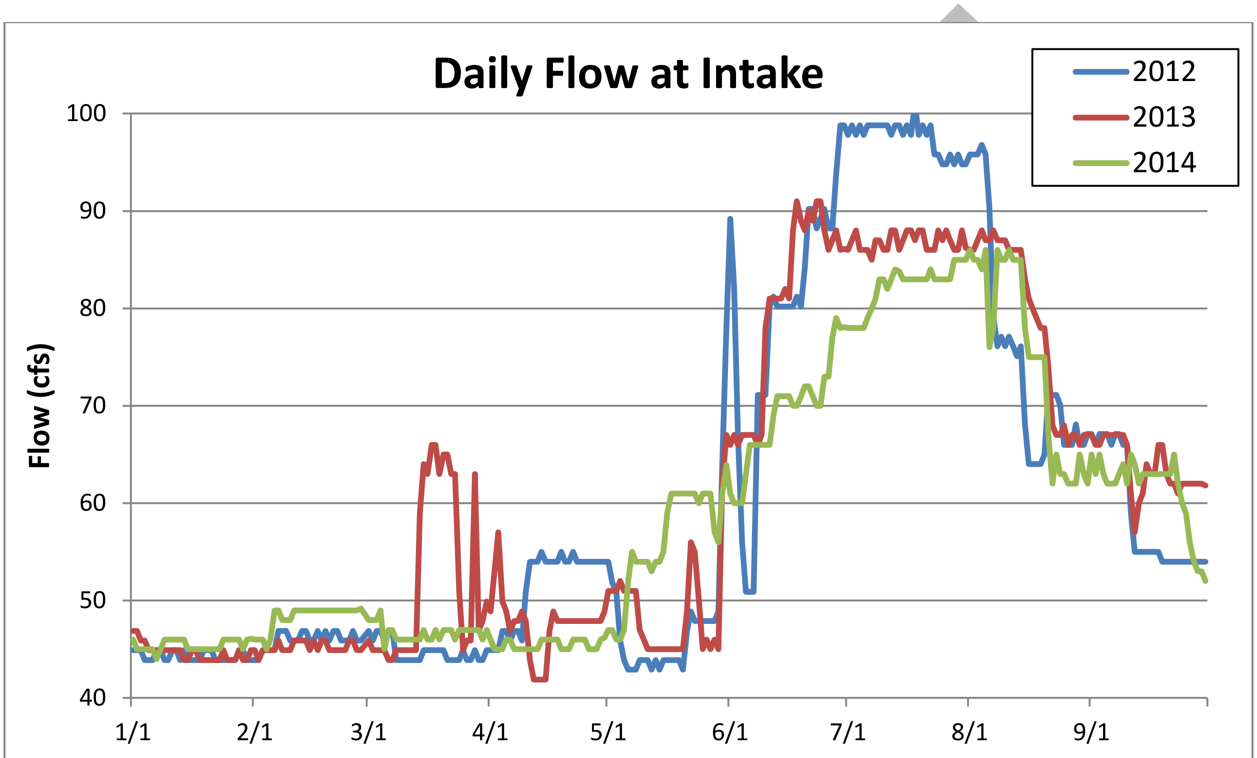


Land Management Figure 17. Island Transects, Lone Pine Transects, and Delta Transects

Island Transects (Isla_1a, Isl_1b, Isl_4b, and Isl_5b); Lone Pine Transects (LP_1a, LP_1b, LP_3b, and LP_2a); and Delta Transects (Delta_3a, Delta_1a, and Delta_1b)

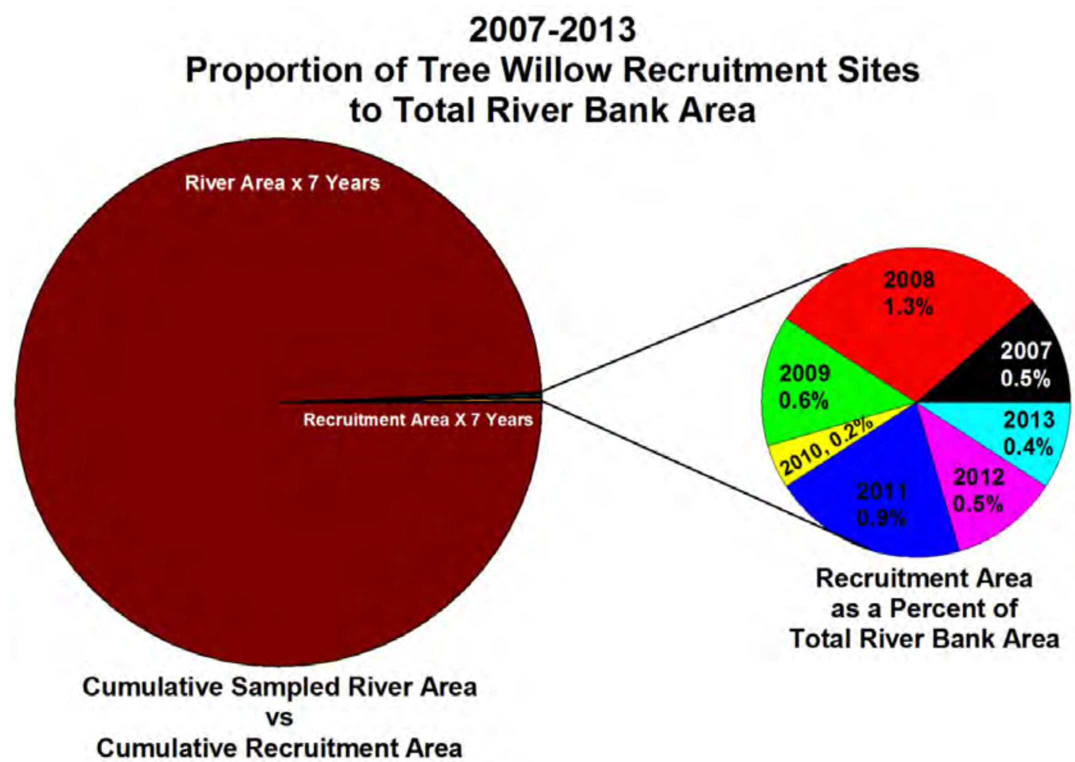
4.8.1 Discussion

Recommended flow changes on the LORP have not yet been implemented. Flows in the summer of 2014 were slightly lower than 2012 and 2013 (Figure 18), yet still reflected the same phenomena of a rising hydrograph as the summer dry out increased, despite the fact that the area is experiencing severe drought conditions for the third consecutive year. Under natural conditions, certain reaches of the Lower Owens River Project could have been dry under a more natural hydrograph. Refer to the 2013 LORP Annual Monitoring report for greater discussion concerning flow impacts on woody recruitment.



Land Management Figure 18. Daily flows from the Intake for 2012-14

In addition to the drought, the consistent 2014 summer base flows may have contributed to the lowest recruitment recorded during the LORP RAS surveys thus far. The RAS survey found 14 tree willow recruitment sites, with all containing between 1-5 seedlings. Figure 19, which does not include the 2014 RAS recruitment events, displays the cumulative proportion of prior recruitment events relative to both sides of the Lower Owens River. In this illustration, each recruitment site was assigned an area of 25 linear meters. The number of events were then summed and divided into the total linear length of the river (199,558 m). Although not depicted in the pie graph, the relative percent to the entire area for 2014 recruitment events spans 0.17% of the total area, slightly lower than the 2010 year which was the previously record low number. While both recruitment area and total sampled area are largely generalizations in this instance, this example illustrates that woody recruitment does occur on the Lower Owens River, but given the current conditions (and perhaps historic conditions) the Lower Owens is not, and most likely will not, develop into a woody dominated river system.



Land Management Figure 19. Relative proportion of cumulative recruitment areas to entire cumulative linear area sampled on the Lower Owens River.

As the Lower Owens River aggrades and emergent vegetation extends up onto point bars, opportunities for riparian woody recruitment will decrease. The eventual disappearance of recruitment sites is further assured because existing flow management that includes the present seasonal habitat flow regime will not generate enough energy to expose mineral soils for contact with willow and cottonwood seeds.

LADWP Watershed Staff proposes an experimental treatment on a small section in the White Meadow Riparian pasture using mechanical impacts from livestock to facilitate tree recruitment by increasing opportunities for seed contact with wetted mineral soils. Hoof action combined with high intensity grazing would be used to remove herbaceous biomass and expose mineral soil to facilitate willow and cottonwood seed contact on point bars. A series of three grazing cells using temporary fencing running perpendicular to the riparian boundary fence east to the river would be constructed and stocked using a short duration high intensity grazing prescription. The proposed timeframe would begin a month prior to seed fly. All cells would be stocked for the month prior. Livestock would be removed from one cell immediately before seed fly to examine the indirect effects of hoof action and herbivory for site preparation. In the other grazing cell, livestock would remain for several days after seed fly in order to see if hoof action would have any direct effect on seed germination. The third cell would be hand seeded with Goodding's willow (*Salix gooddingii*); red willow (*Salix laevigata*); and common Three-square (*Schoenoplectus americanus)* along the wetted edge.

Monitoring of pre and post conditions would be included in the project. The proposal for this experiment is the summer of 2015.

Browsing of willows by elk and livestock in discrete locations is influencing tree vigor and survivability to varying levels, yet these locations in relation to the larger area are less than 0.1%. The current flow regime has a much larger impact on willow vigor and survivability across the majority of the project area than browsing. Consequently, flow management within the LORP must be addressed if increasing woody riparian habitat is to remain a LORP goal.

4.9 LORP Ranch Leases

The following sections are presented by ranch lease. The discussion includes an introduction describing the lease operations, pasture types, a map of the lease, and utilization results from 2013-14, a summary of range trend results at the lease level, and a presentation of range trend results by transect when significant changes occurred. All range trend data for the Thibaut and Island range trend transects are presented in Appendix 2. Reference to plant species by plant symbol are found in Appendix 1, which contains a list of the plant species, scientific names, common names, plant symbol, and functional group assignment for species encountered on the range trend transects.

4.9.1 Intake Lease (RLI-475)

The Intake Lease is used to graze horses and mules employed in a commercial packer operation. The lease, which is approximately 102 acres, is comprised of three fields: Intake, Big Meadow Field, and East Field. The Intake Field contains riparian vegetation and an associate range trend transect. The Big Meadow Field contains upland and riparian vegetation; however, it is not within the LORP project boundaries. There are no utilization or range trend transects in the Big Meadow Field due to a lack of adequate areas to place a transect that would meet the proper range trend/utilization criteria. Much of the meadow in the Big Meadow Field has been covered with dredged material from the LORP Intake. The East Field consists of upland and riparian vegetation. The Big Meadow and Intake Fields were not used by livestock during the construction of the Intake structure, which lasted until the 2008-09 grazing season. There are no irrigated pastures on the Intake Lease. There are no identified water sites needed for this pasture and no riparian exclosures planned due to the limited amount of riparian area within the both pastures.

The following table presents the summarized utilization data for each field for the current year.

Land Management Table 7. End of Grazing Season Utilization on the Intake Lease, RLI-475

Field	Utilization	Transect	Utilization
Intake Field*	10%	*STEWART_01	10%

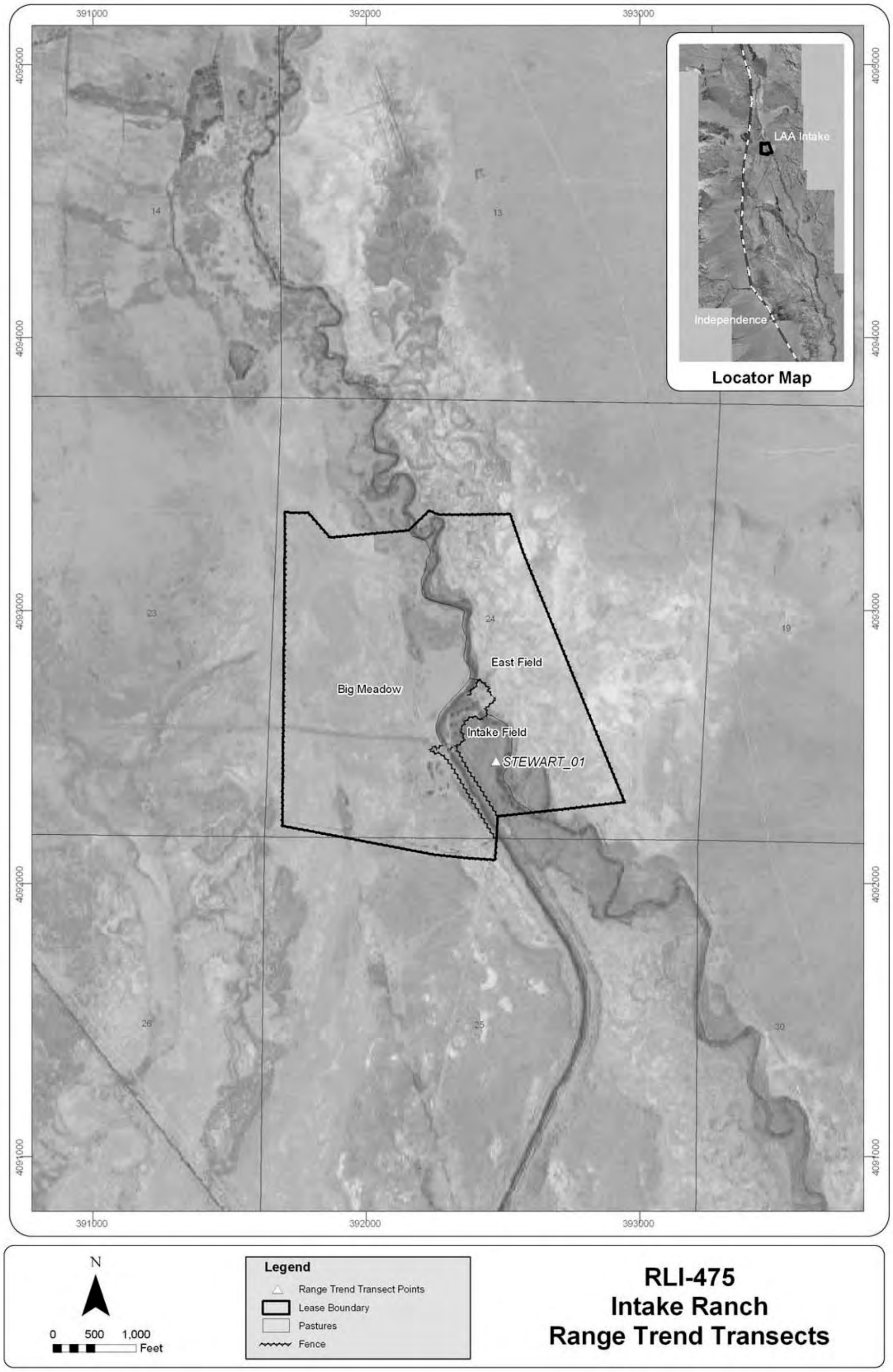
**Riparian Utilization, 40%*

<u>Summary of Utilization</u>

Utilization for the Intake Lease in 2014 was 10%, well below the allowable 40% utilization standard.

<u>Summary of Range Trend Data and Conditions</u>

Range Trend data was not collected in 2014 on the Intake Lease.



Land Management Figure 20. Intake Lease RLI-475, Range Trend Transects

4.9.2 Twin Lakes Lease (RLI-491)

The Twin Lakes Lease is a 4,912-acre cow/calf operation situated just south of the Los Angeles Aqueduct Intake. It includes a reach of the Owens River that lies mainly north of Twin Lakes, which is located at the southern end of the Twin Lakes Lease. Of the 4,912 acres, approximately 4,200 acres are used as pastures for grazing; the other 712 acres are comprised of riparian/wetland habitats and open water. In all but dry years, cattle usually graze the lease from late October or early November to mid-May.

There are four pastures on the Twin Lakes Lease within the LORP boundary: Lower Blackrock Riparian Field, Upper Blackrock Field, Lower Blackrock Field, and the Holding Field. The Lower Blackrock Riparian, Upper Blackrock Riparian, and Lower Blackrock Fields contain both upland and riparian vegetation. The Holding Field contains only upland vegetation. There are no irrigated pastures on the Twin Lakes Lease. Range trend and utilization transects exist in all fields except the Holding Field.

The following table presents the summarized utilization data for each field for the current year.

Land Management Table 8. End of Grazing Season Utilization on the Twin Lakes Lease, RLI-491, 2014

Field	Utilization
Lower Blackrock Field	7%
Lower Blackrock Riparian Field*	6%
Upper Blackrock Field*	20%

*Riparian Utilization 40%**

Riparian Management Areas

Utilization in the Lower Blackrock Riparian (6%) and Upper Blackrock Field (20%) was well below the allowable utilization for the grazing season. Much of the grazing occurred around Drew Slough early in the season and then on the uplands for the remainder of the grazing season. The burned area on the river was in good condition and is still responding well. There are no recommended management changes.

Upland Management Area

Upland utilization was well below the allowable standard of 65% in all fields.

Irrigated Pastures

There are no irrigated pastures on the Twin Lakes Lease.

Fencing

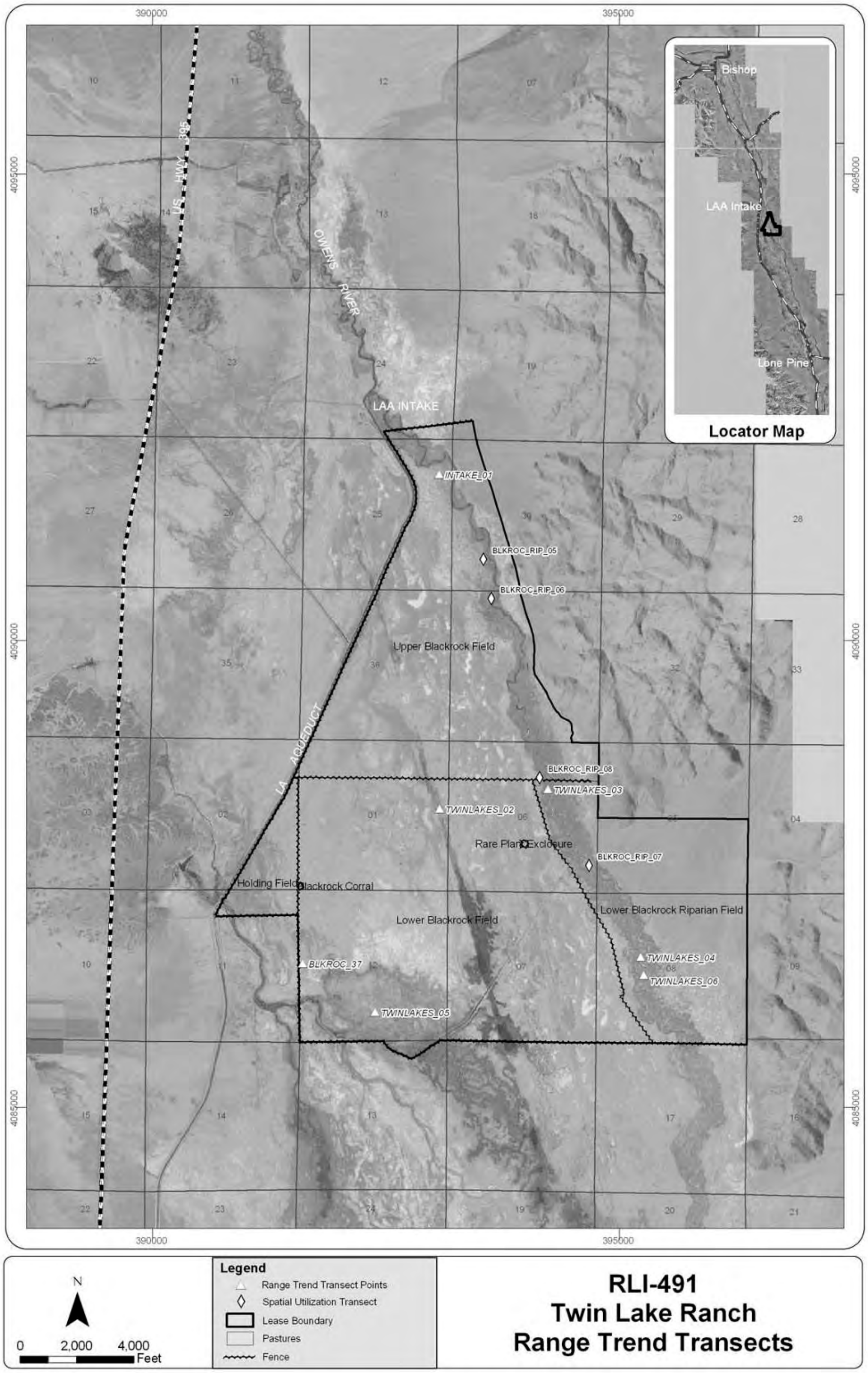
There was no new fencing constructed on the lease in 2014.

Salt and Supplement Sites

Supplement is composed of a liquid mix that is put in large tubs with rollers that the cattle consume. These tubs are placed in established supplement sites and are used every year.

Burning

A range burn was conducted in March resulting in 190 acres of riparian pasture being burned. The purpose of the burn was to remove existing saltcedar slash piles and shrubs that had encroached in to existing perennial grass meadows. Prior to the burn, California Department of Forestry (CDF) and LADWP prepared fire breaks and created buffers around existing riparian vegetation, resulting in complete fire containment, with very little loss to riparian vegetation. Overall the burn resulted in the improvement of the meadow habitat on the Twin Lakes lease.



Land Management Figure 21. Twin Lake Lease RLI-491, Range Trend Transects

4.9.3 Blackrock Lease (RLI-428)

The Blackrock Lease is a cow/calf operation consisting of 32,674 acres divided into 24 management units or pastures. Blackrock is the largest LADWP grazing lease within the LORP area. The pastures/leases on the Blackrock Lease provide eight months of fall through spring grazing, which can begin any time after 60 continuous days of rest. A normal grazing season begins in early to mid-October and ends in mid-May or June.

There are twenty pastures on the Blackrock Lakes lease within the LORP boundary: South Blackrock Holding, White Meadow Field, White Meadow Riparian Field, Reservation Field, Reservation Riparian Field, Little Robinson Field, Robinson Field, East Robinson Field, North Riparian Field, Russell Field, Locust Field, East Russell Field, South Riparian Field, West Field, Wrinkle Field, Wrinkle Riparian Field, Spring Field, Wrinkle Holding, Horse Holding, and North Blackrock Holding. Twelve of these pastures are monitored using range trend and utilization. The other eight pastures are holding pastures for cattle processing or parts of the actual operating facilities.

<u>Summary of Utilization</u>

The following tables present the summarized utilization data for each field for the current year.

Land Management Table 9. End of Grazing Season Utilization on the Blackrock Lease, RLI-428, 2014

Fields	Utilization
North Riparian Field*	39%
Horse Holding	0%
Wrinkle Riparian Field*	28%
Locust Field	53%
Reservation Field	11%
Robinson Field	17%
Russell Field	1%
White Meadow Field	7%
White Meadow Riparian Field*	15%
Wrinkle Field	21%
South Riparian Field*	8%
West Field	18%

**Riparian utilization 40% **

<u>Riparian Management Area</u>

Riparian grazing on the Blackrock lease was below the allowable 40% utilization standard. The North Riparian Field was at the allowable limit but did not go over. While conducting utilization monitoring, Watershed Resources Staff noticed an increase in flooded and inundated meadows in the North Riparian Field

Upland Management Areas

Fields in the upland portions of the Blackrock Lease remained well below upland utilization standard of 65%.

Summary of Range Trend Data and Condition Blackrock Lease

Range Trend data was not collected in 2014 on the Blackrock Lease.

Irrigated Pastures

There are no irrigated pastures on the Blackrock Lease.

Stockwater Sites

One new stockwater well will be drilled south of Mazurka Canyon road. It will be fitted with a solar pump and necessary plumbing for the trough. The lessee will be responsible for water troughs and installation. There are also three other stockwater sites that have been developed as part of the *1997 Memorandum of Understanding Between the City of Los Angeles Department of Water and Power, the County of Inyo, the California Department of Fish and Game, the California State Lands Commission, the Sierra Club, the Owens Valley Committee, and Carla Scheidlinger*, (MOU), which required additional mitigation (1600 Acre-Foot Mitigation Projects). The “North of Mazourka Project” will provide stockwater in the Reservation Field and the “Well 368/Homestead Project” will provide stockwater in the Little Robinson Field and East Robinson Field.

Fencing

There was no new fencing constructed on the lease in 2014.

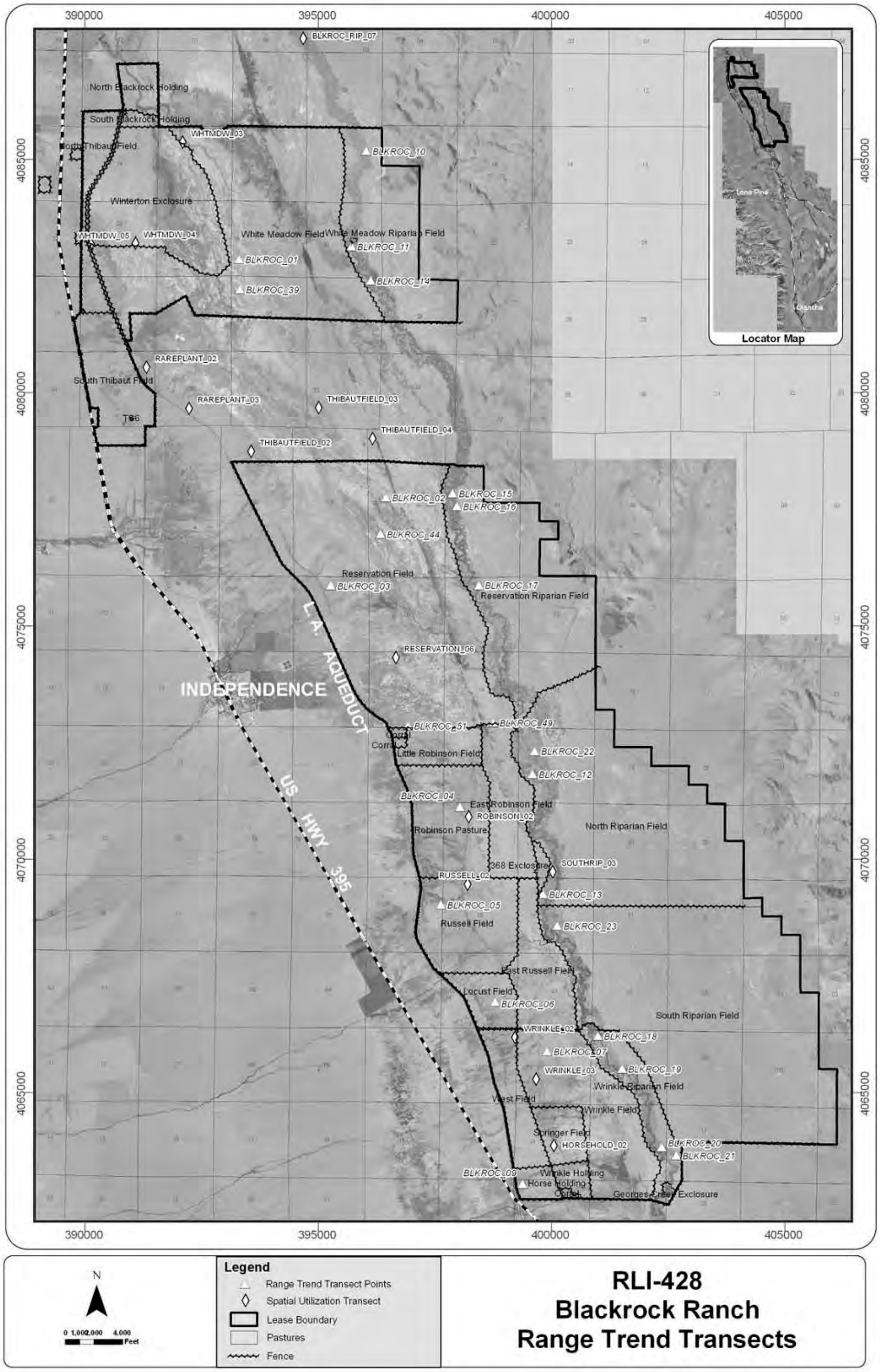
Burning

There was one range improvement burn conducted by the lessee that was approximately 100 acres in 2013. This was only a portion of the total 204 acres prepared by the lessee. The lessee plans on completing the burn in the winter of 2015. A range burn is planned by LADWP of approximately 210 acres in the White Meadow Field.

Slash pile burning along the river is planned for the Blackrock Lease in 2015, and will be done by Inyo County.

Salt and Supplement Sites

Many of the supplement sites located on the Blackrock Lease have been in place for many years and are located in upland management areas. Some of these sites have been moved in order to adapt to the installation of new fencing. These new locations were selected to better distribute cattle within and near the newly created riparian pastures.



Land Management Figure 22. Blackrock Lease RLI-428, Range Trend Transects

4.9.4 Thibaut Lease (RLI-430)

The 5,259-acre Thibaut Lease is utilized by three lessees for wintering pack stock. Historically, the lease was grazed as one large pasture by mules and horses. Since the implementation of the LORP and installation of new fencing, four different management areas have been created on the lease. These areas are the Blackrock Waterfowl Management Area, Rare Plant Management Area, Thibaut Field, and the Thibaut Riparian Exclosure. Management differs among these areas. The Blackrock Waterfowl Management Area can be grazed every other year. During the wetted cycle of the Blackrock Waterfowl Management Area management has a utilization standard of 40%. While in dry cycles the utilization standard is 65%. The irrigated pasture portion located in Thibaut Field was assessed using irrigated pasture condition scoring and the upland portions of the field were evaluated using range trend and utilization transects. The Rare Plant Management Area is evaluated using range trend and utilization transects. The Riparian Exclosure has been excluded from grazing for 11 years.

Summary of Utilization

The following table presents the summarized utilization data for each field for the current year.

Land Management Table 10. End of Grazing Season Utilization for Fields on the Thibaut Lease, RLI-430, 2014

Fields	Utilization
Rare Plant Management Area	27%
Thibaut Field	10%
Waterfowl Management Area	46%

Upland Management Areas

The end-of-season use in the Thibaut Field was 10%, well below the allowable 50% utilization. Use was 22% on the southwestern section of the Thibaut Field while on the eastern section of the field there was no use. Use in the Rare Plant Management Area was 27%, which is well below the allowable utilization grazing standard. The Waterfowl Management Area was grazed to 46% and livestock were removed in December. Watershed Resources allowed the livestock to return in the spring to the Waterfowl Management Area to reduce the graze tules in order to keep the Thibaut Pond area clear. Livestock grazed until they were moved to the mountains for the summer. Post grazing in the Waterfowl Management Area showed good results.

Summary of Range Trend Data and Conditions

Five of the seven transects on the lease remained static when compared to the prior sampling periods. Two transects (Thibaut_02 and Thibaut_03) located on a Saline Meadow which spans across a large portion of the Rare Plant Field and the Thibaut

Field showed significant decreases in perennial grasses in 2014 when compared to all prior years, with the last sampling period being 2010. Since sampling began in 2002 both sites had been relatively stable. Inland saltgrass decreased by 14% and alkali sacaton decreased by 9% on Thibaut_02 in the Rare Plant Field. Licorice plant (GLLE3) decreased by 7%, inland saltgrass dropped by 8%, and alkali sacaton decreased by 13% on Thibaut_03. The drop in Licorice plant which is not a palatable forage species, with a decrease in the two key forage grasses indicates these changes are a result of drought rather than grazing pressure.

<u>Irrigated Pastures</u>

Irrigated Pasture Condition Scores 2011-13

Pasture	2011	2012	2013
Thibaut Field	82%	81%	78%

The northern portion of the Thibaut Pasture (85 acres) comprises the area managed as irrigated pasture for the Thibaut Lease. A result of the completion of the waterfowl management area to the north and the rare plant field to the south is a grazing corridor, which puts heavy pressure on the irrigated pasture. The Thibaut Field was checked in 2014, but not rated. Conditions were similar to 2013 and the field will be rated again in 2016.

LADWP Watershed Resources staff recommends that livestock be moved out of the area periodically during the grazing season to allow the area to rest. This may be achieved by supplemental feeding further south in the Thibaut Field, electric fencing, or turning the livestock out in the southern end of Thibaut Field instead of the corral area.

<u>Stockwater Sites</u>

There is one developed water site in the Thibaut Field, which consists of a flowing well that has a stockwater well drilled next to it, located in the uplands east of the irrigated pastures in the Thibaut Field. Currently, the flowing well is still creating a small wet area for livestock and wildlife. The lessee has also installed a trough near the well.

<u>Fencing</u>

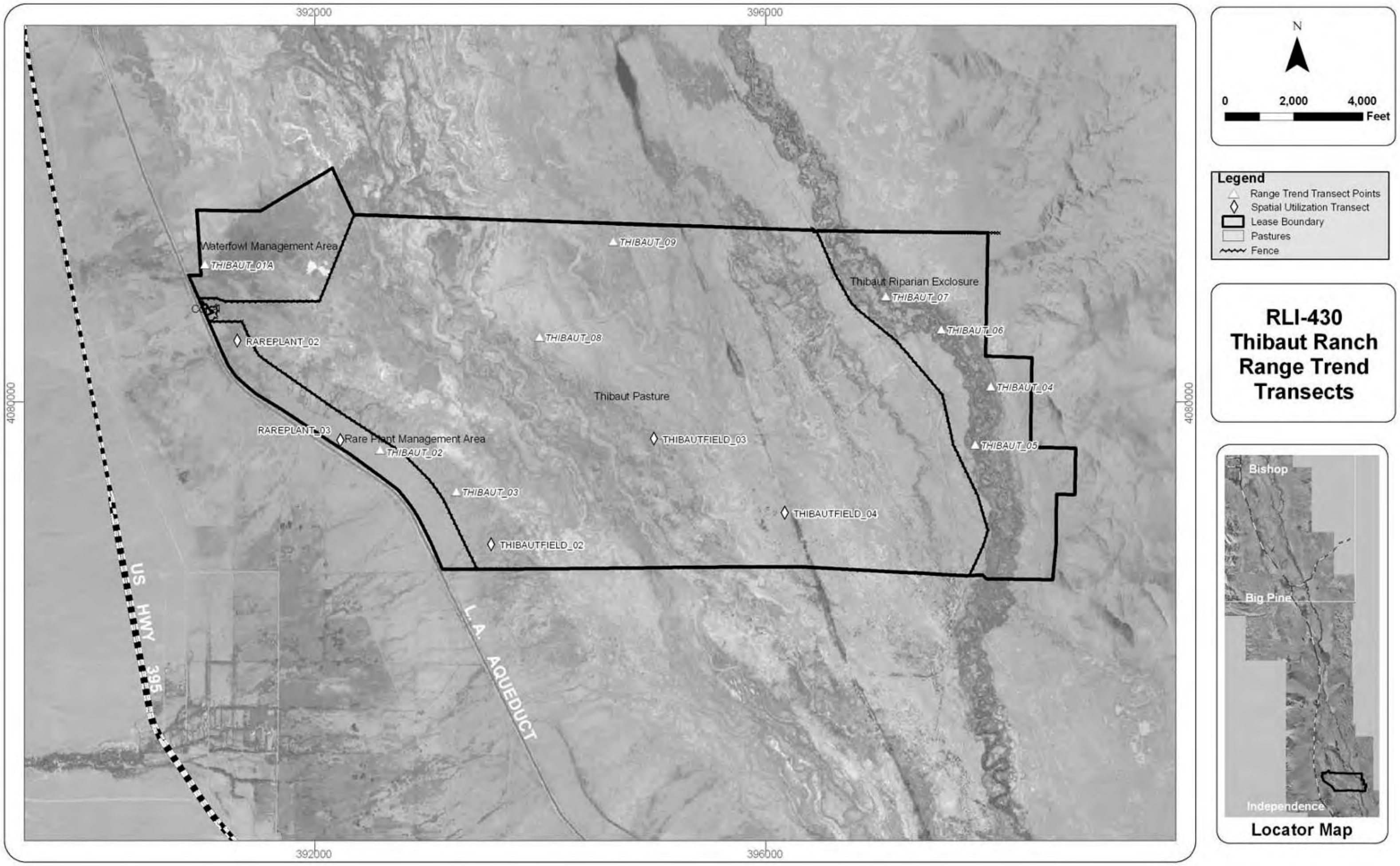
There was no new fence constructed on the lease in 2014.

<u>Salt and Supplement Sites</u>

Hay is spread in locations of the lessees choosing using a truck or a trailer pulled by a truck. Feeding areas had been changed during the 2013-14 grazing season resulting in decreased utilization in the Thibaut Field.

<u>Burning</u>

There are no burns planned for the Thibaut lease in 2014.



Land Management Figure 23. Thibaut Lease RLI-430, Range Trend Transects

4.9.5 Islands Lease (RLI-489)

The Islands Lease is an 18,970-acre cow/calf operation divided into 11 pastures. In some portions of the lease, grazing occurs year round with livestock rotated between pastures based on forage conditions. Other portions of the lease are grazed October through May. The Islands Lease is managed in conjunction with the Delta Lease. Cattle from both leases are moved from one lease to the other as needed throughout the grazing season.

There are eight pastures located within the LORP boundary of the Islands Lease:

- Bull Field
- Reinhackle Field
- Bull Pasture
- Carasco North Field
- Carasco South Field
- Carasco Riparian Field
- Depot Riparian Field
- River Field

<u>Summary of Utilization</u>

The following tables present the summarized utilization data for each pasture for the current year.

Land Management Table 11. End of Grazing Season Utilization for Fields on the Islands Lease, RLI-489 2014

Fields	Utilization
Carasco Riparian Field*	9%
Depot Riparian Field*	45%
Lubkin Field	3%
River Field *	27%
South Field	0%

**Riparian utilization 40%*

<u>Riparian Management Areas</u>

On the Islands Lease all transects were evaluated, use in the Depot Riparian Field was 45% and the River Field was 27%. Two out of the last three years utilization has exceeded 40% on the Depot Riparian Field. The Depot Riparian Field showed concentration of livestock around transects due to supplemental feeding, which accelerated utilization in the field. This can be seen at the transect level especially ISLAND_09, which had a utilization of 90%. Supplement tubs were also placed on the flood plain which served to amplify grazing impacts on the floodplain. Mid-season utilization was 42% in the Depot Riparian Field and livestock were moved. However, the lack of upland forage and the necessity for the cattle to water at the Owens River caused cattle to walk around the existing drift fence and return to the Depot Riparian Field. Watershed Resources staff recommended extending the drift fence to help eliminate over grazing in the future. The River Field was below allowable use but flooding in the area concentrated cattle in dry areas as seen on the transect data. The Carasco Riparian Field and South Field were below the utilization standards.

Upland Management Areas

All upland pastures are well below the allowable 65% utilization rate.

Summary of Range Trend Data in Islands Exclosure

Range trend monitoring was conducted in 2014 on the Islands Lease. Five transects were read and four remained static when compared to previous sampling in 2010. Following the prescribed burn in 2011, shrub cover decreased to 0% on Island_08 and Island_10. Inland saltgrass significantly increased by 16% in the burn area on the Islands_08 transect.

Irrigated Pastures

The B and D Pastures located near Reinhackle Spring were rated in 2013 and received an irrigated pasture condition score of 90%. These pastures will be rated again in 2016.

Irrigated Pasture Condition Scores 2011-13

Pasture	2011	2012	2013
B Pasture	X	90%	90%
D Pasture	X	90%	90%

X indicates no evaluation made.

Stockwater Sites

There are two stockwater sites located 1-1.5 miles east of the river in the River Field uplands near the old highway. These wells were drilled in 2010 and are now operational. The lessee has not yet installed the water troughs at the wells.

Fencing

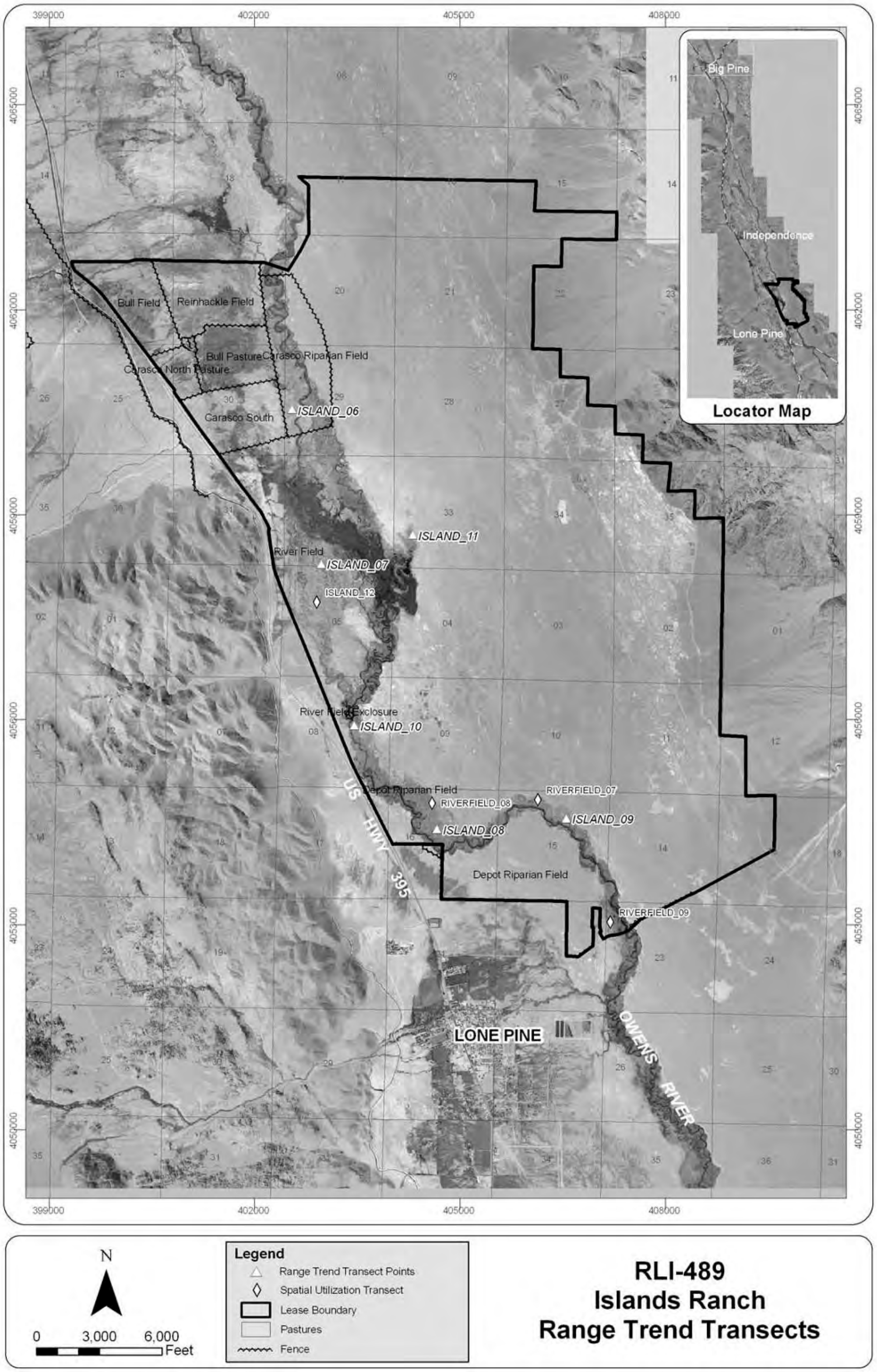
There was no new fence constructed on the lease in 2014.

Salt and Supplement Site:

Cake blocks and molasses tubs that contain trace minerals and protein are distributed for supplement on the lease. The blocks and tubs are dispersed randomly each time and if uneaten they are collected to be used in other areas.

Burning

There are currently no range burns planned for the lease for 2015.



Land Management Figure 24. Islands Ranch RLI-489 Range Trend Transects

4.9.6 Lone Pine Lease (RLI-456)

The Lone Pine Lease is an 8,274-acre cow/calf operation divided into 11 pastures and adjacent private ranch land. Grazing on the lease occurs from January 1 to March 30 and then again in late May to early June. In early June the cattle are moved south to Olancha and then driven to Forest Service Permits in Monache.

There are 11 pastures on the Lone Pine Lease located within the LORP project boundary:

- East Side Pasture
- Edwards Pasture
- Richards Pasture
- Richards Field
- Johnson Pasture
- Smith Pasture
- Airport Field
- Miller Pasture
- Van Norman Pasture
- Dump Pasture
- River Pasture

Summary of Utilization

The following tables present the summarized utilization data for each pasture for the current year.

Land Management Table 12. End of Grazing Season Utilization for Pastures on the Lone Pine Lease, RLI-456, 2014.

Pastures	Utilization
Johnson Pasture	79%
River Pasture - Lone Pine*	37%

*Riparian utilization 40%**

Riparian Management Area

The Johnson Pasture had a utilization of 79% this is over the allowable upland standard of 65%. This was due to the effects of the current drought which decreased the carrying capacity in the Johnson Pasture. A reduced stocking rate or moving cattle sooner is recommended in order to avoid overgrazing in 2015. The River Field utilization was 37%, grazing was high on LONEPINE_3 and 8. Utilization of these locations was discussed while measuring mid-season utilization with the lessee. It will be an ongoing process to reduce utilization on these transects. Recovery from the burn in 2014 was continuing well.

Summary of Range Trend Data

Range Trend transects were not read this year on the

Irrigated Pastures

The irrigated pastures within the LORP project area for the Lone Pine Lease are the Edwards, Richards, Smith, Old Place and Van Norman Pastures. All of the pastures were rated in 2013 and were above the required minimum irrigated pasture condition score of 80%, despite a dry year and lack of irrigation water. These pastures will be rated again in 2016.

Land Management Table 13. Irrigated Pasture Condition Scores 2011-13

Pasture	2011	2012	2013
Edwards	X	X	84
Richards	X	X	84
Van Norman	X	X	84
Smith	X	X	84
Old Place	X	X	84

X indicates no evaluation made

Stockwater Sites

One stockwater well was drilled on the Lone Pine Lease located in the River Pasture uplands approximately two miles east of the river on an existing playa. The lessee had made an effort to install a trough but, the well had a silting problem that plugged the pipes and floats. Watershed Resources staff and pump mechanics have assessed the condition of the well and have determined that the well was not drilled deep enough and is not operable. A new well location has been selected a quarter of a mile south of the current location and will be drilled in 2015.

Fencing

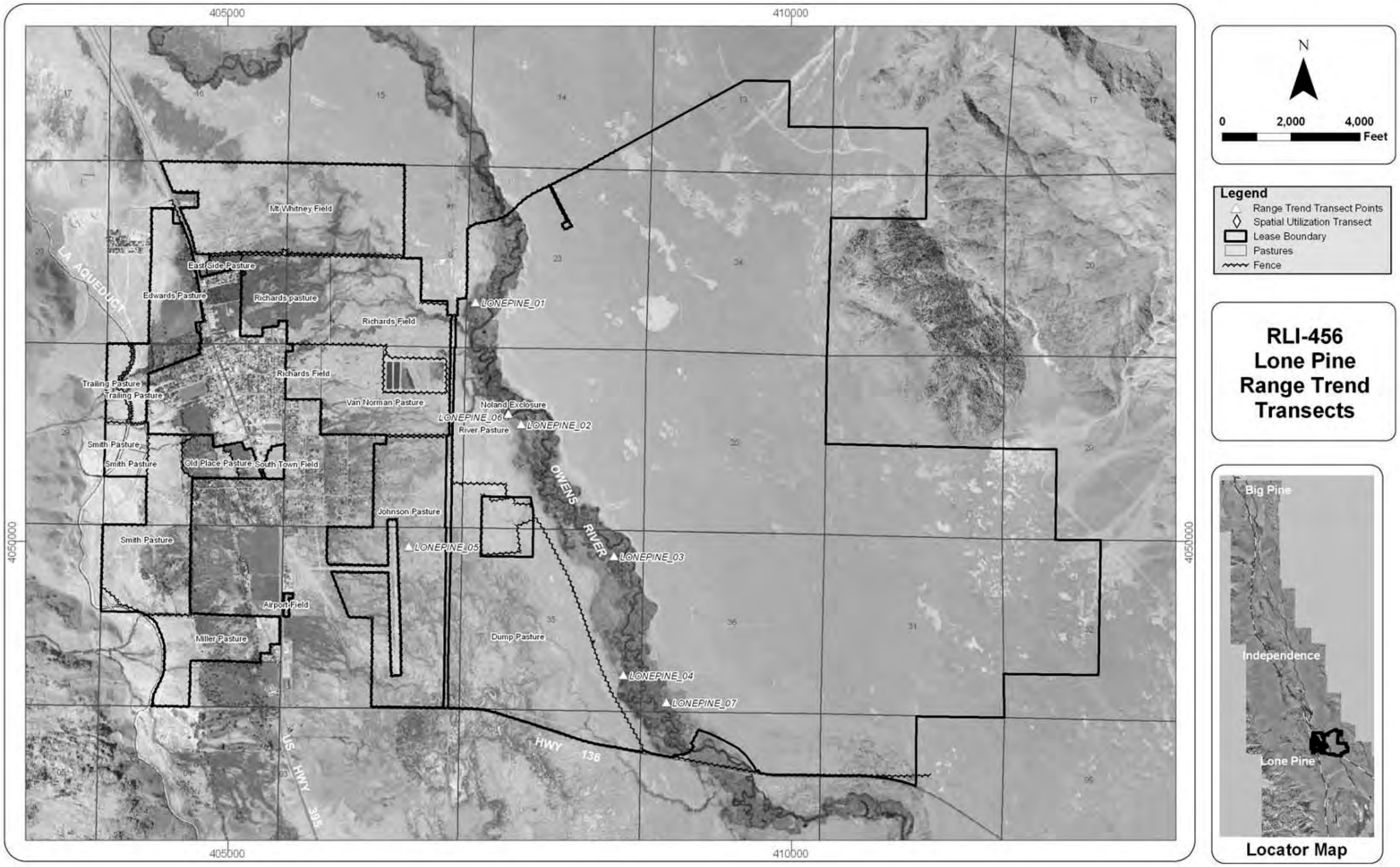
There was no new fencing constructed on the lease during 2014. Repairs have been made to the existing exclosure due to the fire in February.

Salt and Supplement Site:

All supplement tubs were situated outside of the flood plain.

Burning

There may be a burn conducted on the north end of Lone Pine in the Mt. Whitney Field to create a fire break to protect the town of Lone Pine. The burn will be conducted by California Department of Forestry. Some of the area is salt grass meadow and will benefit forage production.



Land Management Figure 25. Lone Pine Lease RLI-456, Range Trend Transects

4.9.7 Delta Lease (RLI-490)

The Delta Lease is a cow/calf operation and consists of 7,110 acres divided into four pastures. There are four fields located with the LORP project boundary: Lake Field, Bolin Field, Main Delta Field, and the East Field. Grazing typically occurs for 6 months, from mid-November to April. Grazing in the Bolin Field may occur during the growing season. The Delta and Islands Leases are managed as one with state lands leases.

Grazing utilization is currently only conducted in the Bolin Field and Main Delta Field which contains the Owens River. The Lake Field is evaluated using irrigated pasture condition scoring. The East Field, located on the upland of Owens Lake, supports little in the way of forage and has no stockwater.

Summary of Utilization

The following tables present the summarized utilization data for each field for the current year.

Land Management Table 14. End of Grazing Season Utilization for Fields on the Delta Lease, RLI-490, 2014

Fields	Utilization
Main Delta Field*	37%
Bolin Field	16%

*Riparian utilization 40%**

Riparian Management Areas

RLI-490 end-of-season utilization in the Main Delta was below the allowable 40%. The transect data shows that use was fairly even throughout due to an improvement in the livestock distribution in this field. Use was high on the southern portion of the field during the past three years.

Upland Management Areas

The Bolin Field was 16%, well below the upland grazing utilization prescription of 65%. Due to drought conditions forage production in this field has dropped, as a consequence grazing was light in the field.

Summary of Range Trend Data and Conditions

Range Trend data was not collected in 2014 on the Delta Lease. Data was collected on the lease in 2013 and will be revisited again in 2016.

<u>Irrigated Pastures</u>

The Lake Field is located west of U.S. Highway 395 north of Diaz Lake. This irrigated pasture was evaluated in 2013 and received a score of 74%. This is below the allowable score of 80%. The main reason of the decreased condition of this pasture is decreased coverage of water spreading over the field water due to drought conditions. Watershed Resources staff does not believe that change is necessary at this time the Lake Field will be re-evaluated in 2016.

Irrigated Pasture Condition Scores 2011-13

Pasture	2011	2012	2013
Lake Field	X	X	74

X indicates no evaluation made

<u>Stockwater Sites</u>

The Bolin Field was supposed to receive a stockwater site supplied by the Lone Pine Visitors Centers well in 2010. After a more in-depth analysis of water availability was undertaken, it was ascertained that there was not an adequate amount of water to sustain both uses. The resulting analysis has stockwater being supplied from a diversion that runs from the LAA. The status of this stockwater situation has not changed in 2014. A new stockwater well will be drilled east of the Owens River to replace the previously drilled well that did not produce water. The well should be drilled in the fall of 2014 or spring of 2015.

<u>Fencing</u>

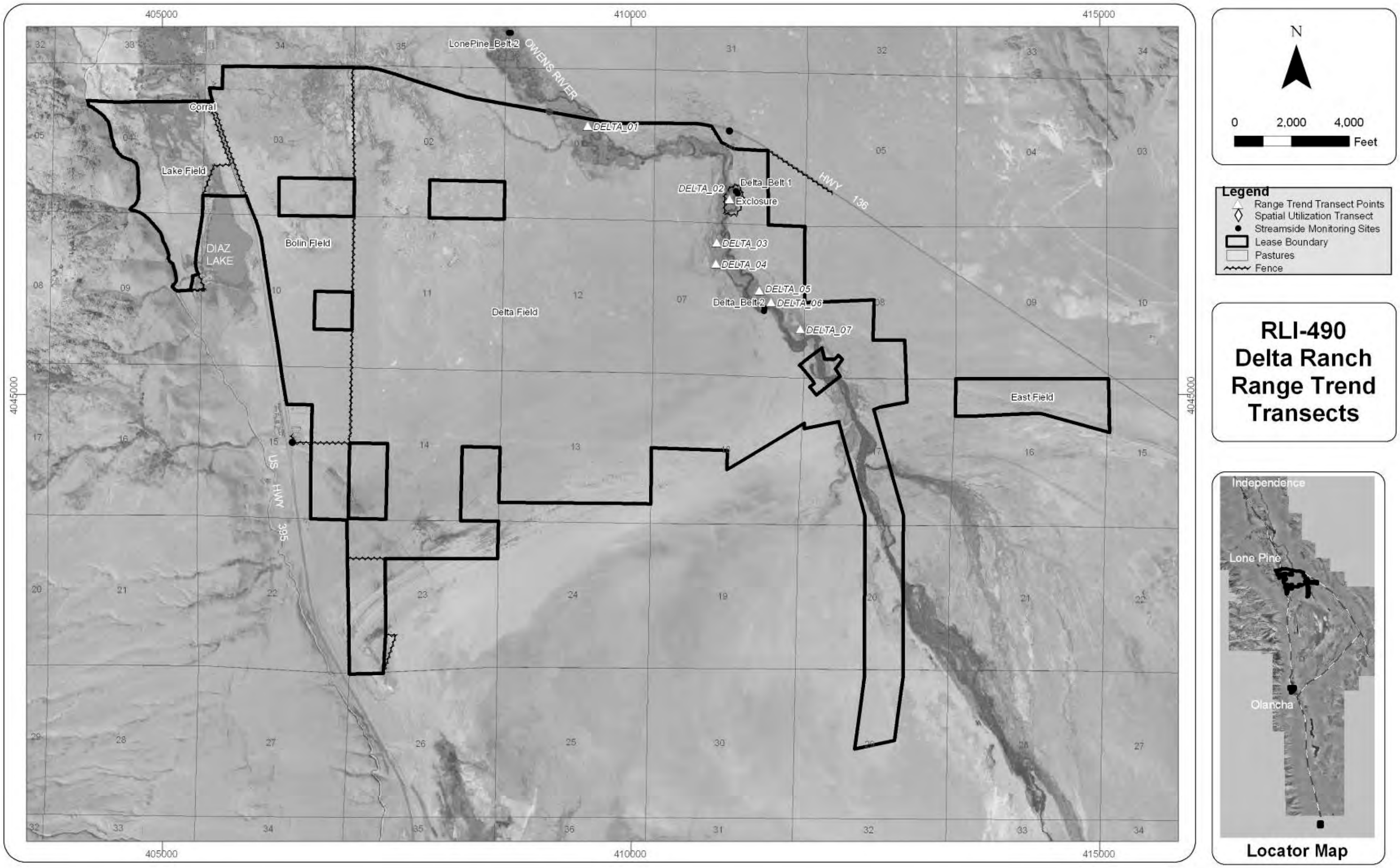
There was no new fencing on the lease for 2014.

<u>Salt and Supplement Sites</u>

Supplement tubs containing protein and trace minerals are used in established supplement sites. Empty tubs are collected by the lessee.

<u>Burning</u>

There are no planned burns for this lease during 2014.



Land Management Figure 26. Delta Lease RLI-490, Range Trend Transects

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4.11 Appendices

4.12 Land Management Appendix 1. Species Encountered Along 40 cfs Base Flow During Spring 2012 Streamside Monitoring.

Plant Code	Species Name	Common Name
ANCA10	*Anemopsis californica*	yerba mansa
ATTO	*Atriplex torreyi*	saltbush
BAHY	*Bassia hysopifolia*	bassia/smotherweed
DISPS2	*Distichlis spicata*	saltgrass
EQAR	*Equisetum arvense*	field horsetail
FOPU	*Forestiera pubescens*	stretchberry
GLLE3	*Glycyrrhiza lepidota*	licorice
HECU3	*Heliotropis curvassum*	salt heliotrope
JUBA	*Juncus balticus*	Baltic rush
LELA	*Lepidium latifolium*	broadleaf pepperweed
LETR5	*Leymus triticoides*	creeping wildrye
SAEX	*Salix exigua*	narrowleaf willow
SAGO	*Salix gooddingii*	Goodding's willow
SALA3	*Salix laevigata*	red willow
SAVE4	*Sarcobatus vermiculatus*	greasewood
SCAC	*Schoenoplectus acutus*	tule
SCAM	*Schoenoplectus americanus*	common threesquare
SCMA	*Schoenoplectus maritimus*	cosmopolitan bulrush
SPAI	*Sporobolus airoides*	alkali sacaton
TARA	*Tamarix ramossissima*	saltcedar
TYDO	*Typha domingensis*	southern cattail
TYLA	*Typha latifolia*	broadleaf cattail

4.13 Land Management Appendix 2. Range Trend for Islands and Thibaut Ranch Leases

Transect	ISLAND_06								
		Frequency							
Life Forms	Species	2002	2003	2004	2007	2008	2009	2010	2014
Perennial Forb	GLLE3	0	4	0	1	0	0	0	4
	NIOC2	0	0	0	0	2	8	6	7
Perennial Graminoid	DISP	90	62	92	103	117	132	116	124
	JUBA	5	5	5	3	5	7	7	6
	LETR5	0	0	0	1	2	0	0	0
	SPAI	105	103	105	98	104	117	76	81
Shrubs	ATTO	19	9	19	7	11	7	4	3
	ERNA10	9	0	3	1	3	7	1	2

indicates a significant difference, α≤0.1 between 2014 and prior sampling event

Shrub Cover (m)	Year						
Species	2003	2004	2007	2008	2009	2010	2014
ATTO	7.57	7.3	9.5	7.85	8.9	5.4	9.84
ERNA10	1.26	2.95	1.35	2.15	2.14	0.6	1.3
Total	8.83	10.25	10.85	10	11.04	6	11.14

Transect	ISLAND_08								
		Frequency							
Life Forms	Species	2002	2003	2004	2007	2008	2009	2010	2014
Annual Forb	2FORB	0	0	6	0	0	0	0	0
	ATTR	0	0	0	0	19	0	0	0
	LACO13	0	0	0	0	5	0	0	0
Perennial Forb	FRSA	0	0	0	0	0	0	0	5
	GLLE3	7	0	7	8	5	0	2	13
	HECU3	3	0	0	0	3	4	2	6
	MALE3	0	0	0	1	0	4	2	7
Perennial Graminoid	DISP	112	77	106	90	94	86	81	129
	JUBA	32	35	37	27	34	38	31	23
	LETR5	9	18	21	8	14	19	13	13
	SPAI	29	13	15	19	7	13	23	17
Shrubs	ATTO	19	4	7	10	28	47	24	0
	ERNA10	20	15	34	24	21	25	31	0
Nonnative Species	POMO5	0	0	0	0	2	0	0	0

indicates a significant difference, α≤0.1 between 2014 and prior sampling event

Shrub Cover (m)	Year					
Species	2003	2004	2007	2008	2009	2010
ATTO	8.45	5.85	5.65	8.75	6	6.72
ERNA10	37.51	16	25.9	18.1	29.75	25.14
Total	45.96	21.85	31.55	26.85	35.75	31.86

Transect	ISLAND_09						
		Frequency					
Life Forms	Species	2006	2007	2008	2009	2010	2014
Annual Forb	ATPH	0	0	0	0	4	0
Perennial Forb	SUMO	9	1	4	1	5	1
Perennial Graminoid	DISP	144	140	152	140	143	140
Shrubs	ATTO	7	9	6	11	2	1
Nonnative Species	BAHY	2	0	3	0	5	0

indicates a significant difference, α≤0.1 between 2014 and prior sampling event

Shrub Cover (m)	Year					
Species	2006	2007	2008	2009	2010	2014
ATTO	8.6	7.0	6.6	9.8	5.4	5.5
SUMO	0.0	0.5	0.0	1.8	2.0	2.2
Total	8.7	7.5	6.6	11.7	7.3	7.7

Transect	ISLAND_10						
		Frequency					
Life Forms	Species	2006	2007	2008	2009	2010	2014
Perennial Forb	CRTR5	23	18	31	30	31	25
	FRSA	22	11	5	17	25	31
Perennial Graminoid	DISP	132	124	139	149	152	149
	SPAI	4	2	2	2	1	1
Shrubs	ATTO	6	3	7	1	1	0

indicates a significant difference, α≤0.1 between 2014 and prior sampling event

Shrub Cover (m)	Year					Burned
Species	2006	2007	2008	2009	2010	2014
ATTO	7.1	7.5	10.8	10.1	8.8	0
SUMO	0.0	0.2	0.0	0.1	0.8	0
Total	7.1	7.7	10.8	10.2	9.6	0

Transect	ISLAND_11						
		Frequency					
Life Forms	Species	2006	2007	2008	2009	2010	2014
Annual Forb	ATPH	0	0	7	4	11	0
	COMAC	0	0	9	5	41	10
Perennial Forb	ANCA10	22	23	23	18	8	21
	NIOC2	72	47	62	59	56	62
Perennial Graminoid	DISP	148	154	154	157	137	145
	JUBA	0	0	0	4	2	4
Nonnative Species	SATR12	0	0	0	3	0	0

indicates a significant difference, α≤0.1 between 2014 and prior sampling event

Transect	THIBAUT_01B	
Frequency		
Life Forms	Species	2014
Annual Forb	ATSES	2
	ATTR	11
Perennial Forb	MALE3	2
Perennial Graminoid	DISP	3
	SCAM6	47
	TYLA	3
Nonnative Species	BAHY	11

Shrub Cover (m)	Year
Plant Species	2014
ATTO	0.4
ERNA10	0.1
Total	0.5

Transect	THIBAUT_02							
Frequency								
Life Forms	Species	2002	2003	2004	2007	2009	2010	2014
Annual Forb	ATPH	0	0	0	0	0	5	0
	ATSES	0	47	5	0	0	0	0
	CHENO	0	33	0	0	0	0	0
	CHHI	0	23	3	0	0	0	0
	COMAC	0	23	0	0	0	4	0
	CORA5	0	9	0	0	0	7	0
Perennial Forb	ASTRA	0	0	4	1	0	0	0
	GLLE3	0	7	9	3	2	2	0
	PYRA	5	10	3	12	8	5	0
	SUMO	0	1	0	0	0	0	0
Perennial Graminoid	DISP	155	153	154	159	151	161	117
	JUBA	14	15	9	16	1	9	2
	SPAI	139	132	137	140	139	136	110
Shrubs	ALOC2	0	0	0	0	0	5	0
	ATTO	0	2	10	2	3	26	2
	ERNA10	7	8	13	18	8	9	7
Nonnative Species	BAHY	0	16	39	0	3	8	2

indicates a significant difference, α≤0.1 between 2014 and prior sampling event

Shrub Cover (m)	Year					
Plant Species	2003	2004	2007	2009	2010	2014
ALOC2	0.0	0.0	0.0	0.0	0.4	0.0
ATTO	0.0	0.4	0.0	0.6	0.2	0.0
ERNA10	4.9	0.3	1.1	0.0	1.1	3.3
Total	4.9	0.7	1.1	0.6	1.7	3.3

Transect	THIBAUT_03							
		Frequency						
Life Forms	Species	2002	2003	2004	2007	2009	2010	2014
Annual Forb	ATSES	0	17	0	0	0	0	0
	CHHI	0	2	0	0	0	0	0
	CORA5	0	15	2	0	0	8	0
Perennial Forb	GLLE3	51	26	37	34	26	28	8
	MACA2	0	0	0	0	0	8	0
	PYRA	0	0	0	0	2	0	0
	STEPH	3	7	13	0	0	0	0
Perennial Graminoid	DISP	128	147	139	121	149	146	122
	JUBA	15	14	5	11	9	16	1
	SPAI	136	141	149	133	140	137	97
Shrubs	ATTO	2	5	11	0	3	6	0
	ERNA10	12	16	36	10	5	6	0
	MACA17	0	0	0	7	5	0	0
	SAEX	0	0	0	5	0	0	0
Nonnative Species	BAHY	0	0	0	0	2	0	0
	SATR12	0	0	0	0	3	0	0

indicates a significant difference, α≤0.1 between 2014 and prior sampling event

Shrub Cover (m)	Year					
Plant Species	2003	2004	2007	2009	2010	2014
ERNA10	6.5	3.1	2.7	2.2	1.3	1.6

Transect	THIBAUT_04									
		Frequency								
Life Forms	Species	2002	2003	2004	2007	2009	2010	2012	2013	2014
Annual Forb	ATTR	0	0	15	0	0	0	0	0	0
	CHHI	0	7	5	0	0	0	0	0	0
Perennial Forb	HECU3	0	0	0	0	0	0	0	0	4
	MALE3	0	0	5	0	0	0	0	0	0
Perennial Graminoid	DISP	0	0	0	0	0	0	0	1	0
Shrubs	ATTO	9	13	19	37	43	48	16	38	13
Nonnative Species	BAHY	0	2	30	0	0	58	0	0	10
	SATR12	0	10	15	0	0	0	0	0	0

indicates a significant difference, α≤0.1 between 2014 and prior sampling event

Shrub Cover (m)	Year							
Plant Species	2003	2004	2007	2009	2010	2012	2013	2014
ATTO	10.2	6.7	34.6	46.8	48.1	25.4	22.9	26.9
Total	10.2	6.7	34.6	46.8	48.1	25.4	22.9	26.9

Transect	THIBAUT_05										
		Frequency									
Life Forms	Species	2002	2003	2004	2005	2007	2009	2010	2012	2013	2014
Annual Forb	CHHI	0	0	0	1	0	0	0	0	0	0
	CHIN2	0	6	3	0	0	0	0	0	0	0
	LACO13	0	0	0	0	0	0	0	0	0	4
	COCA5	0	0	0	0	0	0	0	0	0	4
Perennial Forb	HECU3	0	0	0	2	2	24	37	89	103	68
	MALE3	0	0	0	0	0	10	28	38	38	52
Perennial Graminoid	DISP	0	0	0	0	4	3	0	0	0	0
Shrubs	ATTO	0	7	3	4	2	1	0	0	0	0
Nonnative Species	AMAL	0	0	0	2	0	0	0	0	0	0
	BAHY	0	19	9	42	0	2	29	6	0	16
	DESO2	0	0	16	6	0	0	0	0	0	0
	TARA	0	0	3	0	0	0	0	0	0	0
	SATR12	0	16	24	19	0	0	0	0	0	4

indicates a significant difference, α≤0.1 between 2014 and prior sampling event

Shrub Cover (m)	Year			
Plant Species	2003	2004	2005	2007
ATTO	0.5	0.5	0.3	1.4
TARA	0.0	0.0	0.4	0.0
Total	0.5	0.5	0.7	1.4

Transect	THIBAUT_06									
		Frequency								
Life Forms	Species	2003	2004	2005	2007	2009	2010	2012	2013	2014
Annual Forb	ATRIP	0	0	1	0	0	0	0	0	0
	ATSES	0	3	9	0	0	0	0	0	7
	ATTR	5	1	3	0	0	0	0	0	0
	CHENO	2	0	0	0	0	0	0	0	0
	CHHI	0	0	4	0	0	0	0	0	0
	CHIN2	0	0	3	0	0	0	0	0	0
	GITR	0	0	5	0	0	0	0	0	0
	LACO13	0	0	0	0	0	0	0	0	9
	MEAL6	0	14	72	0	0	0	0	0	0
Perennial Forb	HECU3	1	0	0	0	51	46	69	47	38
Perennial Graminoid	DISP	2	2	2	3	15	14	28	39	38
	SPAI	2	3	3	5	4	2	1	6	5
Shrubs	ATTO	11	8	9	3	0	1	2	0	2
Nonnative Species	BAHY	0	2	1	0	10	88	16	0	65
	DESO2	0	19	3	0	0	0	0	0	0
	SATR12	17	60	52	0	6	0	5	0	34

indicates a significant difference, α≤0.1 between 2014 and prior sampling event

Shrub Cover (m)	Year								
Plant Species	2003	2004	2005	2007	2009	2010	2012	2013	2014
ATTO	0.7	1.1	1.8	11.1	1.7	2.4	4.3	4.5	2.5

Transect	THIBAUT_07									
		Frequency								
Life Forms	Species	2003	2004	2005	2007	2009	2010	2012	2013	2014
Annual Forb	2FORB	0	1	0	0	0	0	0	0	0
	ATSES	2	24	81	0	0	0	0	0	3
	ATTR	26	15	49	0	0	0	0	0	0
	GITR	0	0	3	0	0	0	0	0	0
Perennial Forb	HECU3	1	0	1	0	0	0	0	0	0
	MALE3	7	2	0	9	2	0	6	12	46
Perennial Graminoid	DISP	3	3	0	4	0	0	0	0	0
Shrubs	ATTO	7	16	20	8	18	17	7	1	1
Nonnative Species	BAHY	12	34	37	0	0	92	3	0	23
	DESO2	0	15	34	0	0	0	0	0	0
	SATR12	16	47	45	0	0	0	3	0	6

(shaded cell) indicates a significant difference, α≤0.1 between 2014 and prior sampling event

Thibaut_08 shelved

Thibaut_09 shelved

5.0 2014 Rapid Assessment Survey

Lower Owens River Project
2014 Rapid Assessment Survey

Observations

Lower Owens River Project
Summary of Rapid Assessment Survey Observations

A survey of the Lower Owens River Project (LORP) area, referred to as the Rapid Assessment Survey or RAS, is conducted annually beginning in August. This year, between August 4 and August 25, Inyo County staff surveyed along the wetted edges of the water features in the LORP. These areas include the Lower Owens River, Blackrock Waterfowl Management Area (BWMA), Off-River Lakes and Ponds (OLP), and the Delta Habitat Area (DHA). The observations recorded during this exercise are presented in this report.

The primary purpose of the RAS is to detect and record the locations of problems that can negatively affect the LORP. These are impacts that require physical maintenance such as repairing a damaged or cut fences, trash pickup, tamarisk slash pile removal, and herbicide treatment of noxious weeds.

Project managers and scientists also use RAS data as rough indicators of basic trends in the ecological development of the riparian and riverine environments, especially when RAS data is compiled with information gathered from other LORP studies. For example, RAS observations of woody recruitment can be considered along with river-edge belt transects, designed to look in greater detail at woody recruitment. The combined observations can help project scientists understand how woody recruitment is taking place, and if it is persisting.

The observations made during the RAS effort are categorized by type and Observation Code in Table 1, and the number of observations by impact type and LORP area are presented in Table 2.

Table 1. Catalog of impacts recorded by the RAS

Observation Code	Observation Type	Description
WDY	Woody Recruitment	This year's cohort of willow and cottonwood seedlings
TARA	Saltcedar	*Tamarisk* spp. seedlings, or resprouts from previously treated plants.
ELAN	Russian Olive	*Elaeagnus angustifolia*, seedlings and juveniles (height <1m).
NOX	Noxious Weeds	Any of twenty-one species of locally invasive plants, mainly perennial pepperweed
BEA	Beaver	Sightings or evidence of beaver in the LORP
ELK	Elk	*Cervus canadensis* ssp. *nannodes*, sightings or evidence of tule elk
FEN	Fence	Reports of damaged riparian or exclosure fencing
GRZ	Grazing	Evidence of (off-season) grazing in the floodplain.
REC	Recreational Impacts	Evidence of recreational activity and any adverse associated impacts
ROAD	Road	Previously unidentified roads, road building activities, or roads causing impacts
TRASH	Trash	Large refuse or dumping
SLASH	Slash	New piles of recently cut saltcedar slash
OBSTR	Obstructions	Obstructions to river flow
Other	Other	Other impacts

Table 2. Summary of observations collected by category and area; including Blackrock Waterfowl Management Area (BWMA); Off-River Lakes and Ponds (OLP); and the Delta Habitat Area (DHA).

Observation Code	Observation Type	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	BWMA	OLP	DHA	Total Obs.
WDY	**Woody Recruitment**	0	1	3	0	1	2	0	1	0	**8***
TARA	**Saltcedar Plants (Tamarisk)**	4	54	39	22	33	30	5	3	31	**219**
ELAN	**Russian Olive Recruitment**	0	0	1	1	0	0	9	41	0	**52**
NOX	**Noxious Weeds (Lepidium)**	11	3	6	0	0	0	4	1	0	**25**
BEA	**Beaver**	0	0	4	0	1	1	0	0	0	**6**
ELK	**Elk**	0	1	22	14	21	47	8	0	2	**115**
FEN	**Fence**	0	0	4	1	0	1	0	0	0	**6**
GRZ	**Grazing**	0	0	4	2	1	0	0	1	0	**8**
REC	**Recreation Impacts & Use**	2	1	20	1	5	30	3	5	6	**73**
ROAD	**Road**	0	0	3	1	0	2	0	0	2	**8**
TRASH	**Trash**	2	4	8	2	0	5	4	0	1	**26**
SLASH*	**Slash**	0	0	0	0	0	0	0	1	0	**1**
OBST	**Obstructions**	0	0	0	0	0	0	0	0	0	**0**
OTHER	**Other**	0	1	3	1	6	8	2	1	0	**22**

* Does not include 65 instances of clonal recruitment of Salix Exigua (SAEX)

River-reaches and LORP units

Table 3

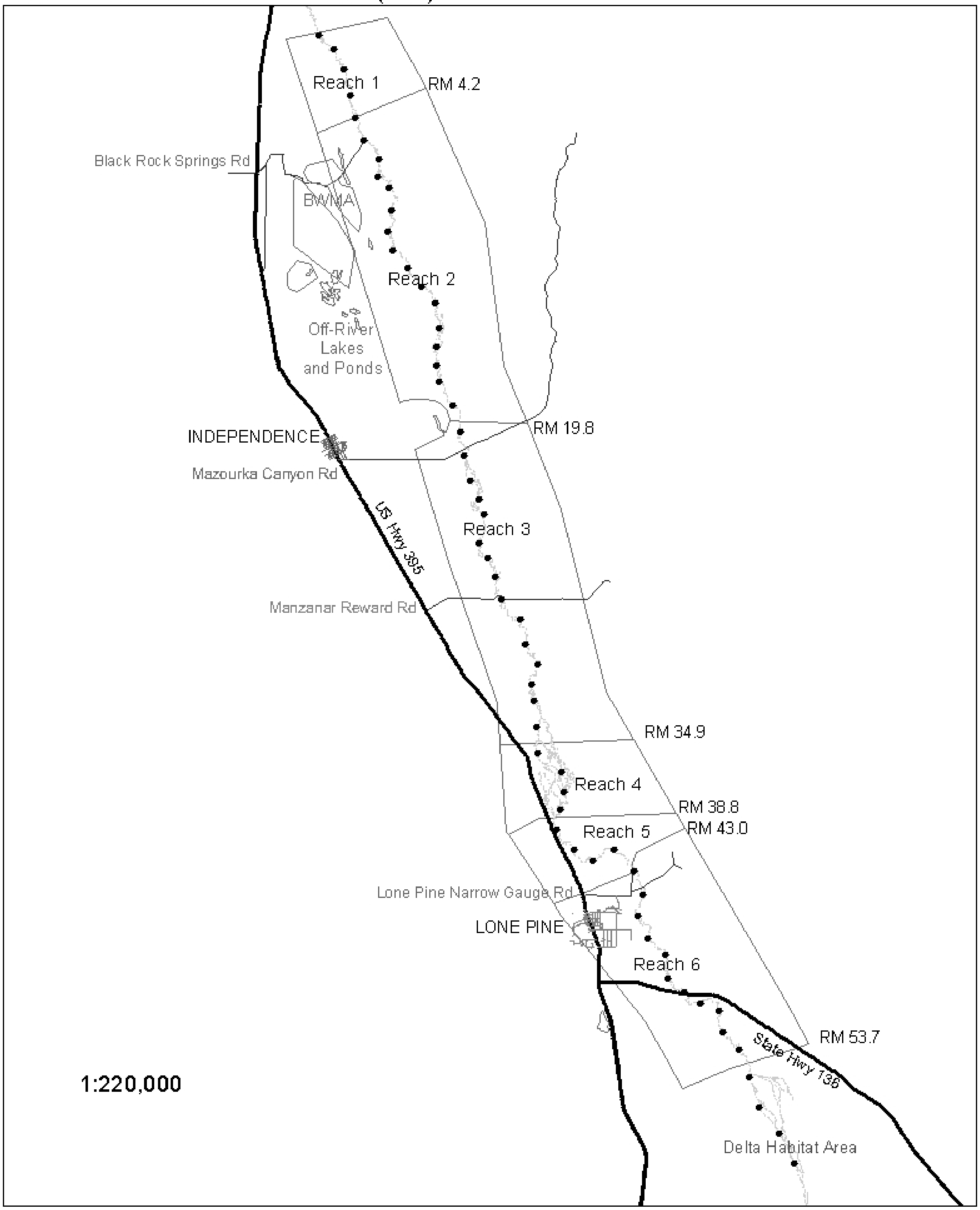
The Lower Owens River is divided up in to six river-reaches. These river segments are defined by valley form, channel/floodplain morphology, and hydrologic variables (Table 3, and "River-reaches and river-miles map"). For the RAS summary, these reaches offer a convenient way to describe a position on the river, and they serve as a common reference for RAS observations taken year to year. Further, individual observations in the river-riparian corridor are often referenced to the nearest tenth of a river-mile (RM). The Lower Owens River Intake is river-mile 0.0, the pumpback station is at river-mile 53.1, the Delta Habitat Area begins at river-mile 53.7, and the river fades into the Owens Lake playa near river-mile 62.0.

When comparing the number of observations found per river-reach, or when looking at the distribution of observations along the length of the river, it is important to note that the lengths of the reaches are unequal. For example, about 90% of woody recruitment observations made in 2013 were recorded in river-reaches 2 and 3, which together encompass about half of river-miles in the entire river-riparian corridor.

Table 3. River reaches: comparisons of reach length, and river type.

	Percent of river length	Total River-miles (RM)	Mile Markers	Description
Reach 1	7%	4.2	0 to 4.2 RM	Wet Incised Floodplain
Reach 2	25%	15.6	4.2 to 19.8 RM	Dry Incised Floodplain
Reach 3	24%	15.1	19.8 to 34.9 RM	Wet Incised Floodplain
Reach 4	6%	3.9	35.0-38.8 RM	Aggraded Wet Floodplain
Reach 5	7%	4.2	38.8 to 43.0 RM	Wet Incised Floodplain
Reach 6	17%	10.7	43.0 to 53.7 RM	Graded Wet Floodplain
Delta Habitat Area (DHA)	13%	8.3	53.7 to 62.0 RM	Delta

River Reaches and River Miles (RM)



Revisited Sites

Maps 2 & 7

Observers returned to specific sites where woody recruitment and evidence of beaver were recorded in 2013, and noted the presence or absence of the subject. A total of 56 sites were revisited. The results from these revisits are found in this report in corresponding category sections.

Summary of Observations by Category

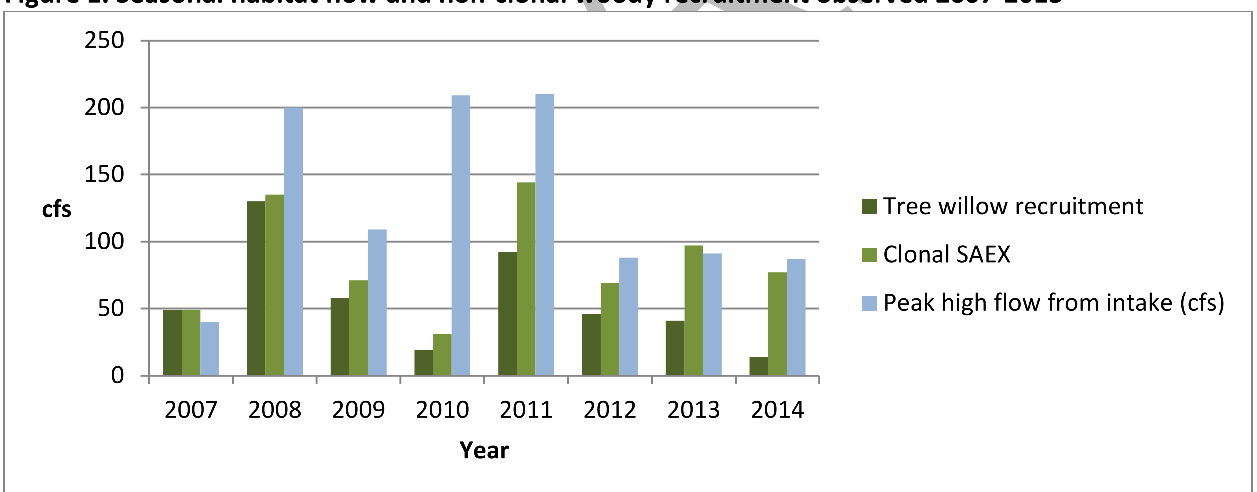
Woody Recruitment (Observation Code: WDY)

Figure 1; Tables 4-8; Map 1

Willow and Cottonwood provide the structural diversity and varied natural habitats that are essential to attracting many of the riverine/riparian avian habitat indicator species, which are indicators of the project's success. A central focus of the RAS has been to identify areas where new trees and shrubs were developing in the newly wetted areas of the LORP. Much attention is given to training field staff on how to locate, identify, and record willow and cottonwood seedlings and juvenile plants that is part of this year's cohort.

Observers located 6 tree willow recruits and two cottonwood recruits. All of the willow recruitment was located in the river-riparian corridor or in the area of the off river ponds. Woody recruitment in 2014 was down 80% from 2013, and less than all prior years (Figure 1).

Figure 1. Seasonal habitat flow and non-clonal woody recruitment observed 2007-2013

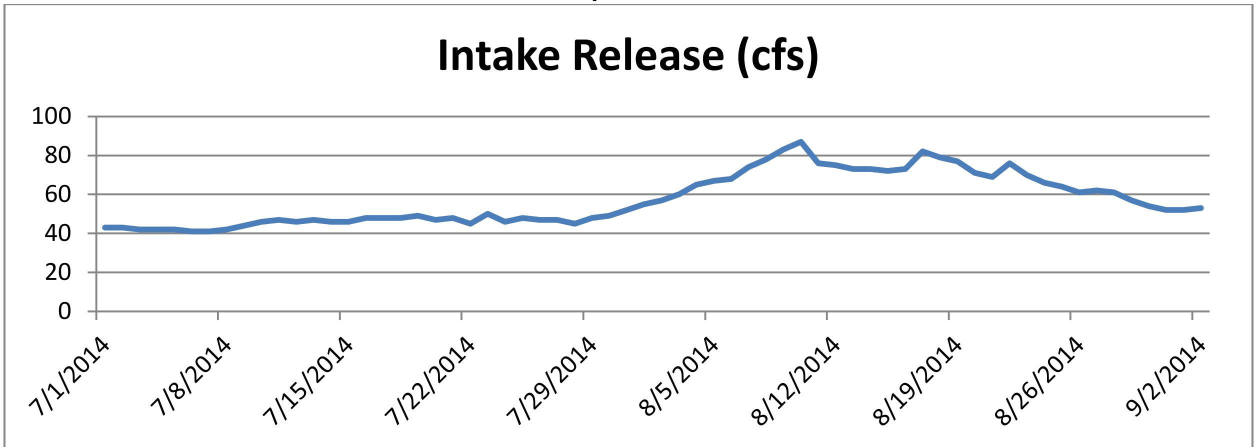


Year	2007	2008	2009	2010	2011	2012	2013	2014
Recruitment sites (does not include SAEX clonal recruitment)	49	130	58	19	92	46	41	8
Recruitment sites (all recruitment including clonal SAEX)	49	135	71	31	144	69	97	73
Peak seasonal flow, released from intake (cfs)	40 base	200	109	209	210	88	91	87

The 2008 seasonal habitat flow was released in the winter (February 13, 2008)

The RAS is conducted in August to be able to detect seedlings that may have germinated as the result of the annual LORP seasonal habitat flow (SHF), which is timed to accompanying willow seedfly. Although there was not a SHF in 2014, flows up to 87 cfs were released from the intake in mid-summer to compensate for downstream losses due to evapotranspiration (Table 4). This is necessary in order to maintain a minimum 40 cfs flow throughout the river. These persistent higher flows and resulting increase in stage especially in the upper two reaches may, by flooding, influence plant recruitment and persistence.

Table 4. Seasonal variation in intake releases required to maintain 40 cfs base flow



Notes:

- Tree willow recruitment (SAGO, SALA3, SALIX) was found at 11 sites, and shrub willow seedlings (SAEX) at one site.
- One of the POFR2 juveniles may have been previously identified and the other was found growing in standing water. One of the 8 tree willows was also growing in standing water.

Table 5. No. of recruitment sites, by species and location &number of recruitment sites

Species Code	Common Name/ Scientific Name	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	DHA	BWMA	OLP	Total
SAEX	Narrow leaf willow/ *Salix exigua*	0	0	0	0	0	0	0	0	0	**0**
SAGO	Black willow/ *Salix goodingii*	0	0	1	0	0	0	0	0	0	**1**
SALA3	Red willow/ *Salix laevigata*	0	1	2	0	1	0	0	0	0	**4**
SALIX	Tree species, hybrid, or unknown willow	0	0	0	0	0	1	0	0	0	**1**
POFR2	Fremont Cottonwood/ *Populus fremontii*	0	0	0	0	0	1	0	0	1	**2**
Total number of Observations		**0**	**1**	**3**	**0**	**1**	**2**	**0**	**0**	**1**	**8**

Table 6. Numbers of plants present at an individual recruitment site

Species Code	Common Name	1 to 5	6 to 25	26 to 100	>100	Total
SAEX	Narrow leaf willow	0	0	0	0	**0**

SAGO	Black willow	1	0	0	0	**1**
SALA3	Red willow	4	0	0	0	**4**
SALIX	Hybrid, or unknown willow	1	0	0	0	**1**
POFR2	Fremont Cottonwood	2	0	0	0	**2**
Total number of recruits by population		**8**	**0**	**0**	**0**	**8**

Table 7. Distribution of woody recruitment relative to landforms

Species Code	Common Name	Channel	Channel to Bank	Bank	Channel to Floodplain	Floodplain	Upland
SAEX	Narrow leaf willow	–	–	–	–	–	–
SAGO	Black willow	–	–	100%	–	–	–
SALA3	Red willow	25%	–	50%	–	25%	–
POFR2	Cottonwood	50%	–	–	–	50%	–

Woody Recruitment Revisits

Table 8; Map 2

Woody recruitment sites found in 2013 were revisited in 2014. Of the 43 sites revisited 66% of last year's cohort was relocated. Persistence was less than last year (2013-85%).

Table 8. Revisit sites: persistence of woody recruitment identified in 2013

	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	Total	Persistence
Present	1	21	8	–	1	1	32	66%
Absent	0	9	1	–	1	–	11	

Saltcedar (Observation Code: TARA)

Tables 9&10; Map 3

Saltcedar (*Tamarix* spp.) is found throughout the LORP, and is the most abundant noxious weed in the project area. In 2014, resprouts and seedlings were recorded at 219 locations (Table 9). This figure is not comparable to 2013, when mature plants were included in the survey. Mature plants were not recorded because their locations were known. TARA locations are provided to the saltcedar program coordinator.

Notes:

- Although five records of TARA were made in the BWMA area, the area is so heavily infested with saltcedar of all ages that it is not feasible to record all sightings.
- Compared to 2013, TARA is increasing in reaches 4, 5, and the Delta, and decreasing in all other reaches.
- When possible, field staff pulled out seedlings once they were recorded. About half the seedlings found were removed (n=21).

Table 9. Total number of observation sites and age class of TARA by location and RM

Age Class	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	DHA	BWMA	OLP	Total
Seedlings	3	25	8	0	0	0	0	5	1	**42**
Resprouts	1	29	31	22	33	30	31	0	0	**177**
Number of Observation/RM	**1.0**	**3.4**	**2.6**	**5.6**	**7.9**	**2.9**	**3.7**			

Table 10. TARA seedling and resprout abundance by LORP unit, or river-reach

Location	Abundance (number of plants per site)				
	1 to 5	6 to 25	26 to 100	>100	Total no. of sites
BWMA-Drew	0	1	0	0	**1**
BWMA-Thibaut	0	0	0	0	**0**
BWMA- Waggoner	0	0	0	1	**1**
BWMA-Winterton	0	1	0	2	**3**
Delta Habitat Area	23	8	0	0	**31**
Off River - Billy	0	0	0	0	**0**
Off River - Goose	0	1	0	0	**1**
Reach 1	3	1	0	0	**4**
Reach 2	45	5	2	2	**54**
Reach 3	33	5	1	0	**39**
Reach 4	21	1	0	0	**22**
Reach 5	33	0	0	0	**33**
Reach 6	30	0	0	0	**30**
Total number of plants, by abundance	**188**	**23**	**3**	**5**	**219**

Russian olive (Observation Code: ELAN)

Table 11; Map 4

Although Russian olive (Elaeagnus angustifolia) is not listed as a noxious weed in California, the California Invasive Plant Council considers this species highly invasive in riparian systems. All mature ELAN plants in water adjacent areas have been recorded in prior years. Documenting seedling or juvenile ELAN is the current focus. For surveillance purposes all ELAN recruitment (plants <1m) is recorded.

Note:

- The observation of 30 sites at Twin Lake and seven sites at Goose Lake indicates active recruitment in these areas. Many acres of mature ELAN crowd out willows at the southern and western edges of Twin Lakes; likely serving as a seed source for the recruitment noted.

Table 11. Abundance at observation sites, by LORP unit, or river reach

Location	Abundance (number of plants/location)				
	1 to 5	6 to 25	26 to 100	>100	Total no. of sites
BWMA-Drew	6	1	0	0	**7**
BWMA-Thibaut	2	0	0	0	**2**

BWMA- Waggoner	0	0	0	0	**0**
BWMA-Winterton	0	0	0	0	**0**
Delta Habitat Area	0	0	0	0	**0**
Off River - Billy	4	0	0	0	**4**
Off River—Goose/Twin	26	7	2	2	**37**
Reach 1	0	0	0	0	**0**
Reach 2	0	0	0	0	**0**
Reach 3	1	0	0	0	**1**
Reach 4	1	0	0	0	**1**
Reach 5	0	0	0	0	**0**
Reach 6	0	0	0	0	**0**
				ELAN, total number of sites	**52**

Noxious Weeds (Observation Code: NOX)

Table 12; Map 5

Other than tamarisk, perennial pepperweed (*Lepidium latifolia*, LELA2) was the only noxious species reported within the LORP this year. Overall, the number of LELA sites is declining in all frequency categories in all areas, with the exception of reach 3, where six new and significant populations were discovered, and the Winterton unit of the BWMA where two significant populations were discovered.

Notes:

- Twenty-five populations of LELA2 were recorded in 2013, this compares to 33 in 2013.
- Reach 1 still has the greatest number of LELA sites (n=11).
- Reach 3 had only one recorded site in 2013, but now has 6 sites, two of these with >100 individuals.
- All observations of Lepidium were recorded as requested by the Inyo County Agricultural Commissioner's office. The Inyo County Agricultural Commissioner's office was provided coordinates for all pepperweed sites detected during the 2013 RAS, and spray crews were dispatched.
- Only five of the 25 sites appeared to the observer to have been previously treated with herbicide.

Table 12. Abundance categories of LELA2 by location

Location	Abundance categories (number of plants/location)				
	1 to 5	**6 to 25**	**26 to 100**	**> 100**	**Total**
Off River - Goose	1	0	0	0	**0**
BWMA – Winterton	0	1	1	2	**4**
BWMA – Waggoner	0	0	0	0	**0**

Reach 1	1	6	3	1	**11**
Reach 2	3	0	0	0	**3**
Reach 3	0	3	1	2	**6**
Reach 4	0	0	0	0	**0**
Reach 5	0	0	0	0	**0**
Reach 6	0	0	0	0	**0**
Total number of populations	**5**	**10**	**5**	**5**	**25**

Beaver Activity (Observation Code: BEA)

Map 7

Beaver activity and evidence was noted at six locations. Beaver where found at five locations in 2013.

Note:

- Four of the six sighting were in Reach 3.
- Field staff revisited eight sites where beaver were found in previous years; seven of the sites were inactive, only one location in reach 3 continued to show evidence of activity.

Dead Fish (Observation Code: DFISH)

Note:

- No dead fish were recorded.

Elk (Observation Code: ELK)

Map 6

Notes:

- Evidence of elk, or direct sightings, were noted at 115 locations; up from 17 in 2013. More than half were seen in reach 5 and 6.
- Browsing on woody vegetation was recorded at 77 locations. Antler rub and sighting were also noted.

LORP Riparian Fence (Observation Code: FEN)

Map 9

Staff surveyed exclosure fencing as well as riparian fence.

Notes:

- Six records were made of damage to riparian fence. Five of the same were reported in 2013.
- Exclosure fence was damaged and in need of repair at five locations.

Grazing Management (Observation Code: GRZ)

Map 8

Notes:

- No cattle feed stations were found in the floodplain.
- Half the sightings were in reach 3. One observer reported 7 cows in one area, in reach 3.

Recreation (Observation Code: REC)

Map 8

Seventy-five discrete impacts associated with recreation, as evidenced by litter, fire rings and such, were recorded in the LORP in all river reaches. This is up from 25 observations in 2013. Recreation evidence was most abundant near roads, and in the Lone Pine area.

Notes:

- Litter (beverage containers, shotgun shells, fishing gear) was the most frequently observed evidence of river recreation use.
- More than half of the recreation impacts noted were in Lone Pine area; reaches 5-DHA (n=41).
- Five fire rings were noted.
- Evidence of continued incompatible ORV use was found in the Delta.

Roads (Observation Code: ROAD)

Map 9

All roads, or vehicle trails that were not present in 2005, or changes in roads were recorded. There were eight observations, double the number form the previous year.

Notes:

- One road in the Delta seems to be recovering, but without signage or barrier, continues to be used.
- The other observations noted a road that provides access to the floodplain in the Lone Pine area, north of Lone Pine Depot Road. This road is believed to have been present prior to 2005; however in 2013-2014 the road has been extended down to access the river bank.

Trash (Observation Code: TRASH)

Map 9

Observers were asked to record large trash items. Barrels, buckets, ladders, pallets, rolls of barb wire, piping, furniture and other items were recorded at 26 locations. This about twice as many observations as in 2013.

Tamarisk Slash (Observation Code: SLASH)

Notes:

- One pile of new slash was recorded at Billy Lake in the upland.

River Obstructions (Observation Code: OBST)

Note:

- No river obstructions were noted.

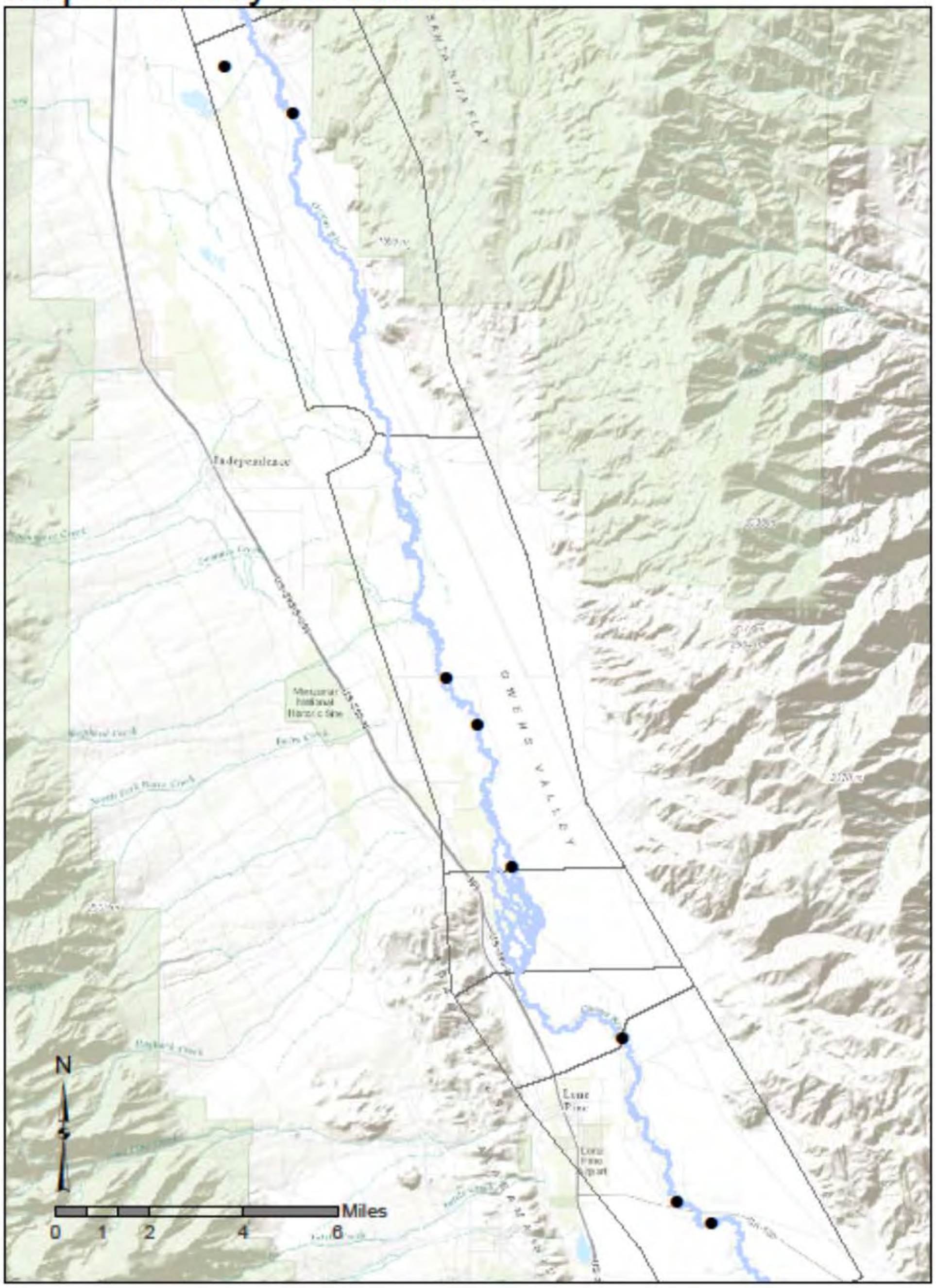
Other (Observation Code: OTHER)

Map 10

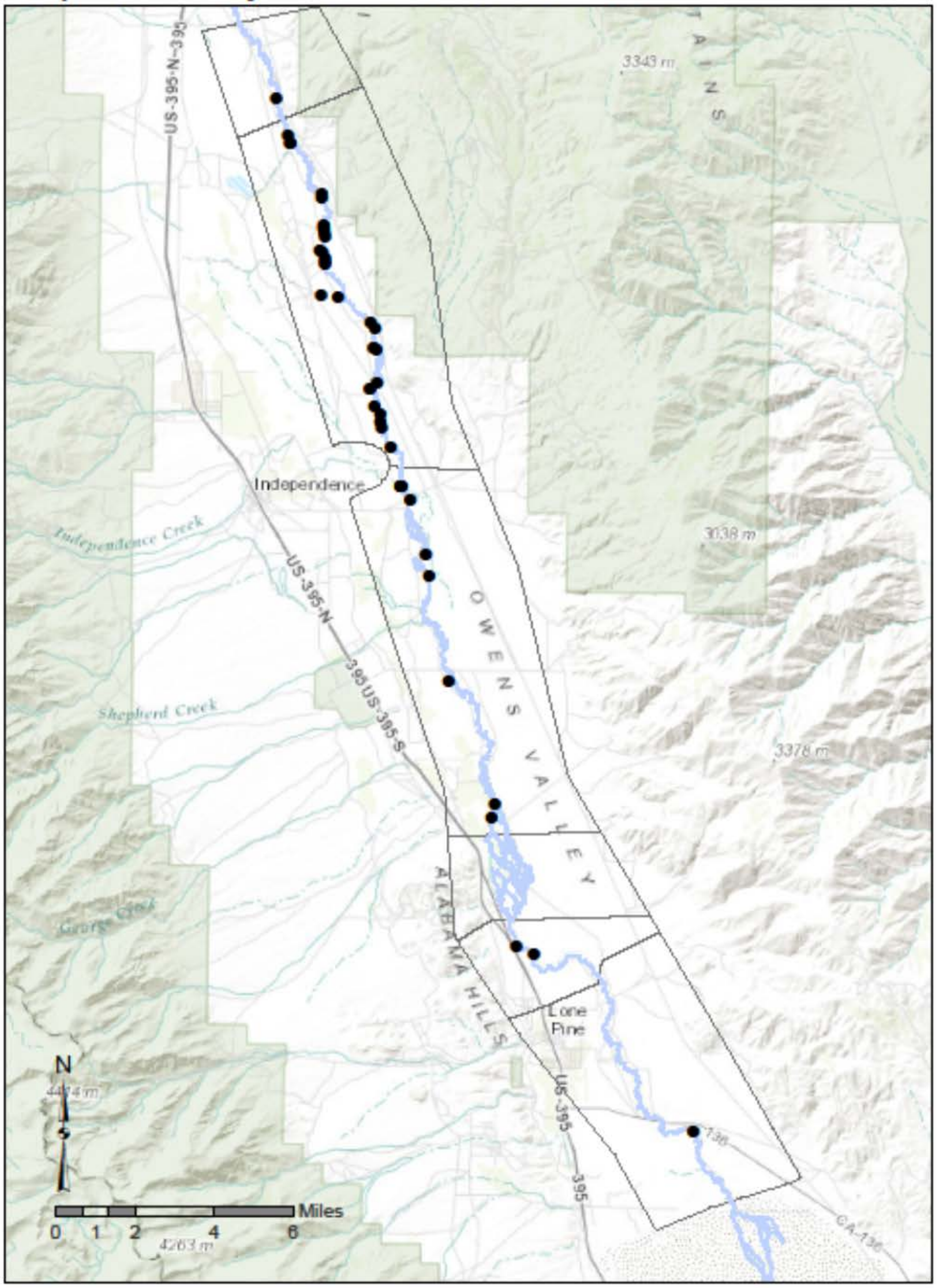
Note:

- Sixteen of the 22 observations were of diseased trees, including a die off of all cottonwoods in one area. Evidence of disease include: leaves yellowing or brown, and fungus and rust. Insect holes in wood were noted.

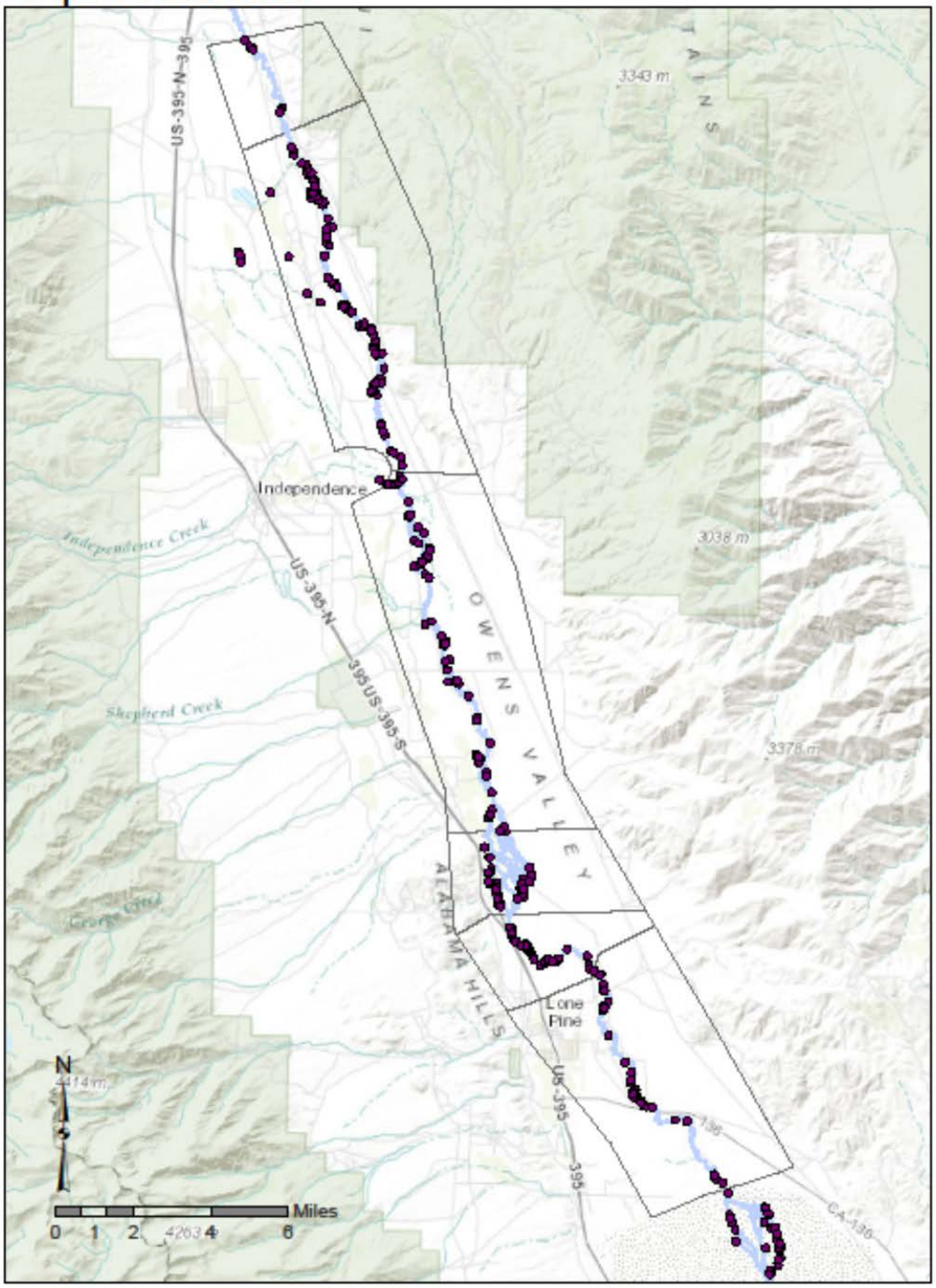
Map 1: Woody Recruitment



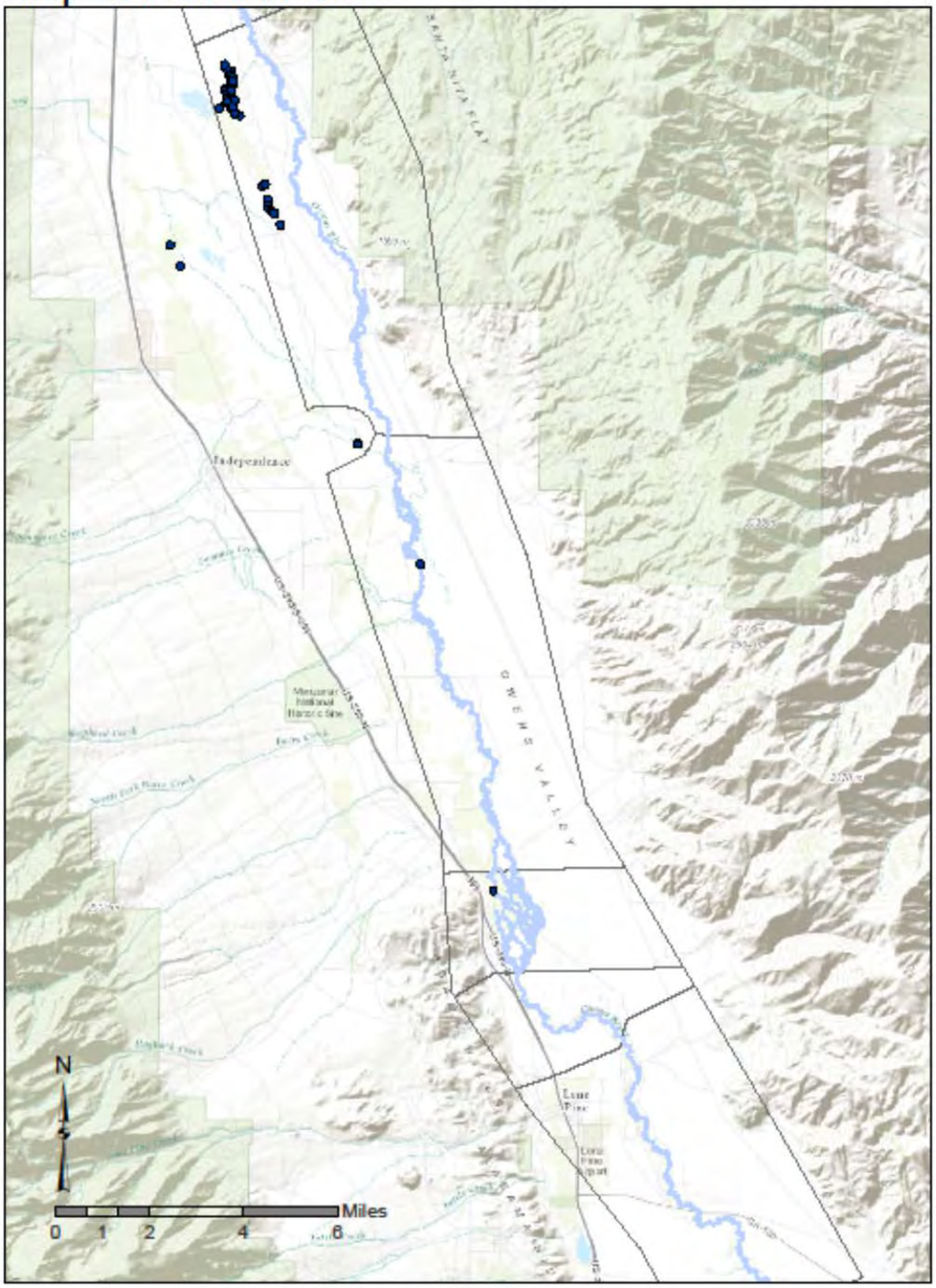
Map 2: Woody Recruitment Revisited



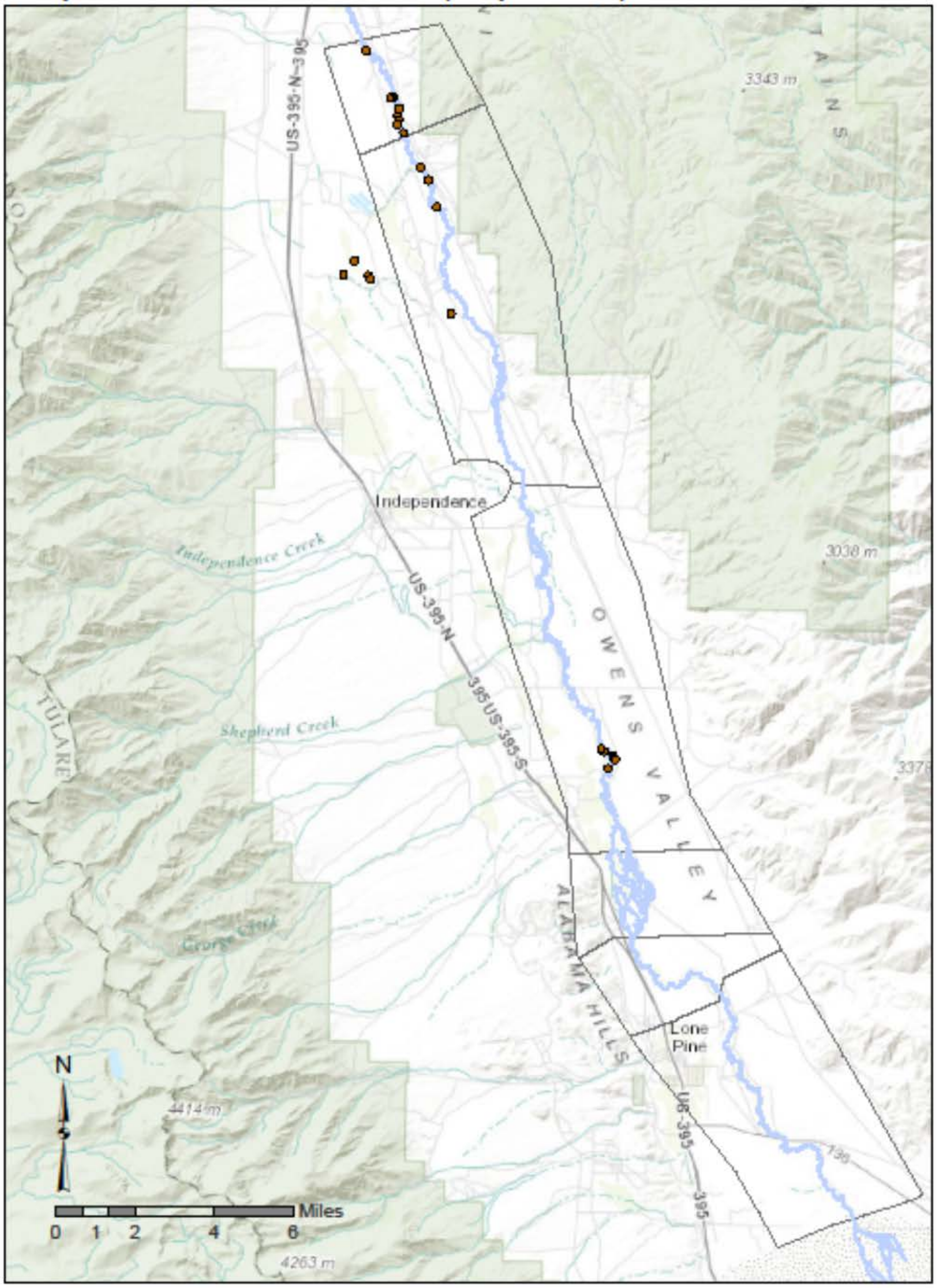
Map 3: Saltcedar



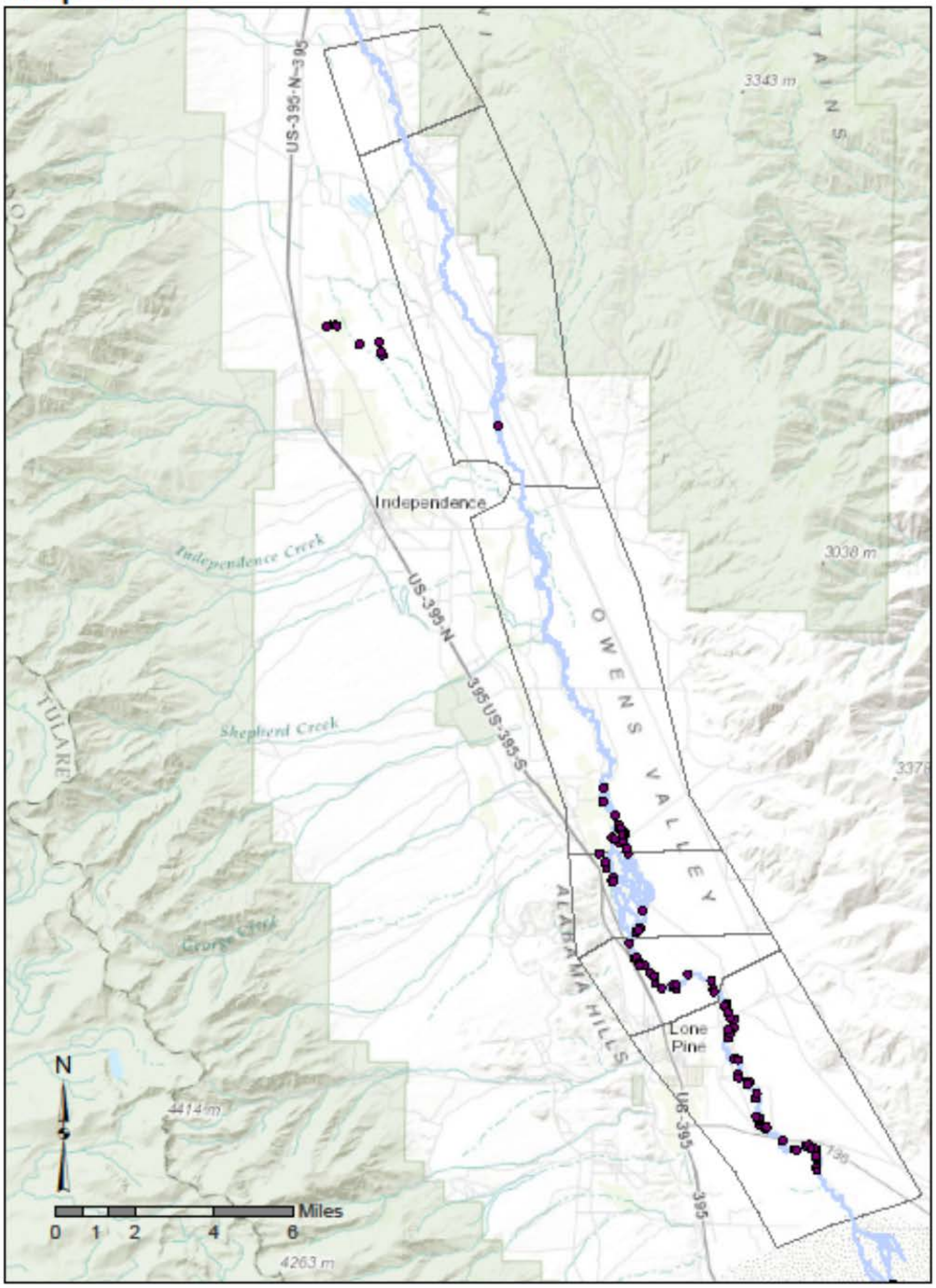
Map 4: Russian Olive



Map 5: Noxious Weeds (Lepidium)



Map 6: Elk



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Independence Creek
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US-395-N
395 US-395-S
OWENS VALLEY
Shepherd Creek
TULARE
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Lone Pine
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4414 m
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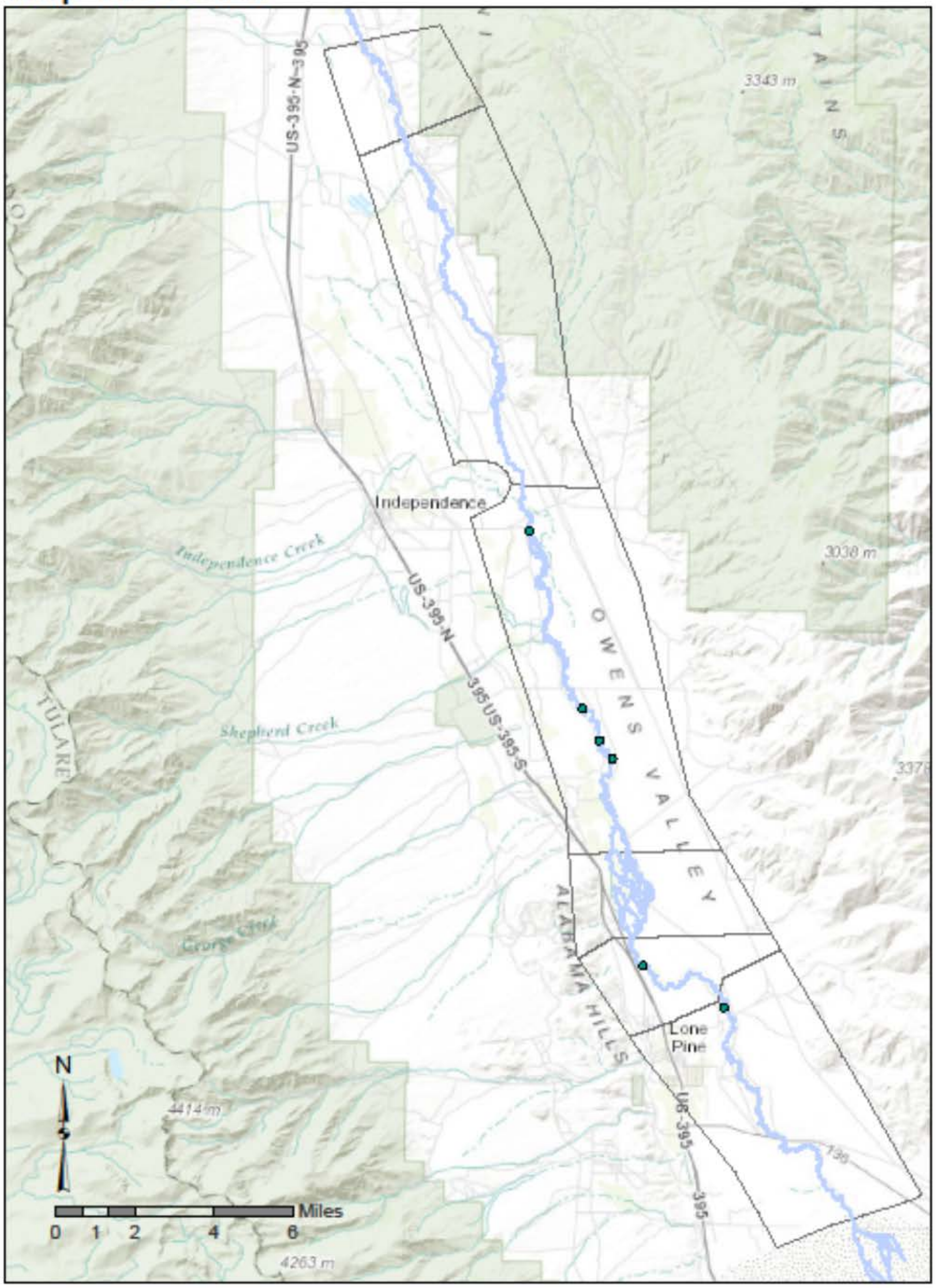
Map 7: Beaver



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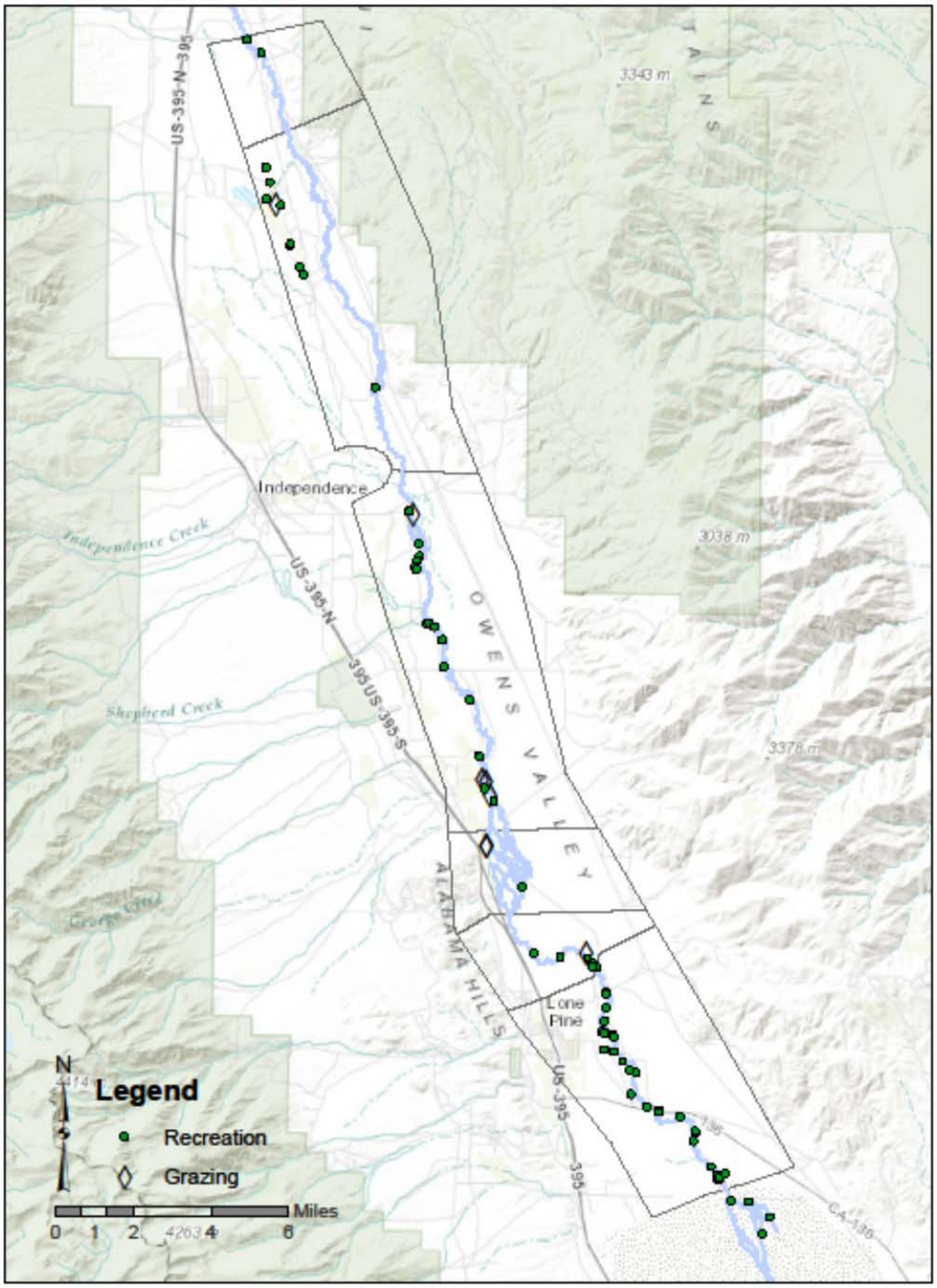
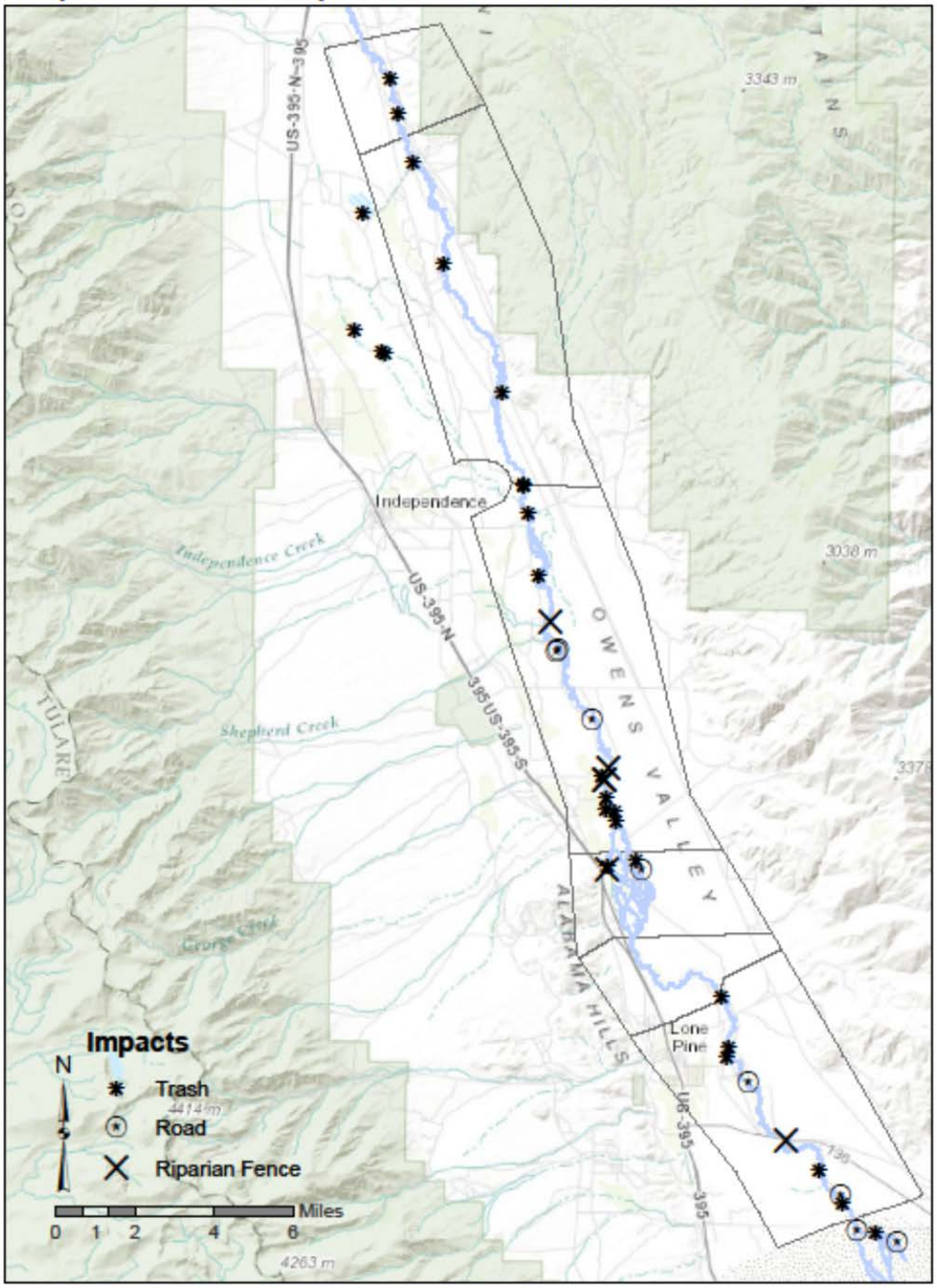
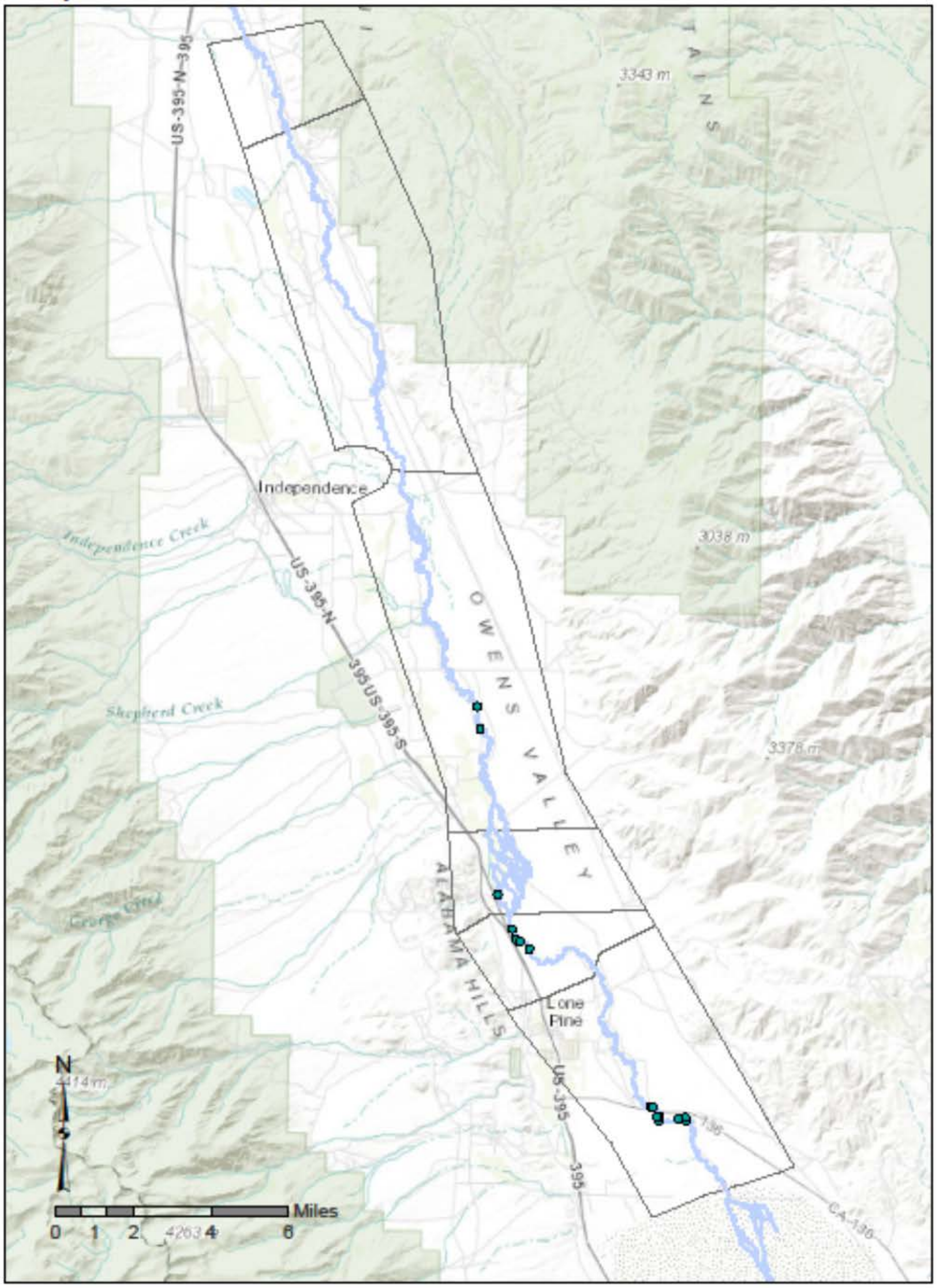
Map 8: Grazing and Recreation



Map 9: Roads, Riparian Fence, and Trash



Map 10: Diseased Willow



6.0 TULE MANAGEMENT AND CONTROL

6.1 Introduction

The Lower Owens River Project (LORP) is successful on many accounts. The project provides perennial stream flow for nearly 60 miles of river that was essentially dry since the early 1900s. Re-establishing flows has restored, to some extent, riverine and riparian habitats which now support both a greater abundance and diversity of aquatic, terrestrial and avian species as compared to pre-project conditions. Despite these successes, the LORP is perceived by some stakeholders and members of the public as falling short of its assumed goal of restoring the river to its “natural condition.” Although it is an open question on what constitutes the natural conditions of the Lower Owens River, it is undeniable that much of the Lower Owens River is choked with a dense mixture of both bulrushes (*Scripus acutus*) and cattails (*Typha spp.*) (collectively referred hereafter as tules). As the river and its supporting biota adjust to the reintroduction of flows, it’s unknown if these tule conditions are short-term or a permanent fixture. If the latter conditions hold true, the assumption and goals of the LORP may need to be changed or more active management of tules may need to occur.

In the event that more active management is warranted, several experimental test plots were established along the Lower Owens River to evaluate the effectiveness of reducing and controlling tules using a variety of methods. These treatments included: herbicide, repeat cutting of stems, planting of competing vegetation and a control, in which no treatments were administered. Monitoring to evaluate the effectiveness of these treatments consisted of monthly repeat photo-points and density count of tule stems at the end of the growing season. Initial results indicate that when compared to the control, herbicide and repeat cutting are equally effective, while the planting of competing vegetation is less effective. Despite these initial results, the long-term effectiveness of these treatments is unknown and implementing a more natural hydrograph with select treatments may prove to be the most beneficial over time.

6.1.1 Setting and Background

The reasons for the colonization and expansion of tules in the Lower Owens River are related to the complex interactions between its physical setting along with past and current management practices. Although much of the following information has appeared in previous documents and reports, it merits repeating as it provides important context to the current conditions in the LORP.

The Lower Owens River meanders across a relatively narrow and low gradient valley that is flanked by the White and Sierra mountain ranges. Snowmelt from this latter range provides the majority of the 470,000 ac-ft per year annual-average runoff (Danskin 1998 p. 38). When accounting for water losses associated with evapotranspiration, groundwater losses, and discharges from springs and seeps, the volume of water available to the Lower Owens River, prior to European settlement, ranged from 123,100 to 235,000 ac-ft per year (Hollett et al. 1991 p.39).

Following the completion of the Los Angeles Aqueduct in 1913, all upstream flows to the LORP were diverted into the Aqueduct (Figure 1). Subsequently, the five miles of river immediately below the Intake for the Aqueduct were essentially dry until 2006 when flows were restored. However, water has been periodically spilled into the river when the Aqueduct was over capacity. Also, the river intercepts groundwater along its lowest reaches, which provided small perennial-flows. Following 1986, in an effort to re-water the river and jump-start restoration, an average daily flow of 25 cfs was annually maintained in the LORP below the Blackrock Return

Diitch. These flows were maintained until 2006 and are believed to be the initial cause of tule colonization and expansion along the LORP (pers. comm. LADWP staff, 2014).

Tule Management Figure 1. Test Plots on LORP

In 2007, base flows of 40 cfs were met at all measuring stations along the river and are maintained for the entirety of the year, with the exception of seasonal habitat flows. These seasonal habitat flows were introduced to provide periodic disturbances within the river and riparian corridor. These habitat flows range from 0-200 cfs and scale proportionally with the amount of predicted snow-melt runoff. These flow conditions, however, are problematic.

The peak 200 cfs seasonal habitat flow, while readily capable of eroding and transporting sediment that composes the bed and the banks of the LORP, are not strong enough to dislodge tules (LADWP 2013). Also, base flows greatly contribute to the maintenance and expansion of tules as stable flow conditions exist for much the year, which is ideal for tule growth. The criteria of maintaining 40 cfs throughout the entirety of the river means that, on average, more than double that amount of flow has to be released from the Intake Structure in order to reach the Pumpback Station during the growing season because of the losses associated with evapotranspiration and conveyance. These sustained higher flows allow tules to expand up the banks and onto the floodplain because of the increase in wetted extent. This is unlike a natural hydrograph for a snow-melt dominant river, where both flows and the wetted extent contract during the latter portion of the growing season.

Further, the Lower Owens River is a smaller vestige of its former self. Because the river presently conveys less than 75 percent of its former flow, the river now occupies only a portion of its former channel. Consequently, tules have expanded onto the past riverbed, which would have carried water prior to the completion of the Los Angeles Aqueduct. This expansion with sustained and elevated flows during the growing season has had two profound impacts on the LORP: 1) the loss of open water in the river below Mazourka Canyon Road to the town of Lone Pine, and 2) a near homogenization of in-channel and riparian vegetation.

6.2 Tule Control Techniques and Feasibility

Because tules are ubiquitous across much of the Northern Hemisphere and have impacts not only on natural systems, but irrigation, drainage, and transportation waterways, a variety of methods have been used to control them. The most prevalent is the use of herbicides and a combination of cutting and mowing. Less common and largely undocumented is the use of aquatic/riparian plant species that can outcompete tules. As with any treatment, each method has its set of limitations.

6.2.1 Cutting/Mowing and Drowning

When drowning, tules are cut below the water surface, effectively submerging the remaining plant, which cuts off the supply of oxygen to their roots and suffocates it. Water depth needs to be sufficient to prevent the cut plants from reaching above the water surface as well as covering standing dead tules to prevent them from supplying oxygen to living root mats. In the LORP, drowning intact tules is not feasible given the wide and shallow dimensions of the stream channel and the fact that tules on average stand 6-8 feet above the floodplain, which would make it nearly impossible to submerge them.

6.2.2 Herbicide

Herbicides, such as glyphosate, kill tules by interrupting their metabolic pathways and are most effective when transported to the rhizomes. Herbicides, while effective and relatively easy to apply, have disadvantages related to the increasing environmental regulatory requirements.

The reasoning for increased regulatory oversight stems from short and potential long-term toxicity associated with using herbicides in/near water.

6.2.3 Competing Vegetation

Using the ecological concept of species competitiveness, removing and reducing tules to allow competing native vegetation to establish and grow might exclude or minimize tule cover. Although there is little in terms of published reports or studies, anecdotal accounts, however, support that this method can be successful. Locally, in portions of Fish Slough removing tules in areas with Three-square (*Schoenoplectus americanus*) has been observed to be successful. Also, unlike tules, Three-square cannot tolerate water-depths greater than a foot, thereby maintaining more open water. What is not known is the amount of continued maintenance needed to control tules until Three-square becomes firmly established.

6.2.4 Experimental Plots

To evaluate the effectiveness of these treatments, several test plots were established along the LORP approximately 2 miles below the Aqueduct Intake (Figure 1). The plots are in a portion of the river that supports an open channel and are approximately 20 ft by 30 ft and are separated from another by a 10 ft buffer to minimize the effects of the treatments on neighboring plots. In all plots, dead tules were removed in early February to negate the effects of existing tules providing oxygen to the root masses. Additionally, approximately 1 lb of Three-square seeds were sown in the competing vegetation plot. In early May 2014, with new tule growth, the herbicide Polaris, which is labeled aquatic safe, was applied liberally to the above water portions of tules and those on the banks. Also at this time, the three-square seed had not germinated, so mature plants were transplanted into the plot. Following this, no other treatment occurred in both the Three-square and herbicide plots for the duration of the study. In the recut plot, tules were cut as close as possible to its root mass every month.

Monitoring of the plots consisted of monthly photos. To provide quantitative results, the number of plant stems within a 1 m diameter plot were counted at the end of the growing season. Two circular plots were read in each of the experimental plots – 1) at the water's edge and 2) in the river channel, at an approximately depth of 3.5 ft. Lastly, a staff gage was installed to monitor water depth in the plots throughout the growing season.

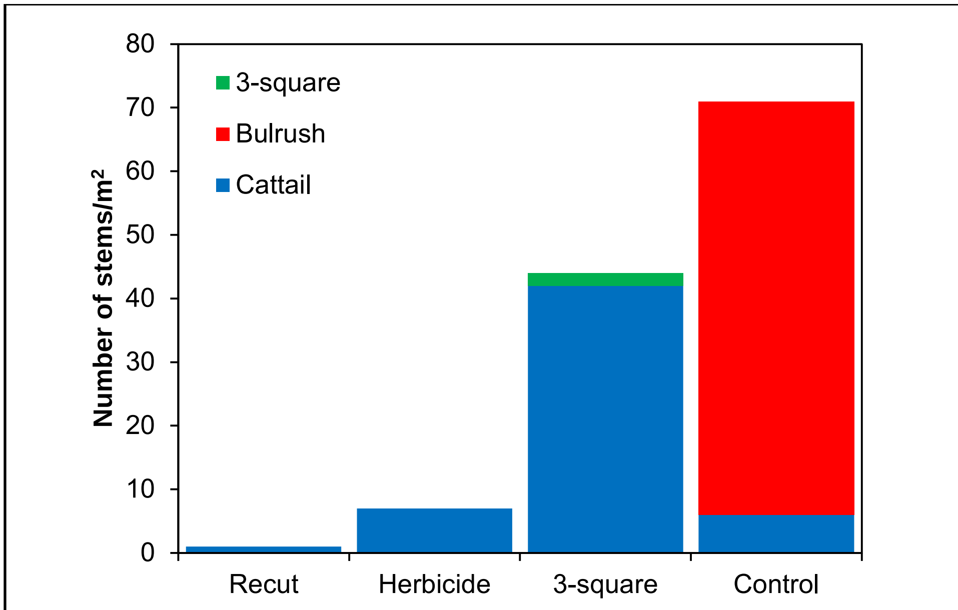
6.3 Monitoring Results

6.3.1 Photo Points

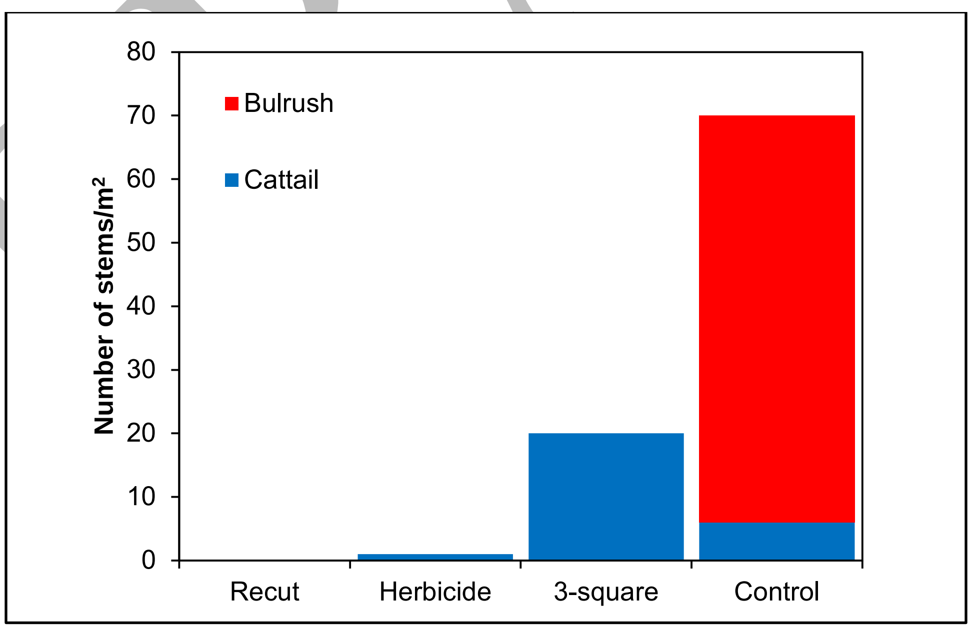
Following the initial cut of tules in February 2014, the plots did not show an abundance of new growth until mid to late May (see Appendix 1). Also in May, there was no germination of the three-square seed and 12 mature three-square plants were transplanted. In early July, near the peak of the growing season, there was ample tule growth on the banks and in the shallow water in the re-cut plot, but at depths greater than 3 ft, tules were nearly absent. In the Three-square plot, 8 of the initial 12 plants were alive and actively growing, although tule regrowth was incredibly dense throughout the plot. Also at this time, the effects of the herbicide were readily apparent, as there was little new growth throughout the entirety of the plot. In the control plot, there was no observable effect of the initial February cutting. By late August, there was little new growth in the recut and the herbicide plots, while in the Three-square and control plots the tules regained their original density both on the banks and in the water. The 1 m circular plots support these observations.

6.3.2 Circular Plots

At the end of the growing season, within a one square-meter at the water's edge, the recut plot had 1 cattail and the herbicide plot had 7, while the Three-square plot had 42 cattails and two Three-square verses 6 cattails and 65 bulrushes in the control plot (Figure 2). At a water depth of 3.5 ft there were no plants in the recut plot and 1 cattail in the herbicide plot (Figure 3). In the Three-square plot there were 20 cattails and in the control there were 6 cattails and 65 bulrushes.



Tule Management Figure 2. Density of Plants at the Water's Edge for Each Treatment Plot at the End of the Growing Season



Tule Management Figure 3. Density of Plants at a Water Depth of 3.5 ft for Each Treatment Plot at the End of the Growing Season

6.3.3 Water Depths and Flows

The initial depth of water across the plots was 2.87 ft in mid-March with 46 cfs being released from the Intake. By late May, both depth and flow increased to 3.45 ft and 61 cfs, respectively. In early July, flow from the Intake was 79 cfs and the plots had an increase in water depth to 4.35 ft. It is estimated that the wetted width in the plots increased by 6 to 8 ft during this period of high flow. By late August, flows had receded to 65 cfs and the depth dropped to 3.50 ft and the wetted marginal retracted from its summer high point.

6.4 Implications

At first glance there appears to be no difference in the effectiveness in reducing tule growth and density by either repeatedly cutting or using herbicide as treatment. However, there was a marked difference in the effort and time between the two treatments. Recutting occurred a minimum of five times while the herbicide was applied once. There is also a question of longevity of the treatments. By late August there was little to no new growth in both plots. This could be attributed to the growth cycles of the tules; during late summer they are actively storing energy in their root masses for the upcoming winter and are not expending energy into new growth. Also there are questions regarding the long-term persistence of the herbicide in the local environment, which would prevent new and competing vegetation from growing. Continued monitoring next growing season should provide additional information to answer these questions.

Regarding the Three-square plot, the failure of the seeds to germinate could be related to a host of reasons, such as poor quality, viability, and that Three-square seeds are reportedly difficult to germinate (Biber 2008). Despite this, it should be noted that the transplanted Three-square was highly successful in terms of establishment and growth. Competition from the tules, because of their initial density, will most likely limit its expansion, but nonetheless this test plot demonstrates that Three-square is relatively easy and successful to plant.

The control plot exemplifies that timing of cutting is also an essential part of reducing tules. By just removing standing dead before the growing season, there is evidently enough energy stored in the root mass that the plants can withstand the initial oxygen deprivation and still promote new growth. Once reaching the surface, the tules resume respiration and grow. Cutting tules late in the growing season thus may be more effective. A new and separate test plot was established in late August 2014 to evaluate this timing effect. Although bulrushes were only found in the control parcel and at high numbers, this should not be taken that they possess a higher degree of vigor or incorporate different life-history strategies. The higher density of bulrushes may be explained simply by the plants' shape. Relative to cattails, they are much more symmetrical in shape, thus their ability to be more tightly packed.

The outstanding question of this work is the longevity of these treatments, particularly cutting and the use of herbicide. The cutting and drowning approach may be short-lived because of the tule expansion onto the banks and floodplain during the higher-flow summer months. These tules, with time, may be able to recolonize the open channel where they were extirpated as the river recedes. Conversely, the use of herbicide may not allow anything to regrow because of its persistence in the environment.

6.5 Summary

Three tule reduction methods were compared to evaluate which treatment was the most effective. The methods compared were herbicide, competition from transplanted Three-square, and repeat cutting of tule stems below the water surface to drown them. These methods were compared in three adjacent test plots along with a control that consisted of no treatment. The initial results support that both herbicide and repetitive cutting are equally effective in reducing tules, with the main distinction being that the former treatment is less labor and time intensive compared to the latter. Using Three-square to outcompete tules was ineffective. However, propagating Three-square from root stock was highly successful. The control, in which no treatment occurred, showed no reduction in tule growth and density despite removing the standing dead.

These results as well as other studies support that there is no stand-alone treatment to reduce tules (Apfelbaum 1985, Sojda & Solberg 1993). Instead, using a combination of the three treatments may be the most effective. However, for these treatments to be successful over the long-term, implementing a hydrograph that mimics cyclic flood and drought events is crucial. These disturbance events largely drive population and species diversity in river and riparian ecosystems. In fact, many riverine species have developed unique traits and strategies to survive, exploit, and even depend on these disturbance events (*e.g.* willows). Presently, however, the Lower Owens River lacks such events (with the exception of periodic high flows, which are limiting) and has led to the monoculture of tules. If active management is sought to control tules, implementing a more varied flow regime in combination with select treatments will most likely create a suite of habitats necessary to support a greater diversity of species along the LORP.

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Los Angeles Department of Water and Power. 2013. LORP Hydraulics and Tule Distribution. 2013 Lower Owens River Project Annual Report. Los Angeles Department of Water and Power, Bishop, CA.

6.7 Appendix 1

Control Plots

February

May

July

August

Herbicide Plots

February

May

July

August

Recut Plots

February

May

July

August

Three-Square Plots

February

May

July

August

7.0 LOWER OWENS RIVER PROJECT CREEL SURVEY

Introduction

The 2014 Lower Owens River Project (LORP) creel survey was conducted to determine if there was a residual effect on the LORP's warmwater fishery from a fish kill that resulted from a July 2013 flood event. Creel survey data will assist with the adaptive management decision making process for the LORP warmwater fishery, as it provides information about the health, abundance, and distribution of game fish throughout the LORP. Fish habitat within the LORP includes the river channel, oxbows, side channels, off-river lakes and ponds, springs, and artesian well ponds. Data from the 2014 creel survey will be compared to the past three surveys to determine if the fish kill had an effect on the LORP's warmwater fishery. The same methods developed during the 2003 pre-flow creel survey were used in the 2014 survey and are described below.

7.1 Methods

7.1.1 Sites

The LORP was divided into five separate fishing areas for the creel survey (Figure 1). Four of the fishing areas are located on the Lower Owens River while the fifth covers designated off-river lakes:

Area 1 - (Owens River from the Pumpback Station Forebay at Owens Lake upstream to the Lone Pine Narrow Gauge Road)

Area 2 - (Owens River from the Lone Pine Narrow Gauge Road upstream to the Manzanar Reward Road)

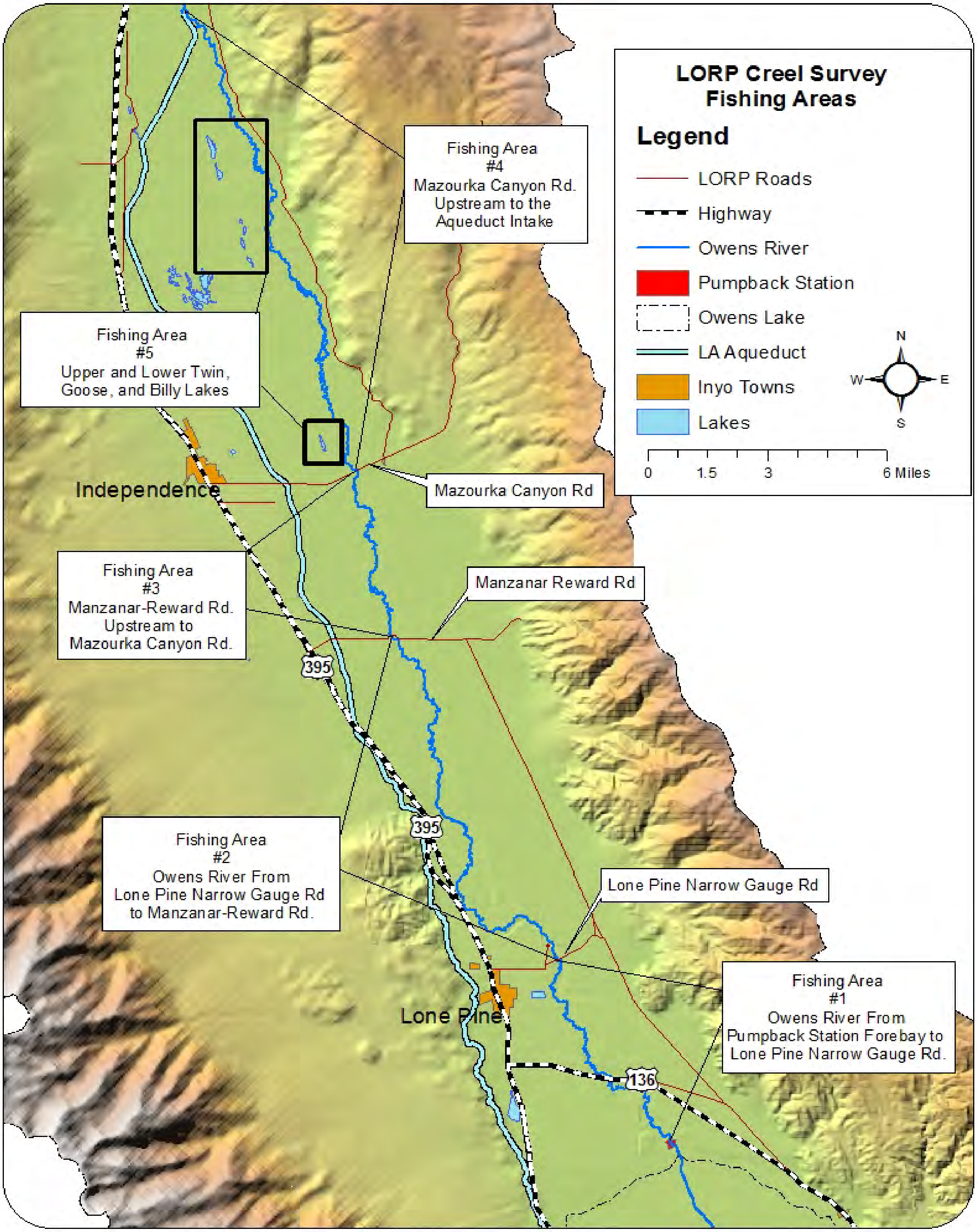
Area 3 - (Owens River form Manzanar Reward Road upstream to the Mazourka Canyon Road)

Area 4 - (Owens River from Mazourka Canyon Road upstream to the Los Angeles Aqueduct [LAA] Intake)

Area 5 - (Upper and Lower Twin, Billy and Goose Lakes)

7.1.2 Volunteers

Anglers from the local area were recruited to help conduct the 2014 creel survey. A total of 24 anglers volunteered and were assigned identification numbers 1 to 24. Each identification number was assigned to one of the above fishing areas (Table 1). Identification numbers 1 to 5 were assigned to Area 1, numbers 6 to 10 were assigned to Area 2, numbers 11 to 15 were assigned to Area 3, numbers 16 to 20 were assigned to Area 4, and numbers 21 to 24 were assigned to Area 5 Volunteers in Areas 1 through 4 were allowed to fish anywhere within their assigned area. In Area 5, each identification number was assigned to an individual lake. Angler 21 must fish Upper Twin Lake, angler 22 must fish Lower Twin Lake, angler 23 must fish Goose Lake, and angler 24 must fish Billy Lake.



Creel Survey Figure 1. Creel Survey Fishing Areas

Creel Survey Table 1. Angler Identification Numbers and Assigned Areas

ANGLER ID NUMBERS	ASSIGNED FISHING AREAS
Numbers 1 to 5	Area 1, Pumpback Station Forebay at Owens Lake upstream to the Lone Pine Narrow Gauge Road
Numbers 6 to 10	Area 2, Owens River from the Lone Pine Narrow Gauge Road upstream to the Manzanar Reward Road
Numbers 11 to 15	Area 3, Owens River form Manzanar Reward Road upstream to the Mazourka Canyon Road
Numbers 16 to 20	Area 4, Owens River from Mazourka Canyon Road upstream to the LAA Intake
Number 21	Area 5, Upper Twin Lake
Number 22	Area 5, Lower Twin Lake
Number 23	Area 5, Goose Lake
Number 24	Area 5, Billy Lake

7.1.3 Season Timing and Methods of Creel Survey

The first creel survey (post implementation) was conducted in the fall of 2010. The second and third creel surveys (post implementation) were conducted in the spring of 2011 and 2013. Adaptive management recommendations in the 2010 LORP Annual Report, recommended elimination of the fall creel survey and only fishing in the spring when indicated by the Monitoring and Adaptive Management Plan (MAMP).

Based on the schedule in the MAMP, 2014 was not scheduled to be a creel survey year, but due to the 2013 flood event and subsequent fish kill, the census was conducted to determine if there was a residual impact on the LORP fishery.

To complete the survey, volunteers fished two periods during the month of May. The first fishing period was from May 1 through May 15, 2014, with each volunteer fishing 3.5 hours during this period. The second fishing period was from May 16 to May 31, 2014, with each volunteer fishing 3.5 hours during this period. No survey fishing can occur during any period outside of May.

Volunteers were limited to 3.5 hours of fishing per day during the survey. The 3.5 hour period does not have to be fished continuously, but it must be done in the same day. The 3.5 hour time limit is the average time an angler in the west fishes on an average fishing day (Dr. William Platts, Ecosystem Sciences, personal communication, August 18, 2010). During the survey, volunteers can fish only within his or her assigned area; however, they may fish anywhere within that assigned area. Volunteers may use any type of fishing gear available, as long as they abide by all applicable State of California fishing rules and regulations.

7.1.4 Creel Records

LADWP has been responsible for the coordination of the creel surveys in the LORP to date. However, this year LADWP supplied Inyo County with the LORP Fishing Creel Survey Guide with datasheets (Figure 2), contact information for past anglers and a description of how it has been conducted in the past. Inyo County then took the lead on organizing the anglers, supplying them with the LORP Fishing Creel Survey Guide and following the survey, collected the datasheets.

Many of the anglers who participated in the 2014 creel survey had taken part in the 2013 survey. Additional anglers were recruited by referrals provided by creel survey veterans.

Two weeks before the survey, anglers were contacted individually to confirm their commitment to complete the survey. At that time they were assigned their fisherman ID number and the provided background on what was expected of them. Each angler was sent a copy of the Lower Owens River, Anglers Creel Census Guide, produced by Inyo County and LADWP. Three data sheets and a postage paid envelope in which to return the forms were also included in the mailed packet.

One week before the survey, all anglers were contacted by phone again and reviewed the Lower Owens River, Anglers Creel Census Guide. Anglers were contacted again around early to mid-May to assure that the individual was able to complete their fishing during the designated session. Some fishermen were not able to fish during one or both sessions, and substitutes were found to complete their assignment.

Most anglers returned their forms by the May 18 deadline; those that did not received reminder calls. Eventually all survey forms were returned. On June 4, 2014, the LORP MOU Consultants were provided an invoice for creel survey honorariums and instructed to send payments to anglers immediately.

One additional contact was made with the anglers to confirm receipt of their honorarium payment, and to thank them for their service.

LORP Creel Survey Return to: Jason Morgan 300 Mandich Street Bishop, CA 93514 Office (760) 873-0429 Cell (760) 878-8954			
Reach Number:	**Date:**	**Name:**	**Fisherperson's Number:**
Total Number of Fish Observed			
Largemouth Bass:	**Brown Trout:**	**Bluegill:**	**Smallmouth Bass:**
Common Carp:	**Channel Catfish:**	**Brown Bullhead:**	**Other Species (Name/Number):**

Fish Caught (Fishing Time 3.5 hours)			
Number	**Species**	**Length (Inches)**	**Condition (Good or Poor)**
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			

Creel Survey Figure 2. LORP Creel Survey Form

7.2 Results

All 24 anglers returned completed data sheets for the first fishing period. In the second fishing period, only 19 of the anglers returned their data sheets. The missing data was from three anglers fishing Area 2 and two anglers fishing Area 5. Compared with previous years, 2013 had 6 anglers (25%) and 2011 had one angler (4%) that failed to return datasheets. By calculating catch per unit effort (fish/hour) years can still be compared with missing data in some years.

In the 2011 annual report, the LORP consultants felt that some anglers were misidentifying smallmouth bass (*Micropterus dolomieu)* as largemouth bass (*Micropterus salmoides)*. Based on their own fishing experience they felt that smallmouth bass were making up about 5% of their catch. To remedy this problem, they suggested that smallmouth and largemouth bass be combined and referred to as bass. This report will again refer to both smallmouth and largemouth just as bass.

Overall, the anglers fished 3.5 hours each for a total of 150.5 hours during the two fishing periods in May of 2014. A total of 415 fish were caught, including 249 bass, 120 bluegill (*Lepomis macrochirus)*, 12 brown bullhead (*Ameiurus nebulosus)*, 6 brown trout (*Salmo trutta)*, 25 common carp (*Cyprinus carpio)*, and 3 channel catfish (*Ictalurus punctatus)* (Table 2).

Overall, catch per unit effort was 2.8 fish per hour. Bass accounted for approximately 60% of the total catch and were caught at 1.7 fish per hour with an average length of 11 inches (maximum 19 inches and minimum 6 inches). Bluegill accounted for approximately 29% of the total catch and were caught at a rate of 0.8 fish per hour with an average size of 5 inches (maximum 8 inches and minimum length 1-inch). Brown bullhead accounted for approximately 3% of the total catch and were caught at a rate of 0.1 fish per hour with an average length of 5 inches. Maximum total length for brown bullhead was 9 inches and minimum length was 2 inches. Brown trout accounted for approximately 1% of the total catch and were caught at a rate of 0.04 and had an average length of 13 inches (maximum 15 inches and minimum 12 inches). Common carp had an average length of 13 inches with a maximum length of 17 inches and minimum length of 6 inches. Common carp accounted for approximately 6% of the total catch and were caught at a rate of 0.2 fish per hour. Channel catfish had averaged 7 inches in length (maximum 10 inches and minimum 5 inches), made up 1% of the total catch and was caught at a rate of 0.02 fish per hour.

Of the 415 fish caught by the anglers, 14 were listed as being in poor condition. Seven of the fish listed as being in poor condition were bass, three were bluegill, one was a brown trout, and three were common carp.

The anglers observed 1,637 fish during the creel survey. The most observed species was common carp with 844 fish observed. Bass was the next most observed species with 444 individuals seen followed by bluegill with 330 individuals seen, then by channel catfish with 18 individuals and one brown bullhead (Table 3).

Creel Survey Table 2. Results of Overall Fish Caught for the LORP Creel Survey, May 2014.

Overall	Bass	Bluegill	Brown Bullhead	Brown Trout	Common Carp	Channel Catfish	Total, Average, Max & Min
Number of Fish Caught	249	120	12	6	25	3	415
Percent of Total Catch	60%	29%	3%	1%	6%	1%	100%
Average size (inches)	11	5	5	13	13	7	10.0
Catch/Hour	1.7	0.8	0.1	0.0	0.2	0.0	2.8
Max Length (inches)	19	8	9	15	17	10	19
Min Length (inches)	6	1	2	12	6	5	1

Creel Survey Table 3. Number of Fish Observed During the LORP Creel Survey, May 2014.

	Period 1	Period 2	Total
Bass	239	205	444
Bluegill	122	208	330
Brown Bullhead	1	0	1
Common Carp	504	340	844
Channel Catfish	16	2	18
Total	882	755	1,637

During the first period, from May 1-15, 2014 the 24 anglers fished 3.5 hours each for a total of 84 hours. During this period a total of 253 fish were caught; 146 bass, 69 bluegill, 10 brown bullhead, six brown trout, three channel catfish and 19 common carp (Table 4). Catch per hour was 1.7 for bass, 0.8 for bluegill, 0.1 for brown bullhead, 0.1 for brown trout, 0.2 for common carp and 0.04 for channel catfish for a total of 3.0 fish per hour. The 24 anglers observed 882 fish during the first period of the creel survey with common carp, bass and bluegill making up the majority of the fish observed (Table 3).

Creel Survey Table 4. Results for the First Period LORP Creel Survey May 1-15, 2014

Period 1	Bass	Bluegill	Brown Bullhead	Brown Trout	Channel Catfish	Common Carp	Total, Average, Max & Min
Count	146	69	10	6	3	19	253
Average size (inches)	11	4	5	13	7	13	8.9
Catch/Hour	1.7	0.8	0.1	0.1	0.04	0.2	3.0
Max Length (inches)	18	8	7	15	10	17	18
Min Length (inches)	6	1	2	12	5	6	1

During the second period, from May 16-31, 2014 the 18 anglers again fished for a total of 63 hours. During this period a total of 162 fish were caught; 103 bass, 51 bluegill, two brown bullhead and six common carp (Table 5). Fish were caught at a rate of 2.4 fish per hour during the second period; bass were caught at a rate of 1.6 fish per hour, bluegill at 0.8 fish per hour, brown bullhead at 0.03 fish per hour and common carp 0.1 fish per hour. The anglers observed 755 fish during this period; 205 bass, 208 bluegill, 340 common carp and two channel catfish (Table 3).

Creel Survey Table 5. Results for the Second Period LORP Creel Survey May 16-31, 2014

Period 2	Bass	Bluegill	Brown Bullhead	Brown Trout	Channel Catfish	Common Carp	Total, Average, Max & Min
Count	103	51	2	0	0	6	162
Average size (inches)	11	5	9	0	0	14	6.3
Catch/Hour	1.6	0.8	0.03	0.0	0.0	0.1	2.4
Max Length (inches)	19	7	9	0	0	16	19
Min Length (inches)	6	3	8	0	0	12	3

During the first fishing period, Area 3 had the highest catch per unit effort at 3.1 fish per hour, followed by Area 4 at 2.1 fish per hour fish, Area 2 at 2.0 fish per hour, Area 1 at 1.5 fish per hour, and area 5 at 1.4 fish per hour (Table 6). During the second fishing period Area 1 had the highest catch per unit effort at 3.0 fish per hour, fish were caught at a rate of 2.7 fish per hour in Area 3, 2.3 fish per hour in Area 5, and 1.8 fish per hour in Areas 2 & 4 (Table 7).

Creel Survey Table 6. Results by Fishing Area for First Period May 1-15, 2014

Reach 1	Bass	Bluegill	Brown Bullhead	Brown Trout	Channel Catfish	Common Carp	Total, Average, Max & Min
Count	38	0	0	0	1	0	39
Average size	9	0	0	0	5	0	2
Catch/Hour	2.2	0.0	0.0	0.0	0.1	0.0	2.2
Max Length	15	0	0	0	5	0	15
Min Length	6	0	0	0	5	0	5

Reach 2	Bass	Bluegill	Brown Bullhead	Brown Trout	Channel Catfish	Common Carp	Total, Average, Max & Min
Count	38	32	10	6	1	17	104
Average size	12	4	5	13	6	13	7
Catch/Hour	2.2	1.8	0.6	0.3	0.1	1.0	5.9
Max Length	18	6	7	15	6	17	18
Min Length	6	1	2	12	6	6	3

Reach 3	Bass	Bluegill	Brown Bullhead	Brown Trout	Channel Catfish	Common Carp	Total, Average, Max & Min
Count	54	3	0	0	1	2	60
Average size	11	7	0	0	10	15	12
Catch/Hour	3.1	0.2	0.0	0.0	0.1	0.1	3.4
Max Length	15	8	0	0	10	16	16
Min Length	8	6	0	0	10	14	6

Reach 4	Bass	Bluegill	Brown Bullhead	Brown Trout	Channel Catfish	Common Carp	Total, Average, Max & Min
Count	5	8	0	0	0	0	36
Average size	10	5	0	0	0	0	11
Catch/Hour	0.3	0.5	0.0	0.0	0.0	0.0	2.1
Max Length	14	6	0	0	0	0	16
Min Length	7	4	0	0	0	0	8

Reach 5	Bass	Bluegill	Brown Bullhead	Brown Trout	Channel Catfish	Common Carp	Total, Average, Max & Min
Count	11	26	0	0	0	0	37
Average size	11	4	0	0	0	0	13
Catch/Hour	0.8	1.9	0.0	0.0	0.0	0.0	1.4
Max Length	17	8	0	0	0	0	16
Min Length	8	2	0	0	0	0	8

Creel Survey Table 7. Results by Fishing Area for Second Period May 16-31, 2014

Area 1	Bass	Bluegill	Brown Bullhead	Brown Trout	Common Carp	Channel Catfish	Total, Average, Max & Min
Count	23	19	0	0	0	0	42
Average size	12	5	0	0	0	0	16
Catch/Hour	1.6	1.4	0.0	0.0	0.0	0.0	3.0
Max Length	17	6	0	0	0	0	17
Min Length	8	3	0	0	0	0	3

Area 2	Bass	Bluegill	Brown Bullhead	Brown Trout	Common Carp	Channel Catfish	Total, Average, Max & Min
Count	6	12	0	0	0	1	19
Average size	7	5	0	0	0	10	23
Catch/Hour	0.6	1.1	0.0	0.0	0.0	0.1	1.8
Max Length	10	8	0	0	0	10	8
Min Length	5	3	0	0	0	10	3

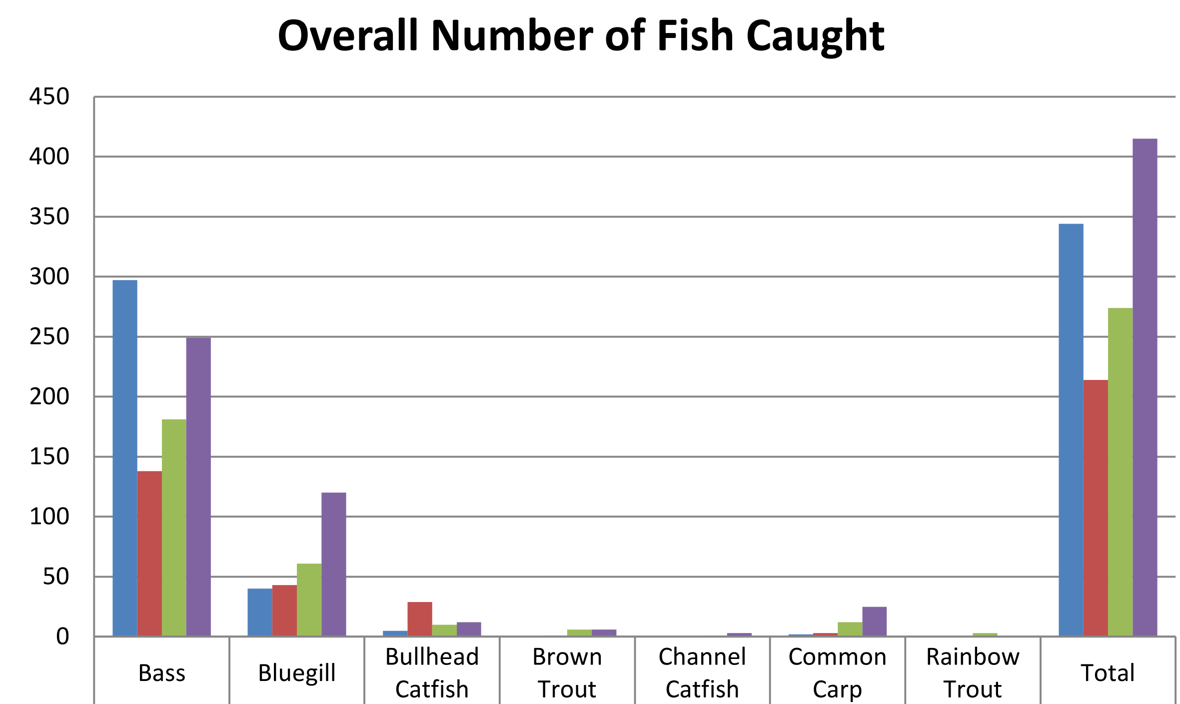
Area 3	Bass	Bluegill	Brown Bullhead	Brown Trout	Common Carp	Channel Catfish	Total, Average, Max & Min
Count	20	9	4	0	5	0	38
Average size	13	4	4	0	16	0	37
Catch/Hour	1.4	0.6	0.3	0.0	0.4	0.0	2.7
Max Length	18	6	5	0	20	0	20
Min Length	10	2	3	0	12	0	2

Area 4	Bass	Bluegill	Brown Bullhead	Brown Trout	Common Carp	Channel Catfish	Total, Average, Max & Min
Count	31	0	0	0	0	0	31
Average size	11	0	0	0	0	0	11
Catch/Hour	1.8	0.0	0.0	0.0	0.0	0.0	1.8
Max Length	16	0	0	0	0	0	16
Min Length	7	0	0	0	0	0	7

Area 5	Bass	Bluegill	Brown Bullhead	Brown Trout	Common Carp	Channel Catfish	Total, Average, Max & Min
Count	16	0	0	0	0	0	16
Average size	12	0	0	0	0	0	12
Catch/Hour	2.3	0.0	0.0	0.0	0.0	0.0	2.3
Max Length	16	0	0	0	0	0	16
Min Length	8	0	0	0	0	0	8

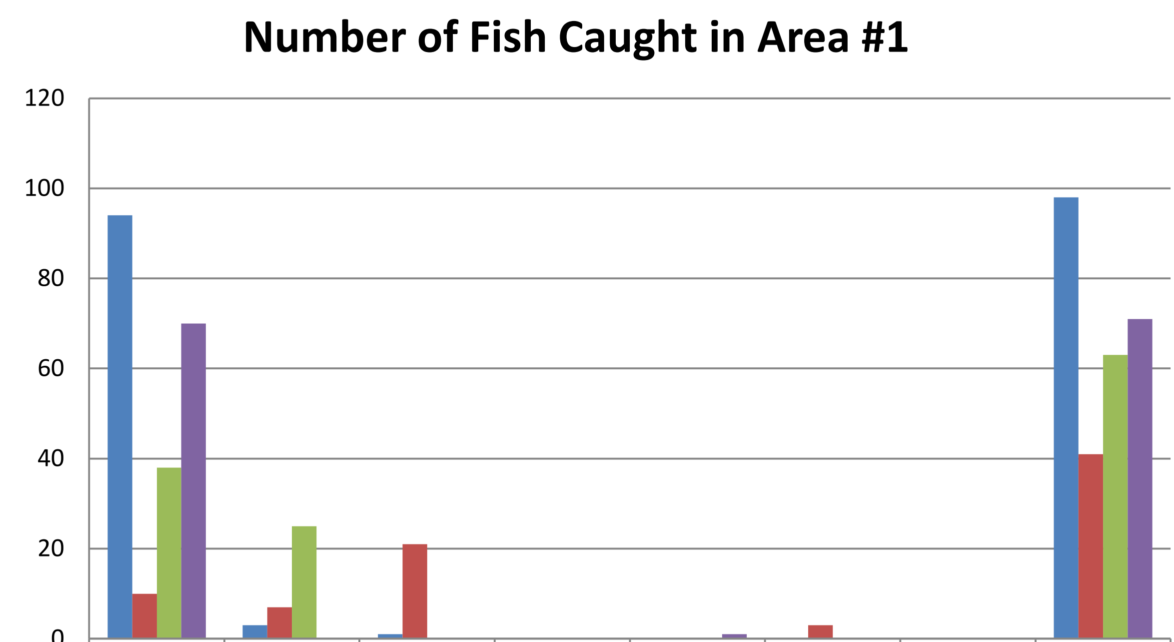
Based on personal observations during the 2013 fish kill, the majority of the fish that died were found in Area 1 which is from Lone Pine Narrow Gauge Road to the Pumpback Station Forebay at Owens Lake. There were approximately 400 to 500 largemouth bass, 5 to 10 common carp and a few bluegill observed dead in the Pumpback Station forebay. The 2014 creel survey was conducted to determine what affect the fish kill had on the LORP's warm water fishery.

When examining the overall numbers of total fish caught in the five fishing areas, the numbers have been steadily increasing since the 2011 survey and were the highest ever in 2014 (Figure 3). Reasons for the decrease in total number of fish caught from 2003 to 2011 have been discussed in past annual reports (2010, 2011 and 2013 LORP Annual Report). When looking at just Area #1, where the majority of the fish died during the fish kill, total number of fish caught continued to increase from a low of 41 in 2011, to 63 in 2013, to 71 in 2014 (Figure 4). In 2013, just one month prior to the fish kill the anglers were able to catch a total 38 bass, yet in 2014 after the fish kill that anglers were able to catch a total of 70 bass a 32 fish increase from 2013. Of note is that no bluegill were caught in 2014 in Area #1, but in 2013 the anglers caught 25.



	Bass	Bluegill	Bullhead Catfish	Brown Trout	Channel Catfish	Common Carp	Rainbow Trout	Total
2003	297	40	5	0	0	2	0	344
2011	138	43	29	1	0	3	0	214
2013	181	61	10	6	1	12	3	274
2014	249	120	12	6	3	25	0	415

Creel Survey Figure 3. Overall Number of Fish Caught for all Fishing Areas

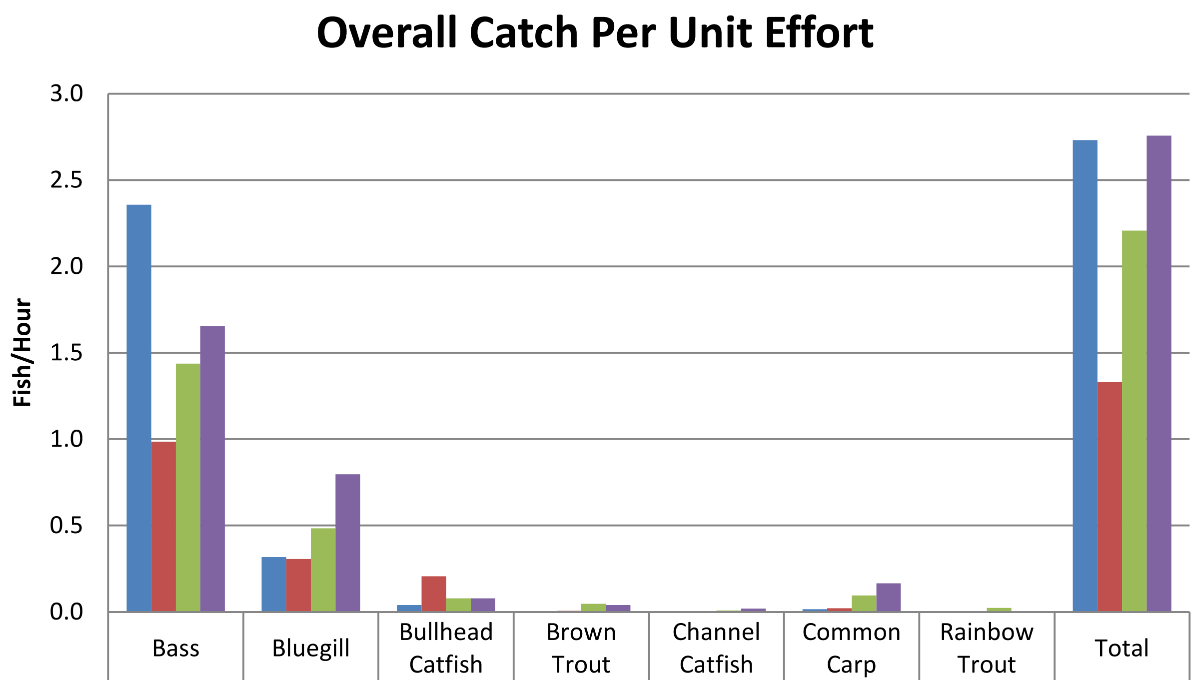


	Bass	Bluegill	Bullhead Catfish	Brown Trout	Channel Catfish	Common Carp	Rainbow Trout	Total
2003	94	3	1	0	0	0	0	98
2011	10	7	21	0	0	3	0	41
2013	38	25	0	0	0	0	0	63
2014	70	0	0	0	1	0	0	71

Creel Survey Figure 4. Number of Fish Caught in Area #1

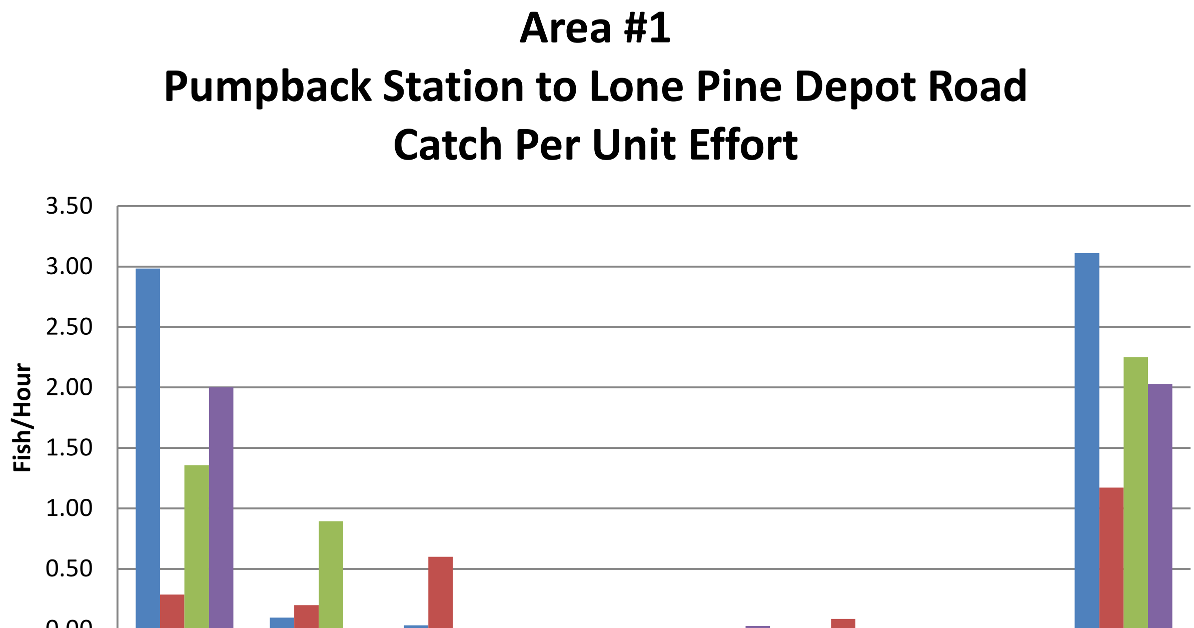
Overall catch per unit effort for the five fishing areas has also been steadily increasing since the 2011 survey and reached a high in 2014 of 2.8 fish/hour (Figure 5). Catch per unit effort for Area #1 showed a slight decrease of 0.3 fish/hour from 2013 to 2014 due to the lack of bluegill (Figure 6). When examining just bass there was an increase of 0.6 fish/hour when comparing the 2013 and 2014 survey years.

In 2013, the anglers fish in Area #1 reported that of the 38 bass caught 31 were in good condition and seven were in poor condition. All the bluegill caught in 2013 were reported to be in good condition. In 2014, the anglers reported that all 70 bass caught were in good condition.



	Bass	Bluegill	Bullhead Catfish	Brown Trout	Channel Catfish	Common Carp	Rainbow Trout	Total
2003	2.4	0.3	0.04	0.0	0.0	0.02	0.0	2.7
2011	1.0	0.3	0.21	0.01	0	0.02	0	1.3
2013	1.4	0.5	0.1	0.05	0.008	0.1	0.02	2.2
2014	1.7	0.8	0.1	0.04	0.02	0.2	0.0	2.8

Creel Survey Figure 5. Overall Catch per Unit Effort for all Fishing Areas.



	Bass	Bluegill	Bullhead Catfish	Brown Trout	Channel Catfish	Common Carp	Rainbow Trout	Total
2003	2.98	0.10	0.03	0	0	0	0	3.11
2011	0.3	0.2	0.6	0	0	0.1	0	1.2
2013	1.4	0.9	0	0	0	0	0	2.3
2014	2	0	0	0	0.03	0	0	2.0

Creel Survey Figure 6. Catch per Unit Effort for Fishing Area #1.

Tabular results from the 2003 creel survey are included (Table 8) for reference (unpublished data).

Creel Survey Table 8. Creel Survey Data for Lower Owens River Project, May 2003

Area 1. Owens River From Pumpback Forebay to the Lone Pine Station Road

Angler ID#	Date	Fish Caught	Number Caught	Combined Lengths (inches)	Maximum Length (inches)	Minimum Length (inches)	Condition
1	5/8/2003	Bass	14	188	16	10	good
1	5/26/03	Bass	14	135	13	6	good
2	5/9/2003	Bass	13	129	13	7	good
2	5/16/2003	Bass	18	176	14	6	good
3	5/13/2003	Bass	3	25	9	7	good
3	5/30/2003	Bass	6	57	14	8	good
4	5/22/2003	Bass	16	78	10	3	good
5	5/13/2003	Bass	7	54	11	5	good
5		Bullhead Catfish	1	9	9		good
5	5/30/2003	Bass	3	27	12	7	good
5		Bluegill	3	19	7	6	good

Hours Fished: 31.5
Catch Rate: 3.1 fish per hour
Average Fish Length: 9.2 inches
Maximum Size: 16 inches, Minimum Size: 3 inches
Max Average Size: 11.6 inches, Minimum Average Size: 5.9 inches

Area 2. Owens River From the Lone Pine Station Road to the Manzanar-Reward Road

Angler ID#	Date	Fish Caught	Number Caught	Combined Lengths (inches)	Maximum Length (inches)	Minimum Length (inches)	Condition
9	5/4/2003	Bass	4	48	14	10	good
9		Bluegill	5	14	3	2	good
9		Bullhead Catfish	3	35	13	10	good
9		Carp	1	15	15		good
9	5/18/2003	Bass	10	84	14	6	good
10	5/12/2003	Bass	6	73	15	10	good
10		Bluegill	2	12	6	6	good
10	5/26/2003	Bass	5	57	12	10	good
10		Bluegill	6	43	8	6	good
6	5/4/2003	Bass	14	151	16	5	good
6	5/19/2003	Bass	14	154	15	6	good
7	5/7/2003	Bass	6	72	14	10	good

Hours Fished: 24.5
Catch Rate: 3.1 fish per hour
Average Fish Length: 9.9 inches
Maximum Size: 16 inches, Minimum Size: 2 inches
Maximum Average Size: 12.1 inches, Minimum Average Size: 6.8 inches

Table 8 (continued) Creel Survey Data for Lower Owens River Project May 2003

Area 3. Owens River From the Manzanar-Reward Road Upstream to Mazourka Canyon Road

Angler ID#	Date	Fish Caught	Number Caught	Combined Lengths (inches)	Maximum Length (inches)	Minimum Length (inches)	Condition
12	5/5/2003	Bass	4	30	9	5	good
12		Bluegill	9	47	6	4	good
12	5/31/2003	Bass	3	29	12	8	good
11	5/31/2003	Bass	7	59	12	5	good/poor
11		Bluegill	7	34	5	4	good
11		Carp	1	15	15	15	good
14	5/15/2003	Bass	3	31	13	8	good
14	5/18/2003	Bass	3	33	12	10	good
14		Bullhead Catfish	1	8	8	8	good
15	5/15/2003	Bass	3	35	15	7	good
15		Bluegill	3	13	5	4	good
15	5/20/2003	Bass	4	30	10	6	good
15		Bluegill	2	9	5	3	good

Hours Fished: 24.5
Catch Rate: 2.0 fish per hour
Average Fish Length: 7.5 inches
Maximum Size: 15 inches, Minimum Size: 3 inches
Maximum Average Size: 9.8 inches, Minimum Average Size: 6.7 inches

Area 4. Owens River From the Mazourka Canyon Road Upstream to the Intake

Angler ID#	Date	Fish Caught	Number Caught	Combined Lengths (inches)	Maximum Length (inches)	Minimum Length (inches)	Condition
No fishable water until flow introduction occurs							

Area 5. Upper and Lower Twin, Billy, Coyote, and Goose Lakes

Angler ID#	Date	Fish Caught	Number Caught	Combined Lengths (inches)	Maximum Length (inches)	Minimum Length (inches)	Condition
21	5/3/2003	Bass	9	128	18	12	good
23	5/15/2003	Bass	1	8	8	8	good
23	5/31/2003	Bass	1	8	8	8	good
23		Bluegill	2	13	7	6	good
22	5/12/2003	Bass	6	68	12	9	good
22	5/20/2003	Bass	18	206	16	6	good
22		Bluegill	1	6	6	6	good
2	5/12/2003	Bass	11	132	14	9	good
2	5/20/2003	Bass	14	156	14	9	good
3	5/15/2003	Bass	1	9	9	9	good
3	5/31/2003	Bass	10	109	13	8	good
24/4	5/11/2003	Bass	10	129	18	10	good
24/4	5/24/2003	Bass	10	119	16	6	good
1	5/3/2003	Bass	12	156	18	10	good
1	5/17/2003	Bass	14	197	18	6	good

Hours Fished: 45.5
Catch Rate: 2.6 fish per hour
Average Fish Length: 12.0 inches
Maximum Size: 18 inches, Minimum Size: 6 inches
Maximum Average Size: 13.0 inches, Minimum Average Size: 8.1 inches

The May 2014 creel survey results continue to demonstrate that even with the 2013 fish kill the LORP contains a healthy diverse warmwater fish community that is self-sustaining with multiple age classes from young of the year to adults.

Six different species of fish were caught during the May 2014 creel survey. Five of these species were warmwater species and have been caught in the past and include bass, bluegill, brown bullhead, common carp, and channel catfish. Brown trout was the one cold-water species caught in 2014.

The overall catch per unit effort in May of 2003 was 2.7 fish per hour. In May of 2011 after the LORP was re-watered, the overall catch per unit effort dropped to 1.3 fish per hour then increased to 2.2 fish per hour in 2013. In 2014, the overall catch per unit effort increased to 2.8 fish/hour a 0.1 fish/hour increase over the 2003 value of 2.7 fish/hour. There are many factors that contribute to the overall catch per unit effort between sampling years. Such factors include: water temperature, weather, flows, angler access, experience of the anglers, etc. There was significant wind on all of the May weekends, with wind gusts from 25-50 mph at times. Those that went out on the weekends noted that it was sometimes difficult to fish under these conditions.

By examining total fish lengths collected during the September 2010 survey (2010 LORP Annual Report), the May 2011 (2011 LORP Annual Report), the May 2013 (2013 LORP Annual Report) and the 2014 surveys results, it appears the LORP is still producing multiple age classes from young of the year to adults for all warmwater species caught.

Of the 415 fish caught, 94.7% were reported to be in good condition. The other 5.3% (8 bass, 6 bluegill, 3 brown trout and 4 common carp) were reported to be in poor condition. Anglers were not instructed to and gave no reason why they thought their fish were in poor condition. Their instructions were to list fish in good condition if the fish appeared healthy and showed no signs of sickness or damage, and had no lesions. If the fish appeared unhealthy or showed signs of damage or had lesions, it was listed as poor condition. Based on 95% of the fish caught were reported to being in good condition even after the fish kill, it appears that managed river flows and available habitat are capable of maintaining the warmwater fishery in good condition.

With approximately 400 to 500 dead bass observed in the forebay and probably more upstream in the cattails/tules during the 2013 fish kill, one would expect to see a decrease in the overall numbers of bass caught as well as a decrease in the catch per unit effort in Area #1 when compared to past surveys. However, examining the data, anglers in Area #1 overall caught eight more fish than in 2013 and 30 more than in 2011. The anglers caught 32 more bass in 2014 when compared to 2013 and 60 more bass when compared to 2011. One thing to note is that no bluegill were caught in 2014, yet the anglers caught 25 in 2013, seven in 2011 and one in 2003. One possible reason why no bluegill were caught is that the anglers fishing Area #1 in 2014 strictly fish for bass. Based on observations during the fish kill, less than five bluegill were observed dead in the forebay, thus, the fish kill did not have a detrimental effect on the bluegill population in this area.

Catch per unit effort in Area #1 showed an overall decrease of 0.3 fish/hour from 2013 to 2014. The probable reason for the decrease in 2014 is that no bluegill were caught in 2014. Because bluegill are a schooling species, if anglers are able to catch one, they are likely able to catch many in the same school of fish. Examining catch per unit effort for bass in Area #1 there was a 0.6 fish/hour increase from 2013 to 2014.

The next creel survey is designated by the MAMP for May 2015 and should be conducted in the same manner as the past creel surveys.

The purpose of the creel survey is to determine if there was a residual effect on the LORP's warmwater fishery from a fish kill that resulted from a July 2013 flood event. Methods developed during the 2003 creel survey were utilized in the May 2014 creel survey and will be used in future monitoring. Volunteer anglers fished five separate fishing areas for a total of 150.5 hours and caught 415 fish with an overall catch per unit effort of 2.8 fish per hour. Fish caught ranged from young of the year to adults for all warmwater species and were in good condition. The 2014 creel survey results demonstrate that the 2013 LOPR fish kill had little to no effect on the warmwater fisheries and that the LORP still contains a healthy, self-sustaining warmwater fishery.

7.3 References

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8.0 2014 LORP WEED REPORT

Inyo/Mono Counties Agricultural Commissioner's Office

Introduction:

The Inyo and Mono Counties Agricultural Commissioner's Office (AgComm) manages certain invasive weed infestations within the LORP project area in conjunction with The City of Los Angeles Department of Water and Power (LADWP). Target weeds for AgComm management and control include California Department of Food and Agriculture (CDFA) designated weeds. Management of these species is accomplished both by efforts to eradicate known weed populations within the LORP area, as well as through monitoring the LORP area for pioneer populations. The detection component is critical to the protection of the LORP as this region is a recovering habitat with many disturbed areas, and also because eliminating these threats early is far less costly than attempting to do so once established. Disturbed conditions make this area more conducive to weed establishment, as does increasing recreation use.

While protecting native habitat is the paramount goal of this project, there are many other positive consequences resulting from this work. A healthy native plant habitat will support wildlife (including some threatened and endangered species), help to reduce stream bank erosion and dust, maintain healthy fire regimes, preserve the viability of open-space agriculture, and conserve recreational opportunities.

Summary of LORP Weed Management Activities in 2013

LORP invasive plant management during 2014 included both treatment of known sites throughout the growing season, as well as ongoing survey activities to identify new infestations. Field staff numbers were the same as 2013, supported by both joint contributions from Inyo County and LADWP as well as grant funding through the Sierra Nevada Conservancy. All known *Lepidium latifolium* sites within the LORP area were treated three times. Invasive plant populations totaled 1.36 net acres, up significantly over 2013. Increases occurred exclusively within two sites near Blackrock, and these areas will receive additional scrutiny in 2015. The Blackrock area also contributed 5 of the 7 newly discovered sites, all of which were found along roadways. Individual sites totaled 46 in 2014, up 7 sites discovered by field staff during surveys. Of the 46 known sites, 22 sites had no plants present in 2014. Of these 22 no growth sites, 11 had no growth for 4 years. After five continuous years of no growth, sites may be considered eradicated, so if current trends continue, these 11 sites will be dropped from the total in 2015.

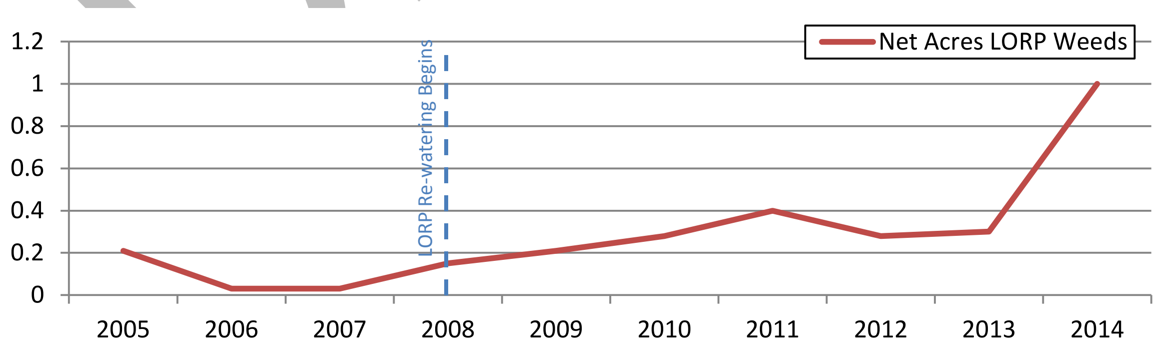
Table 1 – Count of LORP Invasive Weed Sites

Year	Total Number of Sites	New Sites Discovered	Sites with No Growth
2002	2	0	0
2003	2	0	1
2004	3	1	1
2005	4	1	1
2006	4	0	1
2007	4	0	1
2008	12	8	1
2009	17	5	4
2010	32	15	5
2011	35	3	19
2012	38	3	19
2013	39	1	29
2014	**46**	**7**	**22**

Survey efforts continued in 2014, with over 40,000 acres surveyed within the LORP area. This includes areas of known infestations, several surveys into other areas to ensure no new populations are allowed to establish undetected, and surveys of areas indicated as containing weed populations during 2013 rapid assessment surveys (RAS).

Treatment methods followed successful strategies used in 2013, including low-volume, directed spot treatments using selective herbicides. These applications were made on foot using backpack sprayers to mitigate damage to native plant communities within the LORP. AgComm will continue to employ these methods as long as these results continue and staffing levels permit.

Chart 1 – Net Acreage of Weed Populations on LORP



Management Difficulties

The most significant management difficulty continues to be maintaining adequate resources for effective management. Although previously discovered populations continue to decline as a result of control efforts, new populations continue to appear. Detecting small invasive plant populations in the vast LORP project area early in the colonization cycle while treatment activities are most effective, has become a difficult task to maintain. Resources provided through a grant agreement from the Sierra Nevada Conservancy have helped greatly in facilitating proper management activities during the 2014 growing season, and this contract will continue until next year.

9.0 SALTCEDAR CONTROL PROGRAM

The goal of Saltcedar Control Program is to eliminate existing saltcedar stands, to prevent the spread of saltcedar throughout the Lower Owens River and associated wetland environments, and to sustain the ecological restoration that is now occurring in the LORP.

PROGRAM BACKGROUND

Saltcedar (*Tamarix ramosissima*) is an invasive non-native shrub or tree that can grow to 25 feet and live up to 100 years. Given favorable conditions, a tree can grow 10 to 12 feet in one season. Saltcedar can compete with native vegetation and degrade wildlife habitat. Its presence in the southern Owens Valley has the potential to interfere with the LORP goals of establishing a healthy, functioning Lower Owens River riverine-riparian ecosystem.

References to the importance of managing saltcedar can be found in documents that guide the saltcedar program and govern the LORP:

- The LORP Monitoring, Adaptive Management, and Reporting Plan (MAMP), notes that saltcedar may increase in some areas of the river because of seed distribution with stream flows. The MAMP states that the potential risk of infecting new areas with saltcedar is considered a significant threat in all management areas
- The 1997 Memorandum of Understanding (MOU), between Inyo County, City of Los Angeles, Sierra Club, Owens Valley Committee, CA Dept. of Fish and Game and California State Lands Commission, expresses that saltcedar reinfestation in the LORP area would compromise the goal of controlling deleterious species whose “presence within the Planning Area interferes with the achievement of the goals of the LORP” (1997 MOU B. 4)
- Parties to the Long-Term Water Agreement (LTWA) recognized that even with annual control efforts saltcedar might never be fully eradicated, but that ongoing and aggressive efforts to remove saltcedar will be required. (Sec. XIV. A)

PROJECT MANAGEMENT AND STAFF

The Saltcedar Control Program is administered by the Inyo County Water Department, and managed by a Saltcedar Project Manager. Work crews are hired seasonally and consist of eight employees and one shared county employee. In addition, the California Department of Forestry and Fire Protection can provide work crews to assist in efforts to cut, pile, and burn saltcedar. In 2013-2014, the field season began in mid-October and concluded in mid-March.

METHODS

The Saltcedar Control Program personnel use chainsaws, brushcutters, herbicides, and controlled burning to treat and control saltcedar, and remove saltcedar slash in the Owens Valley.

WORK ACCOMPLISHED (Figure 1)
From October 2013-March 2014 Inyo County Water Department saltcedar field crews cut and treated with herbicide 180 acres of saltcedar, within the boundaries described in the Wildlife Conservation Board (WCB) grant work site.

In 2012, work began under the scope of a new WCB grant. Efforts focused on eradicating saltcedar in the water-spreading basins that lie just to the west of the Lower Owens River and river-riparian area. These spreading basins are a concern because they harbor mature saltcedar thickets that serve as vast reservoirs of windborne seed.

Each year the saltcedar crews sweep the Lower Owens River and treat resprouts, pull seedlings, and remove mature plants. Crews are guided to the new growth and regrowth by information obtained in the previous year's Rapid Assessment Survey. This year crews covered about 89 miles of riverbank and floodplain.

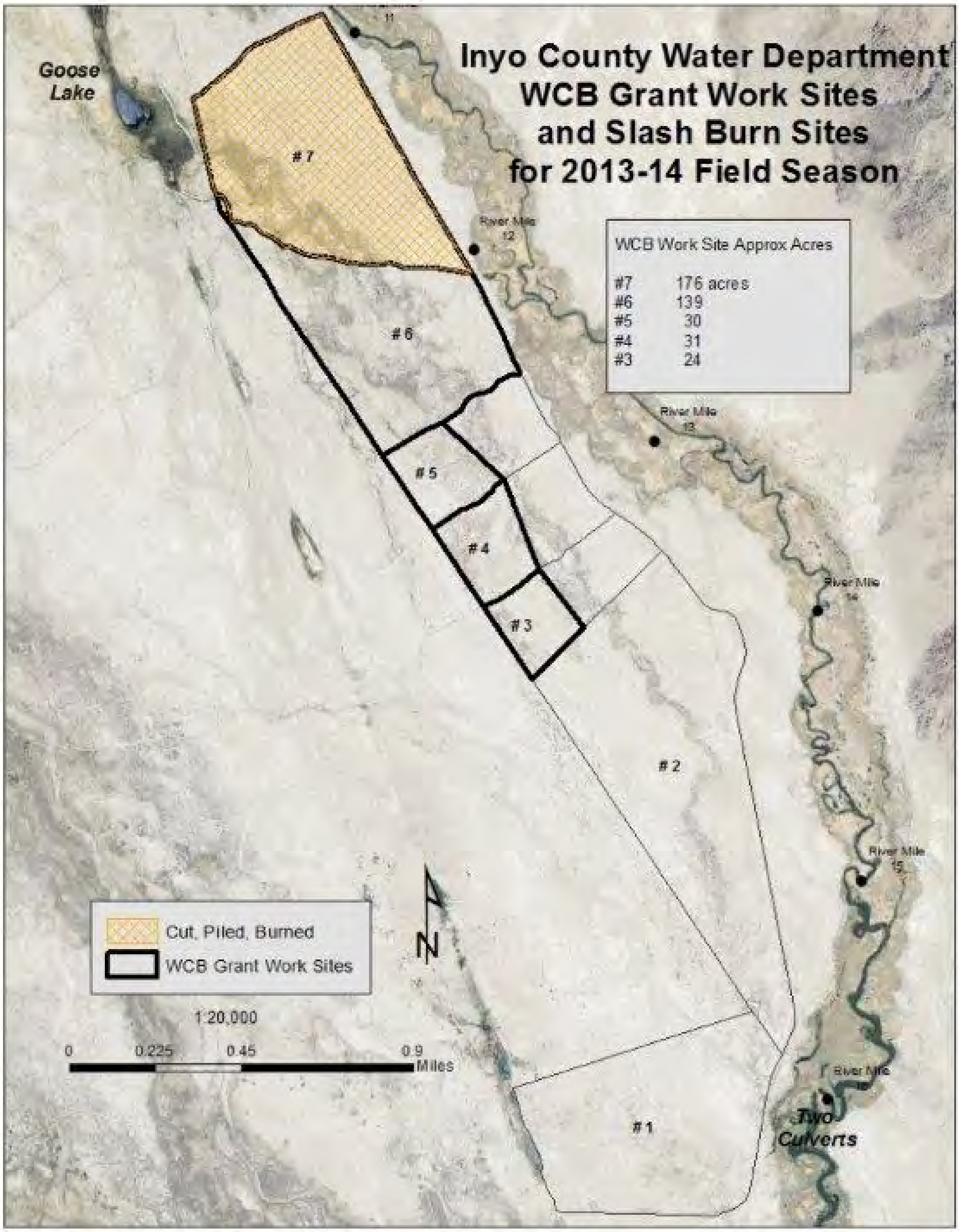
About 120 piles of dry slash, which had accumulated over the years, were burned in the 2013-2014 field season. This effort was assisted by the California Department of Forestry and Fire Protection and the Los Angeles Department of Water and Power,

FUNDING
An ongoing responsibility of the Saltcedar Program, with assistance from the LADWP, is to secure grant funding to maintain an active Saltcedar Control Program.

In December 2011, the Water Department was awarded a new three-year, $350,000 grant from the WCB. LADWP will match this new grant dollar for dollar. The $350,000 matching funds from LADWP will complete their obligation of providing $1,500,000 in matching funds, which is required under the 2004 Stipulation and Order.

The County's three-year Wildlife Conservation Board (WCB) saltcedar eradication grant expires in December 2014. This generous funding had enabled a level of effort that would not have been possible with Inyo County and LADWP contributions alone.

Figure 1. Saltcedar cut areas 2013-2014



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10.0 ADAPTIVE MANAGEMENT RECOMMENDATIONS

2014

Lower Owens River Project

Adaptive Management Recommendations

The MOU Consultants are responsible for issuing Adaptive Management recommendations, prescriptions and actions to ensure the Lower Owens River Project is succeeding. Each year since 2008 when monitoring was initiated, the MOU Consultants have reviewed the annual reports, discussed project objectives and results with managers, and analyzed conditions and trends in order to form adaptive management actions that need to be taken. These adaptive management recommendations are submitted after careful review to move the project forward in a positive direction and minimize or avoid problems.

Prepared by:

Ecosystem Sciences,
LORP MOU Consultants

Contents

5 Recommendations

An action list and description of each Adaptive Management Recommendation for 2014.

What Should Be Done

Recommendations that would help the LORP improve either through direct action, management decision, or communication.

Considerations

Many facets of the LORP do not fall under a direct line of responsibility or condition type. These points merit consideration by all parties that would help to improve the LORP.

6 Discussion / Conclusion

Future of the LORP

What will the LORP look like in the future? A discussion of the important flow changes and decisions being wieghed.

What Came of the River Summit?

Remarks on the river summit, its effectiveness and outcomes.

Limitations of the Agreements

A discussion of the restraints imposed by the legal agreements and operational mandates - lack of flexibility restrains the adaptive management process and ecosystem potential of the LORP.

Resetting Expectations

Key problems and limitations in ecological development are likely to continue without fundamental adaptive management changes.

Time

In addition to enacting adaptive management actions, time and patience is required in building a healthy, balanced ecosystem.

Lower Owens River, upstream of Keeler Bridge

State of the Project 1

It is essential to inform and educate all LORP stakeholders of current conditions if adaptive management is to be effective and successful.

The purpose of this years report is to describe the state of the LORP; what's known and not known, alternative solutions to address problems, and justifications for adaptive management recommendations. The report concludes by addressing the limitations and expectations of the project.

Strategic Adaptive Management

Science vs. Policy

Adaptive management emerged in the 1970s as a way to apply a continuous process to improve natural resource management (Holling 1978). Rather than making a single definitive decision despite information gaps or uncertainty about the ecosystem involved, adaptive management emphasizes learning via the careful monitoring of changing conditions, and incremental adjustments in the light of new information (i.e., monitoring) (Williams et al. 2009, Doremus et al. 2011).

Adaptive management is key to the Lower Owens River Project, and monitoring is key to adaptive management. Adaptive management is not research. Although it can parallel the scientific methodology (Stankey et al. 2003), its purpose is to build knowledge and reduce uncertainty over time by informing managers and scientists through management actions and associated monitoring efforts (MAMP 2008). Adaptive management is also not trial and error, nor a haphazard sequence of different management options (Allen and Gunderson 2010). Adaptive management recommendations are made from the body of scientific knowledge and monitoring data.

Peterson et al. (2003) found that adaptive management and planning scenarios are complementary approaches to understanding complex systems (see figure on facing page, Management Scenarios). Adaptive management functions best when both uncertainty and controllability are high, which means the potential for learning is high (i.e., feedback from monitoring), and the ecosystem can be manipulated. The LORP, by virtue of water and land management, exerts a high degree of control through time as well as high uncertainty, because of change from baseline conditions. Consequently, one can expect adaptive management to be reasonably appropriate and successful under these conditions (Gregory et al., 2006), relying upon the body of scientific knowledge and sound monitoring data.

The reasons for failure of adaptive management programs are numerous and generally are attributable to policy failures including: 1) the failure of decision makers to understand why adaptive management is needed (Walters 2007); 2) the hijacking of management goals for research interests (Walters 1997); 3) using bureaucratic and political inaction as a policy choice (Walters 1997); 4) inadequate funding for increased monitoring needs to successfully compare the outcomes of alternative actions (Walters 2007).

Reasons Adaptive Management Fails

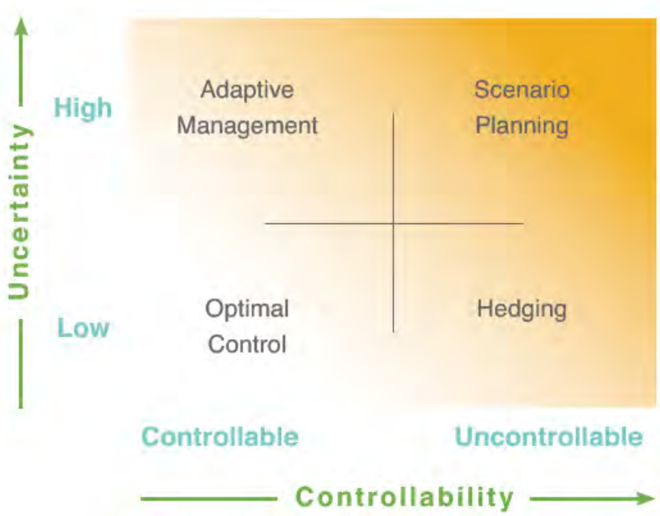
- **the failure of decision makers to understand why adaptive management is needed**
- **the hijacking of management goals for research interests**
- **using bureaucratic and political inaction as a policy choice**
- **inadequate funding for monitoring needs**

A clear example of management failure is Glen Canyon Dam on the Colorado River. The project was established to develop an adaptive management plan, reduce conflict and protect or improve ecological conditions (Susskind et al., 2012). Unfortunately, insufficient attention to the design of the program led to difficulties. Despite the passage of time and dedication of considerable resources to the adaptive management's operation, the dam still releases the same 'modified low fluctuating flows' regime that it did before the adaptive management program was created (Feller 2008). Three highly publicized and much celebrated high-flow experiments similar to that recommended in the LORP have not led to adjustments in the management or operation of the dam, despite the proven value of the higher flows (Melis 2011). This is because the adaptive management program has no procedures to adjust policy over time, and the role of the group in resolving regulatory confusion and inconsistency remains unclear, and considerable discord remains (Camacho 2008).

Decision Making – Limitations and Expectations

There are parallels between the LORP and Glen Canyon that cannot be ignored. Despite adaptive management recommendations necessary, and scientifically sound, to meet the goals and objectives established in the MOU and Stipulation and Order, these documents now hinder achievement of goals. In the case of Glen Canyon there was a single goal to use high flows to scour the streambed and deposit sediments in an effort to clean and replace beaches in the Colorado River below the dam.

The LORP, on the other hand, has multiple goals and objectives which must be balanced to avoid conflicts (e.g., increase in riparian habitat at the loss of livestock forage). The MOU was written with certain expectations about outcomes. However, seven years of experience shows that some expectations (goals) require modification, which means modification of the MOU and Stipulation and Order.



Management Scenarios under different uncertainty and controllability conditions

Adaptive Management is appropriate for systems in which there is a lot of uncertainty that is controllable. In other cases, optimal control, hedging, or scenario planning may be appropriate responses (Peterson et al. 2003).

Adaptive management must be as applicable to policy as to methodology.

Adaptive management must be as applicable to policy as to methodology.

Disallowing changes in flows puts water quality, the fishery and other environmental services are at risk. Like Glen Canyon Dam, conflict and mistrust prevent good decision making. The LORP has the additional limitations of funding and water. Monitoring and all other LORP activities have a fixed amount of monies to carry the program through its entirety. A common failure with adaptive management is underfunding long-term projects at inception or failing to adequately adjust budgets through time (Keith et al., 2011). The annual LORP work plan emphasizes limiting costs to the exclusion of accepting adaptive management recommendations. Water necessary for flow changes in the LORP is fixed with a specified volume. Unfortunately, even though the allowable volume of water could provide relief from water quality conditions and other problems, use of this water is limited to the amount that can be recovered, i.e., pumped-back. Understanding these expectations and limitations are essential to understanding the LORP's current condition and potential condition.

Allen and Gunderson (2010) stated "A lack of engagement of stakeholders in the adaptive management process can lead to stakeholders rejecting results that vary from their expectations." Rejection of adaptive management recommendations for the LORP is both a management and stakeholder problem. The stakeholders are, for the most part, MOU Parties representing their constituents while management authority resides with LADWP and ICWD.

Recognizing that it is essential to inform and educate all LORP stakeholders if our adaptive management recommendations are to be implemented, we have taken a different approach with this annual report. Our purpose in this annual report is to describe the state of the LORP, what's known and not known, alternative solutions to address problems, and justifications for adaptive management recommendations. We will then address the limitations and expectations impeding the project.

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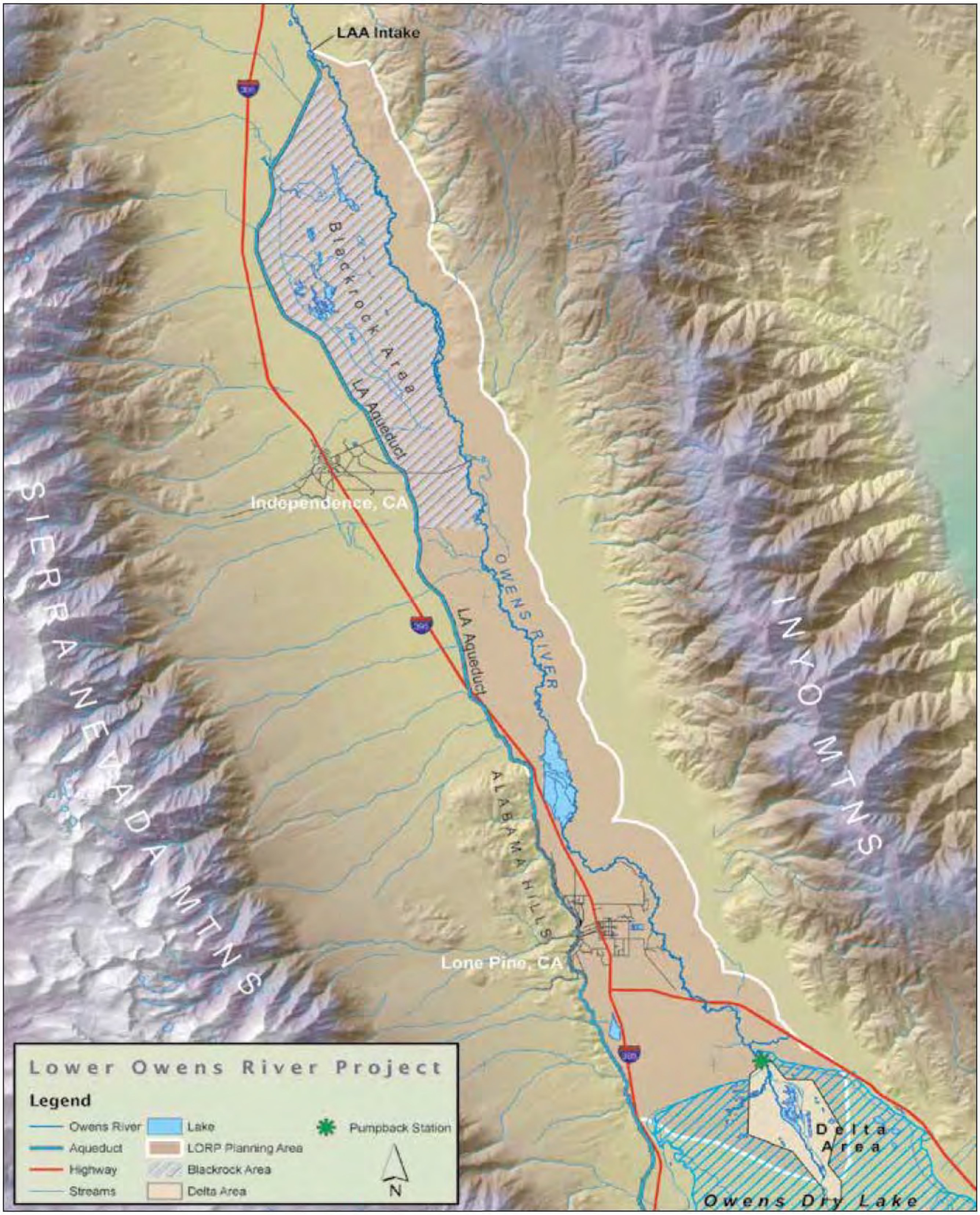


Lower Owens River Project Planning Area

Ecosystem Services

Vision: Transforming the River from Wasteland to Asset

In 1993 a detailed ecological study was initiated on the Lower Owens River from the LA Aqueduct Intake to Owens Lake - approximately 60 miles of river channel and wetland habitat. 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.

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.

LAA Intake and Lower Owens River Release

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 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.

"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."

- Lower Owens River, Memorandum of Understanding, 1997

Pumpback Station Lower Owens River

Ecosystem Services

Managing for Multiple Purposes

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. 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 (Naiman et al. 1992). Ecologically healthy watersheds are dependent upon the nature of the disturbance (e.g., fire, floods, 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 (Naiman et al. 1992).

The disturbance regime in the Lower Owens River was designed to consist of multiple streamflows emulating natural water-year events. This attempt to mimic natural disturbance regime should help to 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 that possesses a biotic 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 a multiple flow regime that will flood riparian areas and appropriate floodplain surfaces. 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.

Inherent in the overall management of the watershed is 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 are anticipated and should increase. To the extent feasible, land management plans will consider these and other recreational uses, as well as livestock grazing and irrigation strategies.

Goals and Objectives

Expectations for the LORP drove the development of the MOU. Each of the MOU Parties may have had different expectations and ideas of how the LORP should proceed, how adaptive management would guide the project through time as well as how adaptive management recommendations would be implemented. This collective uncertainty in outcomes explains the broad description of goals in the MOU.

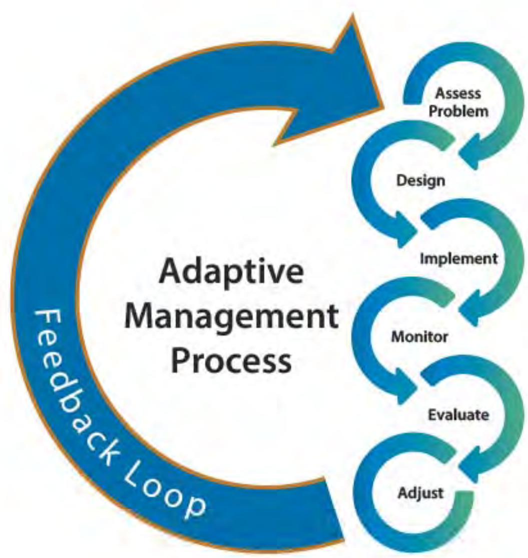
The MOU describes goals for the LORP once the mandated changes in land and water management have been applied over a sufficient period of time. The five goals were recognized as broad and lacking in specifics. Therefore, in consultation with all MOU parties, 13 objectives were identified to attain the LORP goals. These objectives and the monitoring, analysis and adaptive management actions for each are described in detail in the LORP Monitoring and Adaptive Management Plan (MAMP 2008).

LORP goals and objectives have been delineated and described numerous times in previous annual reports and it is not necessary to reiterate them in detail here. However, the goals and objectives become more meaningful when viewed as ecosystem services. Ecosystem services are the benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services, such as nutrient cycling, that maintain the conditions for life on Earth (UNEP 2012).

The LORP ecosystem services are fundamentally multiple-uses for recreation (fishing, hiking, bird watching, etc.), agriculture (grazing, farming) and ecology (habitat sustainability, T&E species, biodiversity). Delivery of all of these services depends upon creating and maintaining a healthy ecosystem, which are the overarching goals of the MOU.

In order to provide the desired ecosystem services, LORP adaptive management must be broken down in discreet parts that fit within the whole. A warmwater recreational fishery depends upon the flows that create instream habitat for all life stages of the target game fish; riparian habitat that supports LORP indicator species and other bird and aquatic life depends upon periodic out-of-channel flows; wetlands must be managed to promote biodiversity by regulating seasonal inflow and outflow. Land management must be compatible with flow management to ensure continued grazing and other agriculture activities are not impacted by losses of forage or arable acreage.

The purpose of monitoring, then, is to (a) provide a feedback mechanism that tells us if and to what degree the LORP is providing the intended ecosystem services, and (b) inform scientists, managers, and stakeholders about the status of the LORP. Adaptive management recommendations are made on the basis of monitoring combined with scientific knowledge to adjust both water and land management actions.



Adaptive Management Process

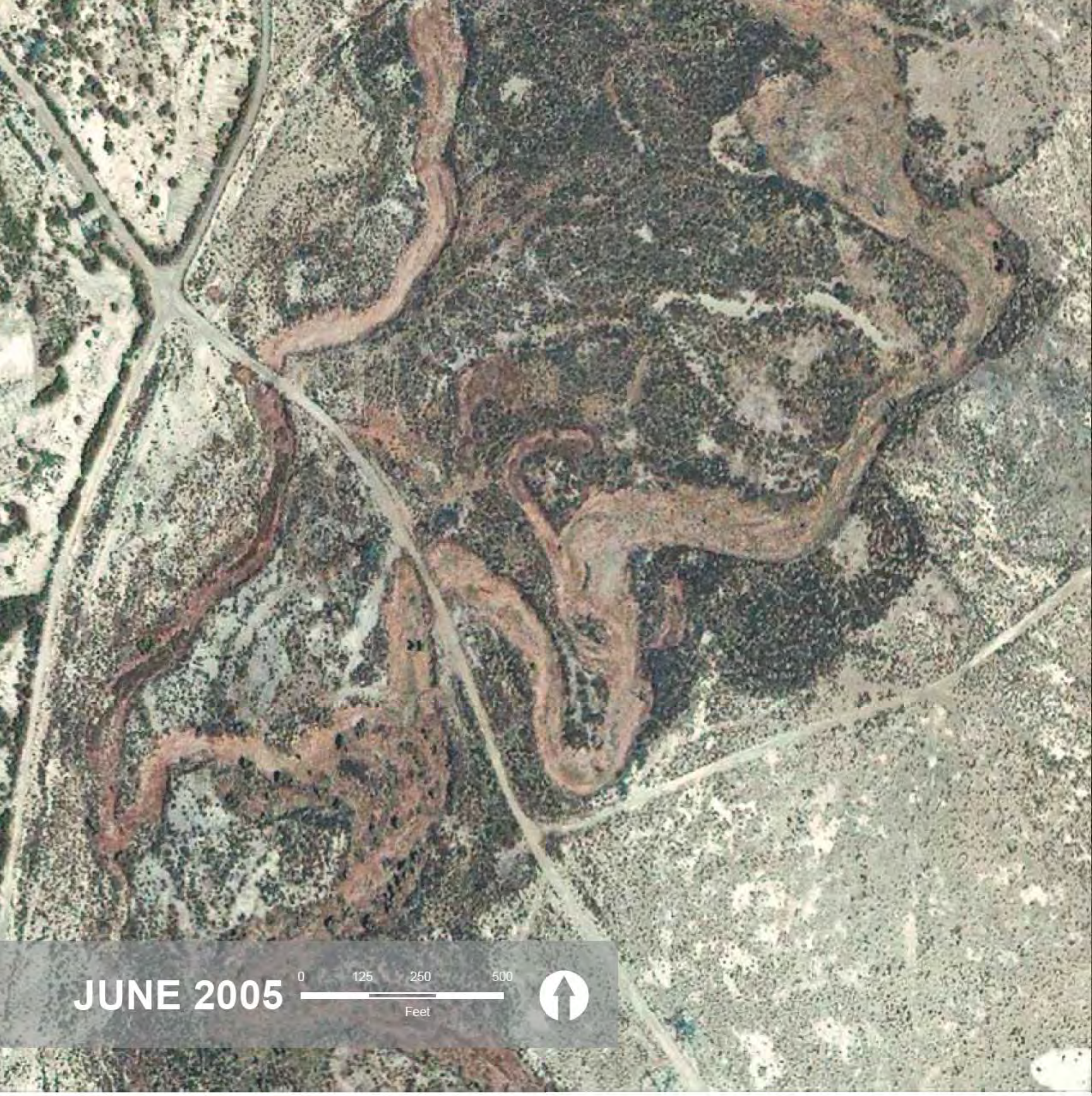
An essential idea of adaptive management is to recognize that management policies can be changed. Thus, managers cannot be rigid in their adherence to certain policies and must be willing to alter their approach for the benefit of the resource. An approach that is not working, although it has worked in other areas or in the past, must be allowed to be changed. Flexibility within the adaptive management process is essential to long-term management.

The River - Then and Now

A Look Back at the River through Change Pairs

Eight years ago, the Lower Owens River was little more than a memory from a century ago. The channels were bone-dry, salt cedar, tumbleweed and dust were the legacy and most valley residents thought the "river" would always look like the lower left photo.

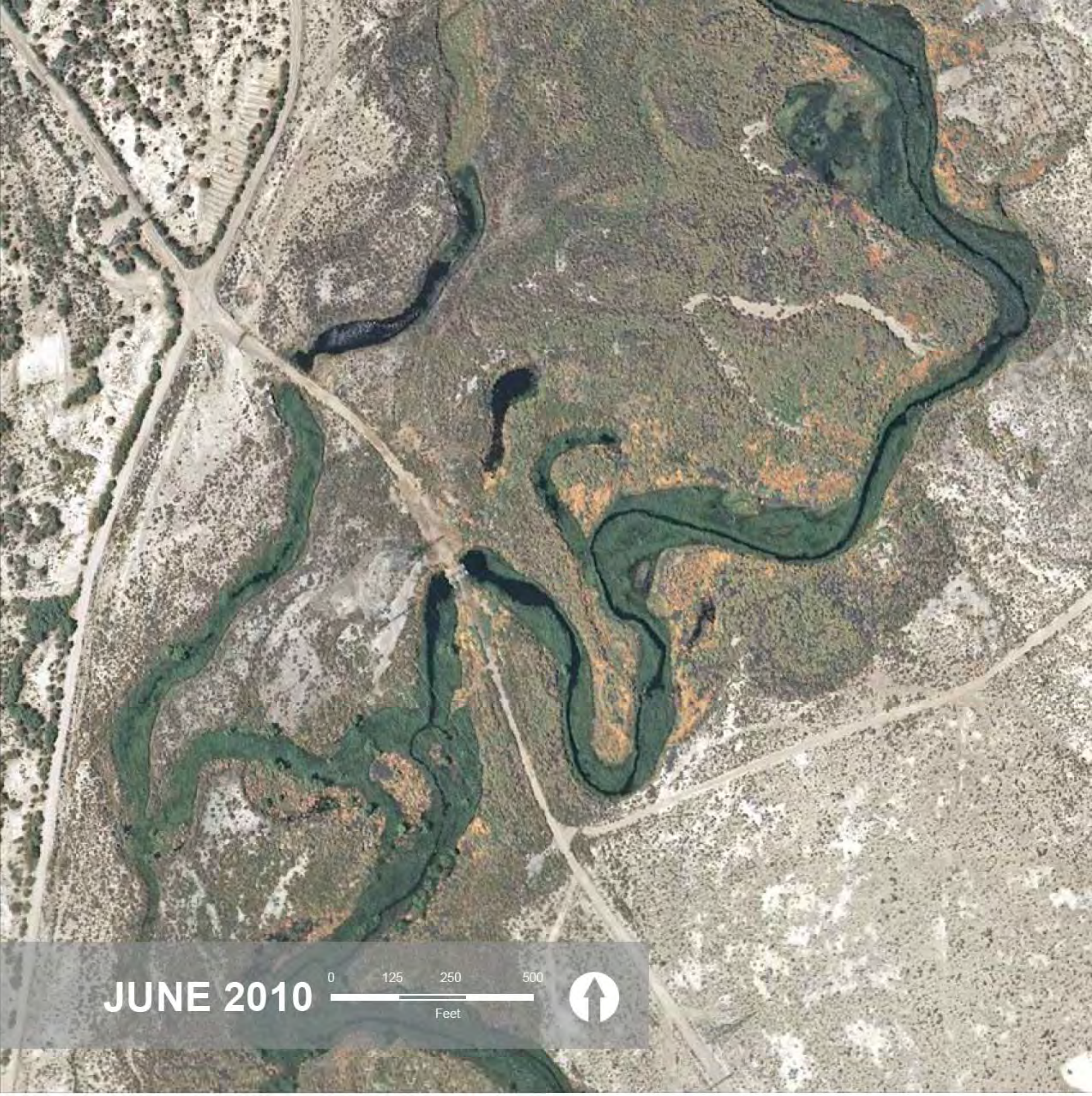
By 2012, with the implementation of the LORP, conditions changed to that shown in the lower right photo. The aerial imagery shows a segment of the river reach between the Intake and Mazourka Canyon Road. This area of the river clearly shows how the groundwater has risen and filled relic oxbows and ponds off the main river channel.



The River - Then and Now

A Look Back at the River through Change Pairs

The river at Two Culverts. Vegetation now occupies the river margins and the uplands between the river, and a relic oxbow has “greened-up” from the near-surface groundwater level. The lighter brown indicate areas of Bassia stands which have now declined.



The photo on the lower left shows a survey marker in the channel prior to rewatering. The photo lower right illustrates the change in channel conditions after removal of salt cedar and rewatering of the channel.

The River - Then and Now

A Look Back at the River through Change Pairs

This river reach is between Manzanar Reward Road and the Islands. This imagery dramatically shows how the river has greened from terrace to terrace. The difference in vegetation conditions is noteworthy between the two images.

One goal of the LORP is to sustain agriculture, which in this case has been an increase in forage for grazing. The numerous oxbows are relics of historical, high flows in the Lower Owens. Now these off-channel areas of the river clearly illustrate how the groundwater has risen and filled the old oxbows and ponds.

Project Status

State of the Project

Over the last few years the development of the LORP appears to have slowed. As well, several undesirable trends and conditions are affecting the Project. While these conditions have been pointed out in past reports it is worth stating again. The past and current flow management regime for the river is causing ecological stagnation and limiting the ability of the river to achieve original goals, expectations and improve overall health and develop a balanced ecological system. While the Lower Owens River is stagnating it is also exhibiting some alarming early signs of stress. While some conditions can be pointed to as early successes since project inception, these could easily be reversed by downward trends in the system.

While there are significant issues with the river there are also many solutions that can be examined, agreed upon and put into effect to slow the declines, reverse many of the concerning trends and bring needed energy to the river system.

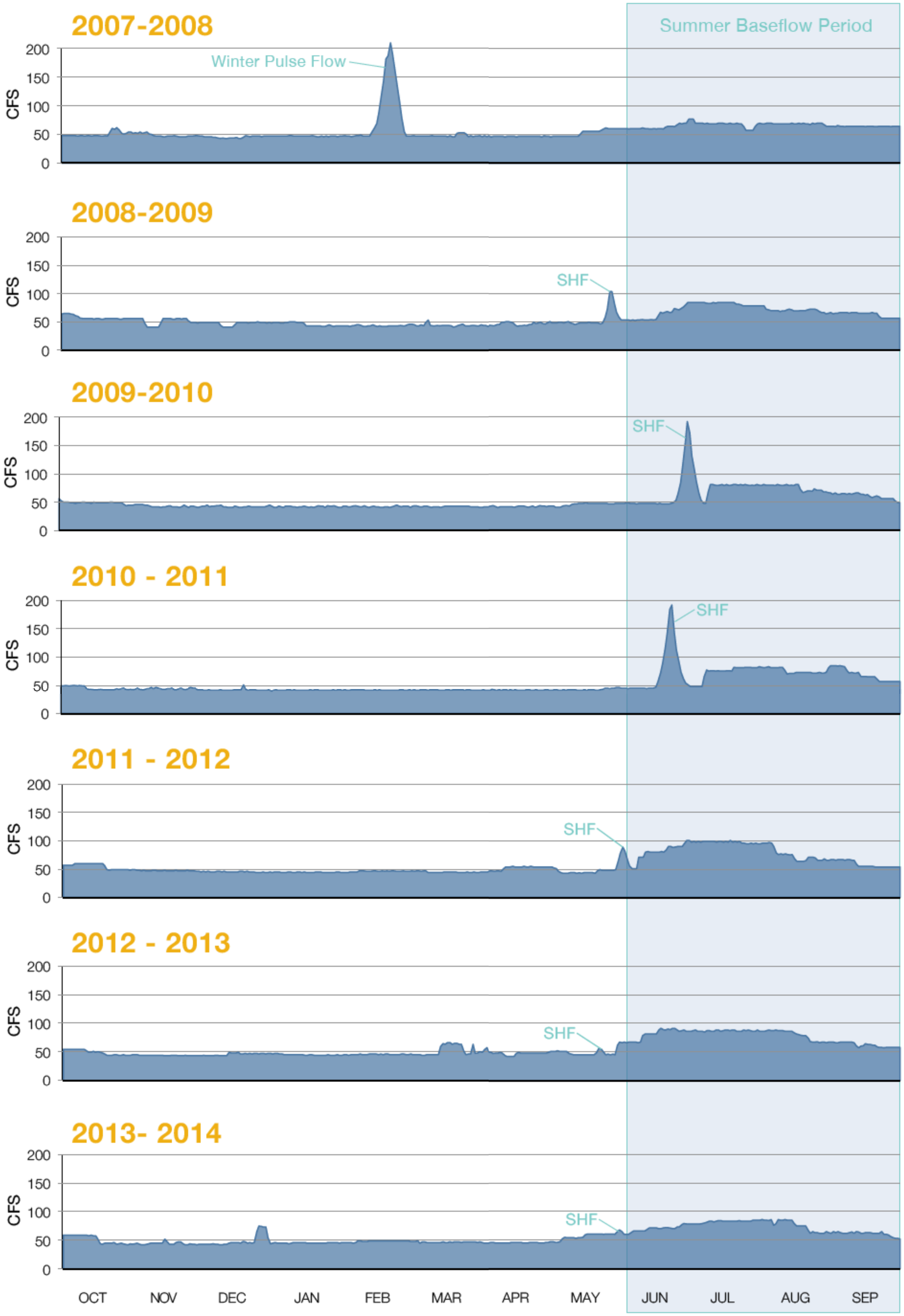
The flow regime for the Lower Owens River, as currently configured, is problematic yet it is the key to whether the LORP will succeed or fail. The current flow regime is managed to attain policy and compliance obligations first and foremost. If these prescribed river flows happen to benefit the riverine ecology, it is secondary to the need to meet fixed legal obligations. As such, the current river baseflow is confounding and recent seasonal habit flows are so small as to be completely ineffective. The Lower Owens River is deteriorating because it is fixed in place by legal stipulations dictating flow regimes that do not conform to any ecological or natural process. Compliance restrictions are inhibiting the LORP's potential and are affecting it negatively.

The MOU Consultants believe that there are several feasible solutions that can positively affect the LORP. These solutions are neither draconian nor outlandish. Each recommendation is based in reality, on scientific principals and expert judgment, and can be attained through mutual cooperation and diligence by all responsible parties.

Over the last seven years the MOU Consultants have made many recommendations for adaptive management. Too many of these recommendations have not been implemented or acted upon. The most difficult and important prescriptions are not followed nor is satisfactory justification given as to why they are not followed. Unfortunately, it is easy to speculate that the adaptive management process is broken, and perhaps has never actually worked as intended.

The past and current flow management regime for the river is causing ecological stagnation and limiting the ability of the river to achieve original goals, expectations and improve overall health and develop a balanced ecological system.

Given the current condition of the LORP, it is imperative that the recommendations that are made here are reviewed, discussed and critically evaluated by all MOU Parties. If the LORP continues to be managed as it has been for the last seven years we can expect continued stagnation and potentially damaging consequences to the ecology that has developed in the riverine-riparian system up to this point. The MOU Consultants do not intend this as a shrill or dire warning of imminent ecological collapse; rather the recommendations are made with the intention that enough time and capacity still is available to navigate the system towards a better and lasting trajectory. This will require thinking and solutions that have not been in the LORP toolbox over the past many years. It requires critical examinations of the project limitations and development of new resource management tactics.



Annual hydrograph of the Lower Owens River from 2007-2014.

These graphs illustrate the diminishing Seasonal Habitat Flows (SHF) through the years since the project was initiated with rewartering flows. It also illustrates the static flow regime and the abnormally high summer baseflows needed to meet the LORP Stipulation and Order of 40 cfs throughout the river system.

Project Status

2013 - 2014 Monitoring and Status

In the 2013 annual report we tabulated the LORP objectives and categorized each as attained, trending, or not attained. After another year of steady state conditions we conclude that nothing has changed in terms of meeting goals and objectives. The critical conditions we addressed last year with adaptive management recommendations are still in place.

Monitoring in 2013-14 included river flows, rapid assessment survey, creel census, BWMA inflows, Delta inflows, range and trend surveys. There was not a seasonal habitat flow in 2013. None of these monitoring results indicate a significant change from the previous year.

The greatest risk for the LORP continues to be water quality and potential fish kills on a scale larger than was experienced in 2013 (and in previous years). The secondary issues are the proliferation of tules and restriction of flows in the lower river, lack of development of riverine-riparian habitat; and appropriateness of MOU designated indicator species.

LORP River Summit

Since 2010 the MOU Consultants have made adaptive recommendations to hold a summit with all MOU Parties to address the issues listed above. The purpose of such a summit was to engage all parties at one time because in order to improve water quality, address tule and riverine-riparian problems as well as modify indicator species, flows mandated in the Stipulation and Order and the MOU will require modification. In order to change the MOU and Stipulation and Order all Parties must be in agreement; also to change Pumpback capacity.

Based on the available data and the 2013 (and previous) fish kills, nearly all of the MOU Parties in attendance at the summit agreed to a two-year experiment to use a dual-flow regime with careful water quality monitoring to determine what change in flow management would improve dissolved oxygen and export flocculants (suspended and dissolved organic material).

At this juncture in the LORP, science and policy come into conflict. As Feller (2008) concluded, collaborative decision-making actually stifles adaptive management by making agreement among stakeholders a prerequisite to change. The LORP MOU requires unanimity from all Parties in order to change flows, which in the view of the MOU Consultants and other scientists is necessary to avoid a water quality crisis and at least establish trends toward attaining goals and objectives.

The Owens Valley Committee (OVC) rejected the adaptive management recommendation to modify flows in the Stipulation and Order and lift the Pump-back limit. While conceding that the LORP is "meeting flow requirements, wetland and riparian habitat have been created, fish and birds are thriving, woody species are germinating and there is reasonable survival given the setting; water quality data are sparse, and tules (bulrushes and cattails) are quite abundant"; the OVC did not believe there was sufficient data presented at the summit to conclude that water quality or the fishery was at risk. Nevertheless, the OVC did make numerous suggestions including: improve water quality by diversion of cleaner creek water, winter flow reductions to offset higher spring flows, mechanical removal of some tule blocks, increase water quality monitoring and divert more LORP funds to research (OVC Comments on the LORP Summit, Sept. 7, 2014).

Because all signatories to the MOU must agree to any changes (Greg James, 2014, Inyo County attorney, personal communication), no further action has been taken toward a two-year agreement to test other flows.

Objectives to Attain LORP Goals

Below is a description of the objectives to attain the goals of the LORP and measures to implement adaptive management recommendations. These are detailed in Section 3.0 of the MAMP (2008) and summarized here.

Base Flow Objective

Maintain an average base flow of 40 cfs throughout the Lower Owens River from the LAA Intake to the Pumpback Station. If the 15-day average falls below 40 cfs, appropriate augmentation releases at the intake or spill gates will be necessary to meet base flow criteria.

Seasonal Habitat Flow Objective

A seasonal habitat flow of 200 cfs will be released at the Intake during average to above average runoff years. Seasonal habitat flows in below average water years will be determined by the standing committee in consultation with CDFG. The seasonal habitat flow in the Lower Owens River is intended to meet habitat expectations, promote establishment of riparian vegetation and enhance riparian habitat conditions. If seasonal habitat flows are not achieving habitat expectations management can modify the timing of seasonal habitat flows, modify the magnitude and/or duration of seasonal flows, release higher quality water from spillgates modify the ramping pattern of seasonal habitat flows, modify tule removal activities, and/or modify utilization rates and timing within riparian and upland pastures.

Fishery Objective

Create and sustain a healthy warm water fishery in the Lower Owens River. Actions that can be taken to meet the objective include release of higher quality water from spillgates during the seasonal habitat flows, tule removal, beaver and beaver dam control, improving grazing utilization rates and timing within riparian and upland pastures, recreational and human use management, and modify water releases to maintain off-channel lakes/ponds.

Indicator Species Objective

Implementation of the LORP must benefit the majority of indicator species and guilds by increasing the quantity and quality of their habitat. Actions that can be taken to meet the objective include modifying the magnitude and/or duration of seasonal habitat flows, modifying schedules for maintenance and mechanical intervention activities, plant native vegetation species, modify fencing or addition of new fencing for riparian and upland pastures, modify utilization rates and timing within riparian and upland pastures, install grazing exclosures, modify livestock management following wildfire, modify recreational use management, use controlled burning.

Riverine-Riparian Habitat Objective

Implementation of the LORP (base flow and seasonal habitat flow compliance) is expected to result in the recruitment of riparian vegetation (habitat), primarily willow and cottonwood.

Recruitment of riparian vegetation can be managed by modifying the timing of seasonal habitat flows, modifying the magnitude and/or duration of seasonal habitat flows, planting native vegetation species and removal of non-native and tule vegetation, modify beaver populations and beaver dams, modify fencing, or addition of new fencing, for riparian and upland pastures, modify utilization rates and timing within riparian and upland pastures, install grazing exclosures, modify recreational and human use management.

Water Quality Objective

Water Quality standards, as outlined in the Lahontan RWQCB Order, are being met within the Lower Owens River.

Compliance with water quality standards is expected to be achieved by modifying water releases during base flows, modifying the timing of seasonal habitat flows, modifying the magnitude/duration of seasonal habitat flows, releasing higher quality water from spillgates, modifying beaver and beaver dam control activities, modifying utilization rates and timing within riparian and upland pastures, and/or modifying recreational and human use management.

Tule/Cattail Control Objective

It has always been recognized that controlling tules will be challenging. It is also recognized that tules do provide valuable habitat especially for fish and waterfowl. The objective is to strike a balance such that tules do not impede project goals. Tule control methods include the timing of seasonal habitat flows, modify the magnitude/duration of seasonal habitat flows, implementing tule removal activities, modifying beaver and beaver dam control activities, modifying the river channel, use of controlled burning, and/or modifying flow.

Objectives to Attain LORP Goals (continued)

Delta Habitat Area 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.

Habitat in the Delta can be maintained by modifying schedules for maintenance and mechanical intervention, activities, modifying fencing, or addition of new fencing, for riparian and upland pastures, modifying utilization rates and timing within riparian and upland pastures, modifying recreational and human use management, modifying Delta base flow water releases, modifying timing, magnitude and/or duration of Delta pulse flow, and/or berm excavation to direct flow or contain flow.

Invasive Species Objective

Control, to the extent possible, exotic and invasive (class A and B noxious weeds) plants, that interfere with the achievement of LORP goals.

Adaptive management actions include modifying the timing of seasonal habitat flows, planting native vegetation species, conducting exotic plant control activities, using controlled burning, modifying utilization rates and timing in riparian and upland pastures, modifying fences, or add new fences for riparian and upland pastures, and/or modifying livestock management following wildfires.

Blackrock Waterfowl Management Area Objective

Approximately 500 acres of habitat area is to be 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. BWMA is adaptively managed by modifying timing and/or duration of wet/dry cycles using Drew, Waggoner, and Winterton wetland cells, berming and/or excavating to direct flow or contain flow, modifying water releases to maintain Off-River Lakes and Ponds, and removing critical flow obstructions.

Range Condition Objective

The LORP emphasizes multi-uses, which includes ranching. Grazing strategies established for each ranching lease is intended to lead to the establishment of healthy riparian pastures and exhibit an upward trend in range conditions. Adaptive management actions to meet range objectives could include conducting exotic plant control activities, use of controlled burning, installing grazing exclosures to improve monitoring, modifying the magnitude and/or duration of seasonal habitat flows, modifying fencing, or adding of new fencing for riparian and upland pastures, changing livestock management following wildfires, modifying utilization rates and timing within riparian and upland pastures, and modifying recreational and human use management.

Lakes and Ponds Compliance Objective

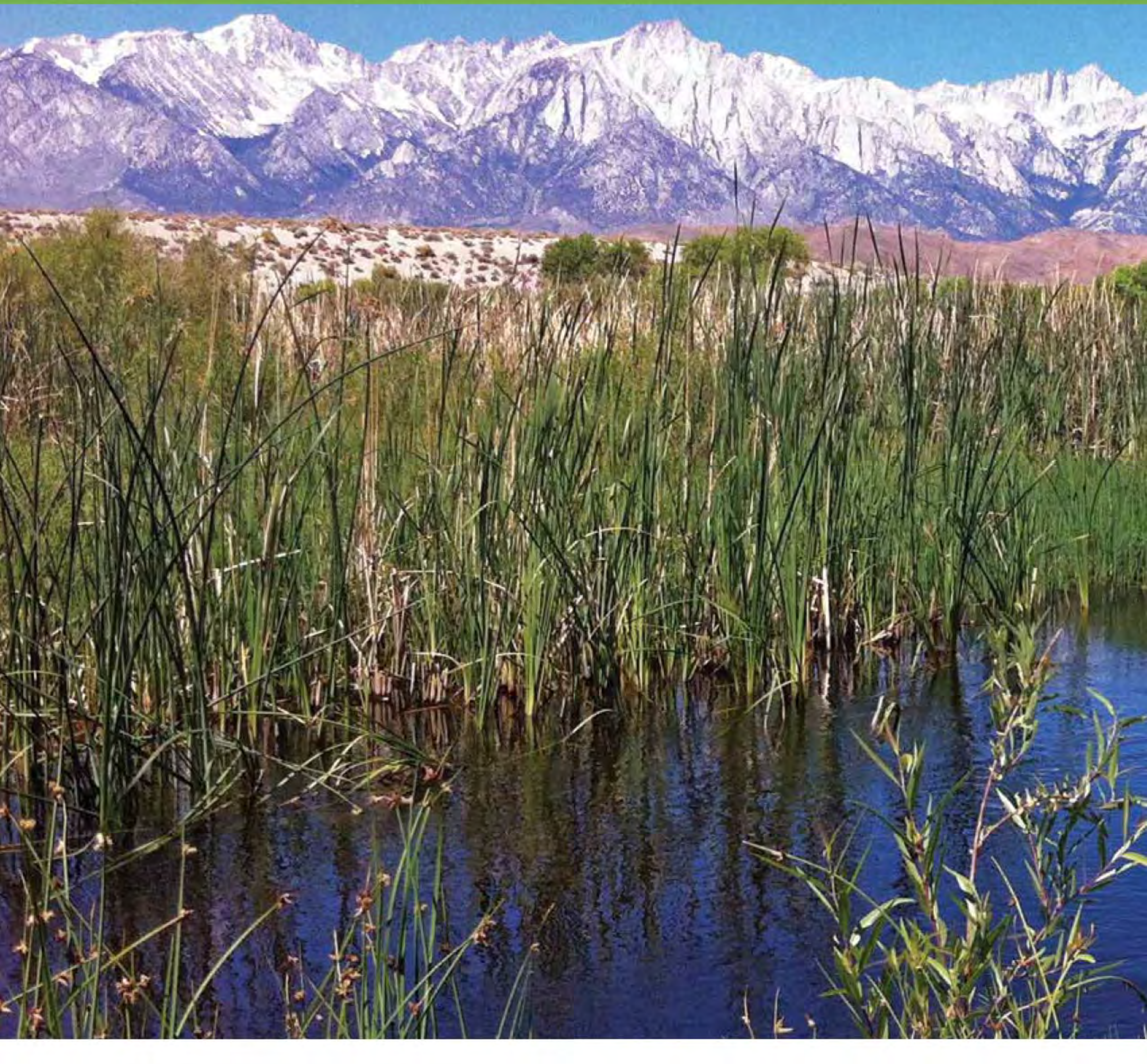
The objective for off-channel lakes and ponds such as Goose and Billy lakes is to maintain existing water surface elevation. In addition, Thibaut Pond will be maintained for 28-acres.

The adaptive management tools will focus on altering inflows from adjacent canals to maintain water levels. Another action specific for Thibaut Pond is a wet/dry cycle somewhat like BWMA. In the past LADWP has affectively maintained 28 acres of suitable habitat for waterfowl by drying Thibaut in the summer and flooding it in the Fall and Winter. This method provides open water habitat as well as tule control.

Recreation Objective

The LORP recreation objective is to provide for continued and sustainable recreational uses, consistent with LORP goals. Adaptive management includes planting native vegetation species and modifying recreational and human use management as impacts or over use of areas occurs.

Indicator Assessment



Lower Owens River, near Lone Pine

Knowledge 2

What We Know

River Flow Regime

The overarching goal of the LORP is the establishment of a healthy, functioning Lower Owens River riverine-riparian ecosystem as well as creating and maintaining a healthy warmwater fishery. Hill and Platts (1998) describe the restoration of rivers as a linear process; riparian habitat strongly influences geomorphic processes and must develop ahead of in-channel habitat to maximize complexity and sustain habitat. The development of riparian systems is part of a directional sequence known as the reversible process concept (Amoros et al. 1987), within which the directional sequences are rejuvenated by erosion, deposition, and flood disturbance. This also establishes a dynamic equilibrium in which nutrient and organic inputs are absorbed, accumulated or exported depending upon stream flow (Dodds 2007).

Healthy fish populations are dependent upon stream flow regimes that protect the ecological integrity of their habitat. Fish habitats are the consequence of linkage among the stream, floodplain, riparian and upland zones (Hill et al. 1991). Stream flow dependent fluvial-geomorphic processes form and control fish habitat (Rinne and Miller 2006; Smith and Kraft 2005; Rosgen et al. 1986; Platts et al. 1985).

Thus, the key to a successful LORP is instream and out-of-channel flows, their periodicity, duration and magnitude (Hill and Platts 1998). Natural stream flows vary through time and flow management in the LORP should mimic rivers in the Eastern Sierra Nevada. The Kern River above Lake Isabella represents a natural flow condition (Kaplan-Henry and Courter 2012); spring runoff from snow melt begins in early March, peaks in late May-early June then rapidly declines to very low flows throughout the summer; however a winter peak typically occurs in early December. The hydrograph on the facing page shows the Kern and LORP flows and illustrates how “unnatural” LORP flows are by comparison.

Looking at the Kern River systems can provide guidance when recreating the most critical components of the natural flow regime. The Kern River hydrograph shows a stark contrast in comparison to the LORP flows since implementation. The LORP peak flows are much lower and base flows much higher. The ratio of maximum flows to minimum flows illustrates how the LORP is managed more like a canal, than a natural river system.

Clearly, the LORP flows do not emulate natural flow conditions of a typical Sierra Nevada stream. At the present time this flow dissimilitude is codified and unlikely to change.

In 2007, MOU Parties developed criteria that led to certification of the 40 cfs base flow. The Parties agreed to a Stipulation and Order that mandates river flows.

In a letter to MOU Parties and the Court, the MOU Consultants objected strenuously to the Stipulation and Order arguing, “An example of long-term flow management to meet the biological and ecological goals in the MOU is a critical flow decision that is probably going to be necessary in about five years, maybe less. Based on monitoring and adaptive management, we can expect that a set flow of 40 cfs will create a canal not a river. Natural river flows fluctuate, canals do not.”

Stipulation and Order that mandates river flows:

- **A minimum of 40 cfs will be released from the Intake at all times.**
- **No in-river measuring stations can have a 15-day running average of less than 35 cfs.**
- **The mean daily flow at each in-river measuring station must equal or exceed 40 cfs on 3 individual days out of every 15.**
- **The 15-day running average of any in-river measuring station can be no less than 40 cfs.**

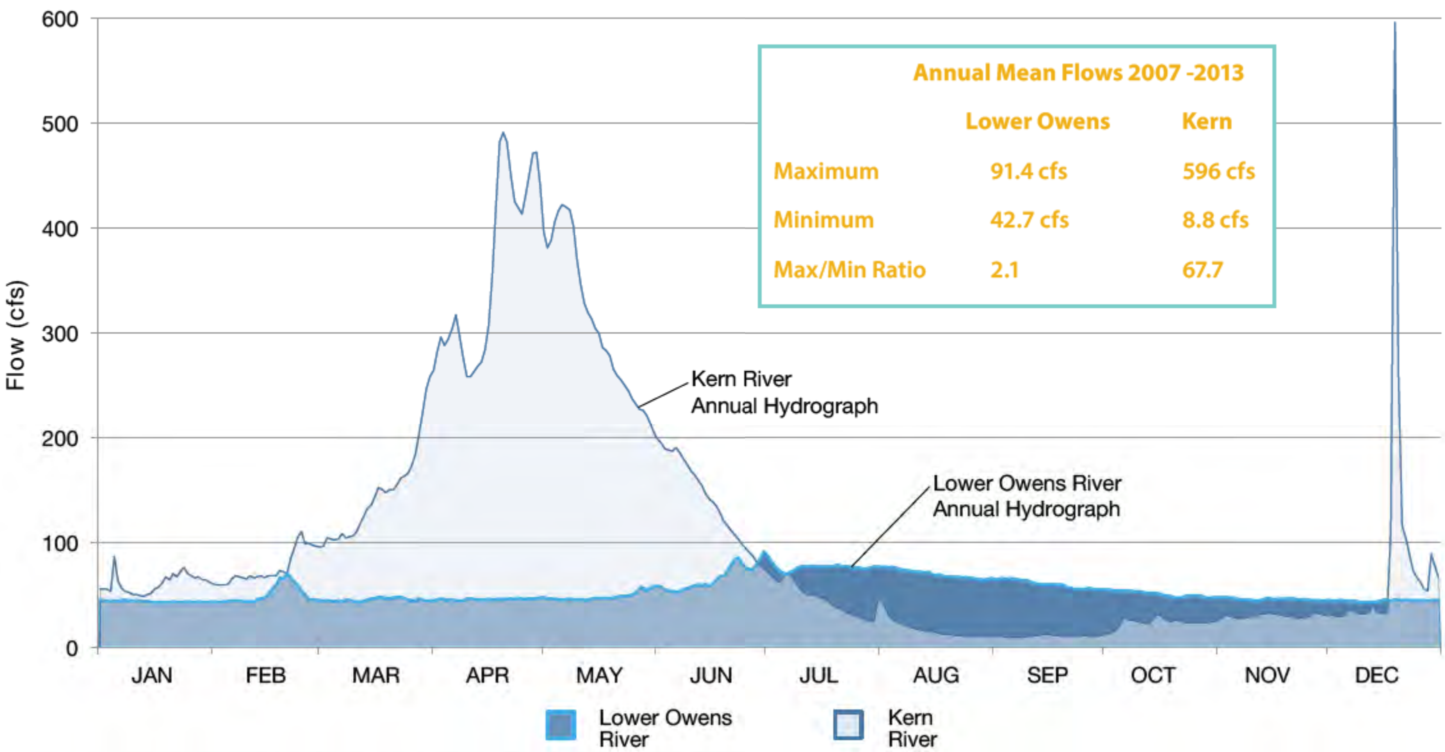
Although the intent has always been to initiate the project with 40 cfs base flow and 200 cfs pulse flow, this should not be viewed as the beginning and end. To achieve the biological/ecological goals of the MOU, it will be necessary to create a river, not a canal, in the long-term.

Unfortunately, the predictions made in 2007 have come true. The static flow management of the past seven years has resulted in canal like conditions of a tule choked channel in places, accumulation of organic material and diminishing water quality, threat of fish kills, and loss of forage lands.

Although we can point to the attainment of some ecosystem services as described in the 2013 annual report, the critical biological/ecological conditions described above in which the stream, floodplain, riparian and upland zones are linked by stream flow dependent fluvial-geomorphic processes will be more difficult to attain with flows codified in the Stipulation and Order. However, this is not to say the LORP cannot be successful in different ways.

To achieve the biological and ecological goals of the MOU, it will be necessary to create a river, not a canal, over the long-term.

First it will require reexamination of expectations by MOU Parties. As the OVC indicated in their comments on the river summit, there is an abundance of life in the wetlands and riparian areas, fish and birds appear to be thriving, and tules may, in time, be out-competed. Perhaps, the initial expectations of an open, woody-riparian dominated river need to be revisited. Second, without flows that mimic natural rivers, attainment of MOU goals will require different ideas and proposals. These are addressed in further sections.



Hydrograph of mean daily flows for the Kern River and the Lower Owens River from 2007-2013. This comparison illustrates a natural hydrograph in the Kern River basin versus the artificial flow regime of the Lower Owens.

What We Know

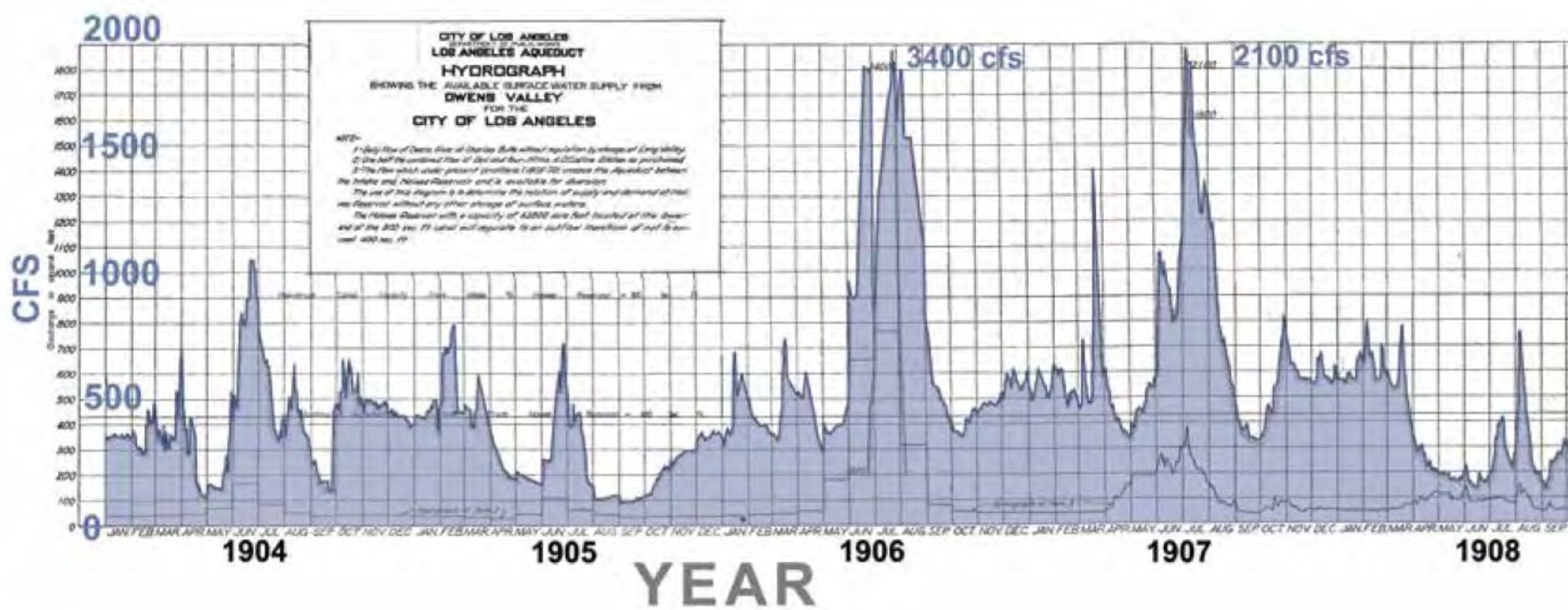
Historic Flow Regime

The historic flow regime of the Owens River was variable (hydrograph below). Prior to the large scale development of water diversions in the Owens Valley, flow in the Owens River ranged widely from month to month and year to year. Other than the graphic provided below, no accurate long-term record of historic natural flows in the Lower Owens is known to exist. Researchers have estimated pre-diversion flows for various sections of the river; Owens River Gorge and outflow from Pleasant Valley Reservoir (Danskin 1998, Smeltzer and Kondolf 1999). Based on estimates by Smeltzer and Kondolf (1999) and assuming a 15-20% (Danskin 1998) increase in flow from the bottom of the Owens River Gorge to the Lower Owens, pre-diversion flows in the Lower Owens were likely in the range of 247 to 318cfs for base flow, 635 to 742cfs for annual peak flows, and 3,531 to 3,885cfs for the 10,000 year flood. The estimated 10,000yr flows seem low compared to the data provided by City of Los Angeles hydrographers (graphic below). Historic flows in the Lower Owens were likely augmented an additional 10-15% (Danskin 1998) by tributaries (Symmes, Hogback, Lone Pine, Independence, etc.) within the LORP boundary before the river emptied into Owens Lake. As a system driven by the melting of the Sierra snowpack, the Owens River's maximum monthly discharge normally occurred in June and often in May or July with minimum discharge in August or September (Brothers 1984, Smeltzer and Kondolf 1999). Generally speaking, the groundwater system, low gradient and low valley precipitation led to a fairly continuous historical flow to the river (Brothers 1984, Danskin 1998) that was interrupted by large flow events induced by precipitation and snow pack.

Drought and Sierra Snowpack

California is facing one of the most severe droughts on record (CA.gov 12/10/2014). Climate research suggests that drought conditions in California may be more common in the future. Research indicates that climate change will bring more frequent drought conditions to the state and potentially reduce Sierra snowpack by half, as predictions suggest that more precipitation will fall as rain rather than snow and snow melt will occur earlier and more rapidly (California

Hydrograph of the Lower Owens River from 1904 to 1913. Daily flows in the river prior to the LA Aqueduct Intake.



Water Action Plan 2014). The primary driver of this situation is increasing temperatures which will reduce snowpack leading to reduced streamflows, especially in the spring (USGCRP 2009). Drought, climate change and reduced Sierra snowpack have a significant effect on LORP conditions. The Seasonal Habitat Flow (SHF) is tied to the Sierra snowpack. If future snowpack remains low, under present management, the LORP will not receive a SHF, making conditions similar to 2013 and 2014 the norm. As mentioned throughout this document, reduced SHF's will have a detrimental effect on the ecology of the Lower Owens River.

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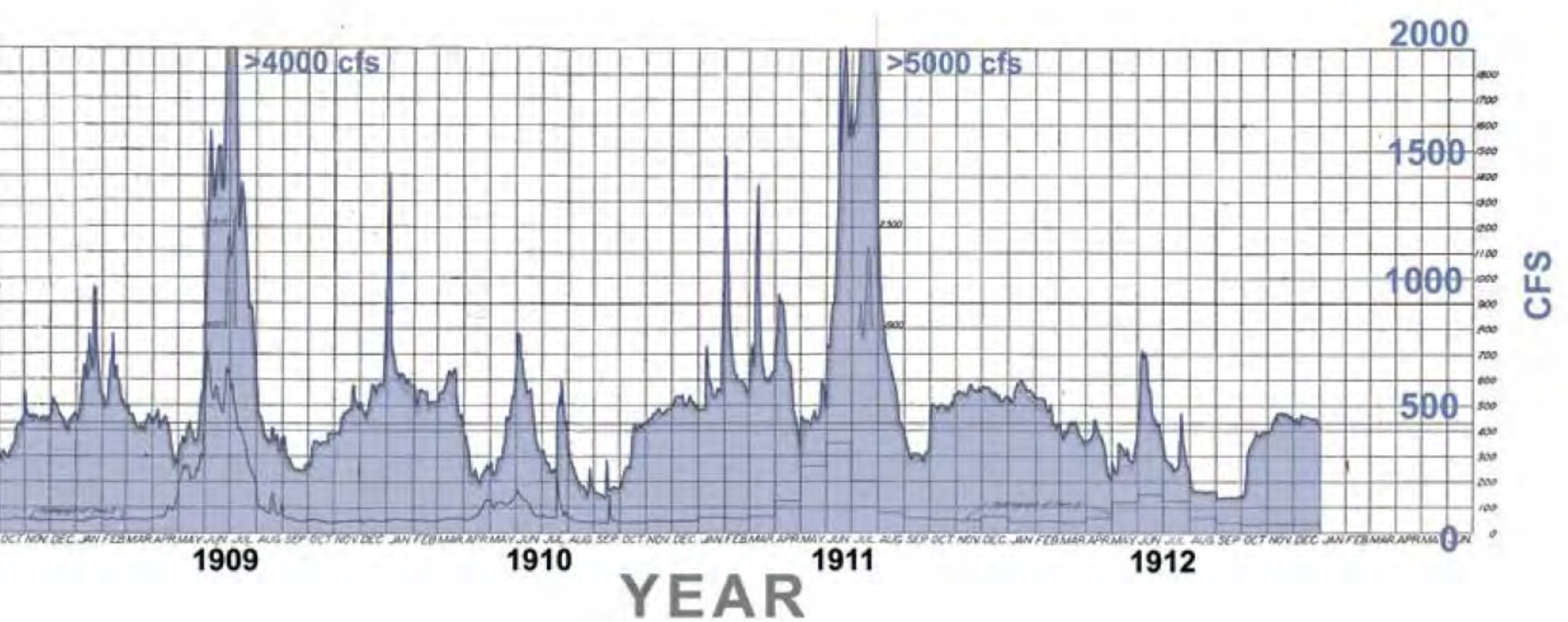


What We Don't Know

Species, Habitat, Indicators

The MOU includes some 28 indicator species of fish, birds and mammals. These are listed in the MAMP (2008) as members of guilds. Guilds are grouped based on similarities in feeding and breeding strategies, habitat preferences, and behavior and species size. In theory, because all species in a guild are affected similarly by habitat changes, one guild member, or indicator species, can be used to assess impacts on other members (MAMP, 2008; Rice, et al. 1984). In the case of avian indicator species, it was expected that they could be distributed into four guilds parallel to the river: wetland open-water, successional shrub, woodland, and grassland. Avian surveys in these ecotypes have found some of the target species, but many have not been noted and some in very few in numbers.

The question is, are these indicators species the most appropriate or are these guilds too limited to reflect food web dynamics?

We do not know if or how the LORP indicator species (28 species of fish, birds and mammals) are thriving, surviving, or in decline.

Ecologists have long recognized the importance of ecological resource subsidies that allow material biomass, organisms, and, fundamentally, energy transfer to food webs across ecosystem boundaries (Polis et al. 2004). However, only recently has research showed that energy transfer from streams to far distant ecotypes occurs. Muehlbauer, et al. (2014) found that in rivers, this distance – defined as the biological stream width - is often much larger than has been defined by hydro-geomorphic metrics alone. In fact, this study found that energy subsidies (as macroinvertebrates) in the BSW can be up to 10,000m from the stream bank. As Muehlbauer concludes, this greatly improves our understanding of ecosystem conditions that permit spatially extensive subsidy transmission.

The last reliable vegetation mapping (complexity and abundance) performed in the LORP was in 2010. Because we do not know how ecotypes or guilds have developed from the stream bank to terraces, nor the condition of the four guilds across the landscape, we do not know the extent of the LORP's BSW or even if

The LORP MOU includes indicator species of some 28 species of fish, birds and mammals.

it is a functional food web subsidizing energy from one ecotype to the next. A limiting factor will occur when an ecotype is non-existent or of such poor quality that energy transfer is minimal. Without this knowledge we cannot conclude that the question of appropriate indicator species or limited guilds is answerable.

Conversely, the LORP's BSW includes the stream itself, because it extends to both sides of the river, and, therefore, the eight fish indicator species come into question. Results of the creel censuses show a healthy, multi-age class of largemouth bass. Catch rates are high indicating a large population of game fish throughout the river. In addition to largemouth bass, the MOU lists smallmouth bass, bluegill, channel catfish, Owens sucker, Owens tui chub and pupfish, and Owens speckled dace. Creel census results indicate an occasional bluegill or catfish is taken.

Fishes	
Large mouth bass	*Micropterus salmoides*
Small mouth bass	*Micropterus dolomieu*
Bluegill	*Lepomis macrochirus*
Channel catfish	*Ictalurus punctatus*
Owens sucker	*Catostomus fumeiventris*
Owens pupfish	*Cyprinodon radiosus*
Owens tui chub	*Gila bicolor snyderi*
Owens speckled dace	*Rhinichthys osculus ssp.*
Birds	
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*
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*
Mammals	
Owens Valley vole	*Microtus californicus vallicola*

LORP Indicator Species

The viability and strong population of largemouth bass can be correlated with vegetation cover (tules) throughout the river. Miranda and Pugh (1997) found that maximum recruitment of largemouth bass increased with intermediate vegetation density. Their research suggested that production increased during winter, when survival, invertebrate consumption, and length increased at intermediate levels of instream vegetation.

Unquestionably, predation by largemouth bass on young-of-the-year and juvenile native fish explain the demise of dace. Nonnative fish and flow alteration are also threats to native fish persistence in lotic systems (Gido and Propst 2012). Largemouth bass predation in combination with flow manipulations to stimulate woody riparian growth, improve water quality, or control tules may be conflicting actions if native Owens River fish species are to be indicator species. While we can speculate about the causes for the demise of Owens sucker and speckled dace, we do not have data about their presence or absence.

Habitat Conditions for Indicator Species

Speculating about indicator species presence, absence or trends is not the preferred method of monitoring a restoration project. The preferred methods for monitoring indicator species are through direct observation or habitat mapping coupled with an analysis of habitat quality (e.g. CWHR). In this section we'll examine what we don't know about LORP indicator species and their habitat, focusing on the riverine-riparian area.

An indicator species is an organism whose presence, absence or abundance reflects a specific environmental condition (McDonough et al. 2009). The idea of using indicator species to monitor the LORP was enacted because they can signal a change in the biological condition of the project's various restored ecosystems (Riverine Riparian Area, BWMA, DHA, etc.). Indicator species can then be a proxy to diagnose the health of the overall LORP ecosystem (McDonough et al. 2009). Therefore, managers can use an indicator species (or suite of indicator species) as a surrogate for overall biodiversity, monitoring the outcomes of management practices by measuring the rise or fall of the population of the indicator species (McDonough et al. 2009). In practice this is what should be occurring in the LORP, especially in the riverine-riparian area. Unfortunately, due to a lack of direct observation or habitat mapping, within the riverine-riparian area, it is difficult to determine the health of the ecosystem or the effectiveness of using indicator species to monitor the LORP.

Speculating about indicator species is not the preferred method of monitoring a restoration project. The preferred methods is through direct observation and habitat mapping coupled with an analysis of habitat quality

Monitoring of indicator species should be performed multiple times over the life of a project, because caution must be applied when interpreting species population trends to distinguish actual signals from variations that may be unrelated to the deterioration of ecological integrity (Carignan and Villard 2002). Existing riverine-riparian monitoring data indicates that the majority of the LORP's indicator species (including 19 bird species) were surveyed prior to implementation (2002 and 2003) and then again in 2010. These two monitoring efforts were performed well and provide a wealth of information regarding indicator species presence in the riverine-riparian area. Unfortunately, two points are not statistically significant to determine a trend, and the vast difference in conditions (pre-implementation vs. post implementation) does not truly monitor the LORP. Rather, these two data points (2002 and 2003 v. 2010) highlight the change resulting from the addition of water to the system. These two monitoring events do not measure how management of the project is affecting habitat and indicator species abundance or the overall health the LORP riverine-riparian area.

According to the Monitoring and Adaptive Management Plan (Ecosystem Sciences 2008), riverine-riparian avian surveys and landscape vegetation mapping were scheduled for 2013. These monitoring efforts were not performed, nor were they performed in 2014, leaving managers with only one data point (2010) since project implementation to examine the habitat for indicator species in the LORP. This is an insufficient amount of data to assess the health of the Lower Owens riverine-riparian area. In short, we lack the data and knowledge to make informed assertions about the health of the riverine-riparian area and the population status of indicator species.

References

Caitlin McDonough, David Jaffe (Lead Author);Mary Watzin (Contributing Author);Mark McGinley (Topic Editor) "Indicator species". In: Encyclopedia of Earth. Eds. Cutler J. Cleveland (Washington, D.C.: Environmental Information Coalition, National Council for Science and the Environment) First published in the Encyclopedia of Earth December 18, 2009

Carignan, V. and Marc-Andre Villard. 2002. Selecting indicator species to monitor ecological integrity: a review. Environmental Monitoring and Assessment 78: 45-61.

Great Blue Heron
LORP Indicator Species

Sources of Knowledge

Planning, implementation, monitoring and adaptive management of the LORP is dependent upon numerous sources of knowledge from technical memorandum, monitoring data, empirical observations, qualitative observations, reports, expert opinion, and the scientific literature and reports from other projects and research.

The two most important management tools for the LORP are stream flow and land use strategies. Water and land use management together exert the greatest influence on the river's biotic and abiotic components and, ultimately, the degree of functional state attained by the total ecosystem. Consequently, the focus of knowledge acquisition and utilization are on the myriad elements of water and land use ecology.

At the LORP planning stage each ecological component related to management objectives or desired outcomes was addressed through a series of Technical Memoranda. 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.

The more than 20 technical memos established starting points toward restoration of the Lower Owens, but it was the guidance developed in the Monitoring and Adaptive Management Plan that would shift the LORP from planning to implementation.

The principle knowledge source at this stage of the LORP comes from monitoring – quantitative and qualitative observations that measure trends toward goals. Empirical data not only drives adaptive management recommendations and actions, but such data informs expert opinion as well.

Expert opinion is not simply scientific guess work. It is a legitimate practice that can be used to serve a variety of purposes, and may be used to assist in problem identification, in clarifying the issues relevant to a particular topic, and in the evaluation of a condition (Allen and Gunderson, 2011). Expert opinion as used in the LORP is informed by decades of experience from LORP scientists, the MOU Consultants and the Scientific Team. Other scientists within the MOU Parties also provide essential input. Expert opinion is a very collaborative concept within the scientific community. Since inception of the LORP numerous other projects throughout the West have begun, both large and small. New information, experiences and knowledge from other projects, which may have application to the LORP, is acquired through literature publications, reports, conferences, and direct conversations with colleagues.

The LORP is viewed as a case study for other restoration projects, because of the longevity of the project and the timeline in which we have been able to test initial hypothesizes in tech memos with monitoring data. Our adaptive management strategy using triggers and thresholds has been far ahead of other projects. The figure at right illustrates the timeline from baseline data collection to post-implementation monitoring. Within this period of time we have collected information and data on many, but not all, ecological components. Much has been learned since the planning phase and baseline data collection using all the knowledge sources described above.

Acquisition of knowledge is an on-going effort in the LORP. Monitoring provides a stream of data and information which informs adaptive management recommendations. Tapping into the scientific community through research publications and conversations is a valuable two-way source of knowledge. LADWP staff has presented the LORP at conferences and other venues. The MOU Consultants frequently discuss LORP success and approaches with other restoration practitioners.

Augmenting and enhancing expert opinion with input from all scientists involved in the LORP is critical. The LORP does not operate in a vacuum but continually progresses and improves with all of the sources of knowledge available.

However, additional monitoring is needed for critical components of the LORP. There are still several LORP areas where monitoring has not occurred and/or is insufficient. In these areas of interest the only resources available for developing a better understanding of conditions is through opinion and at times qualitative observation.

References

Allen, C.R. and L.H. Gunderson. 2011. Pathology and failure of design and implementation of adaptive management. Jour. Envir. Manag. 92(2011)1379-1384.

Riverine-Riparian Monitoring Schedule from the LORP Monitoring and Adaptive Management Plan

2009

1. Base Flow
2. Base Flow Water Quality
3. Base Flow Fish Condition
4. Seasonal Habitat Flow
5. Seasonal Habitat Flooding Extent
6. Seasonal Habitat Flow Water Quality
7. Seasonal Habitat Flow Fish Condition
8. Rapid Assessment Survey

2010

1. Base Flow
2. Seasonal Habitat Flow
3. Seasonal Habitat Flooding Extent
4. Seasonal Habitat Flow Water Quality
5. Seasonal Habitat Flow Fish Condition
6. Rapid Assessment Survey
7. Indicator Species' Habitat
8. Landscape Vegetation Mapping
9. Site Scale Vegetation Mapping and Landforms
10. Creel Census
11. Avian Census

2011

1. Base Flow
2. Seasonal Habitat Flow
3. Seasonal Habitat Flooding Extent
4. Seasonal Habitat Flow Water Quality
5. Seasonal Habitat Flow Fish Condition
6. Rapid Assessment Survey
7. Fish Habitat

2012

1. Base Flow
2. Seasonal Habitat Flow
3. Seasonal Habitat Flooding Extent
4. Rapid Assessment Survey

2013

1. Base Flow
2. Seasonal Habitat Flow
3. Seasonal Habitat Flooding Extent
4. Rapid Assessment Survey
5. Indicator Species' Habitat
6. Landscape Vegetation Mapping
7. Site Scale Vegetation Assessment Landform Elevation Modeling
8. Avian Census
9. Creel Census

2014

1. Base Flow
2. Seasonal Habitat Flow
3. Rapid Assessment Survey
4. Fish Habitat

Riverine-Riparian Monitoring as it Actually Occured in the LORP

2009

1. Base Flow
2. Seasonal Habitat Flow
3. Seasonal Habitat Flooding Extent
4. Seasonal Habitat Flow Water Quality
5. Rapid Assessment Survey

2010

1. Base Flow
2. Seasonal Habitat Flow
3. Seasonal Habitat Flooding Extent
4. Seasonal Habitat Flow Water Quality
5. Rapid Assessment Survey
6. Indicator Species' Habitat
7. Fish Habitat
8. Landscape Vegetation Mapping
9. Site Scale Vegetation Assessment & Landform Elevation Mapping
10. Creel Census
11. Avian Census

2011

1. Base Flow
2. Seasonal Habitat Flow
3. Seasonal Habitat Flooding Extent
4. Seasonal Habitat Flow Water Quality
5. Rapid Assessment Survey
6. Creel Census
7. Avian Census

2012

1. Base Flow
2. Seasonal Habitat Flow
3. Seasonal Habitat Flooding Extent
4. Seasonal Habitat Flow Water Quality
5. Rapid Assessment Survey

2013

1. Base Flow
2. Seasonal Habitat Flow
3. Rapid Assessment Survey

2014

1. Base Flow
2. Rapid Assessment Survey
3. Creel Census

■ Timeline of LORP post implementation riverine-riparian monitoring. These graphs illustrate when monitoring occurred versus monitoring protocol as specified in the LORP Monitoring and Adaptive Management Plan (MAMP). The monitoring plan schedule was largely was followed until 2013 when significant monitoring was ommitted.

LORP

The First Water in 100 years.

The images on this and the facing page show the leading edge of water from the flow release into the Lower Owens River channel since the building of the LA Aqueduct. These flows were released in 1993 as part of the initial flow studies in prepeartion for the LORP Action Plan, MOU and EIR.

Management Areas 3

River Flow Regime

Baseflows

Background

Lower Owens River base flows mandated by the MOU (1997) have been implemented by LADWP over the past 8 years. LORP base flows were first released in December 2006. LADWP has followed the MOU (1997) guidelines and related Stipulation and Orders governing flow management over these past 8 years. During these years, the river flowed under base flow conditions at least 11.5 months out of each year. In 2014, only base flows were released during the entire year. Therefore, base flows to date have been the major controlling influence on the Lower Owens River and are the determining factor for riverine-riparian conditions. Base flow will always be the major controlling influence on riverine-riparian conditions as long as present flow management practices continue.

Base flows have resulted in a productive river with a healthy warm-water fishery and abundant wildlife. Because the river has to function under fairly uniform year-round flow conditions (uniform in fall, winter, and spring and higher in summer), controlling water quality, increasing woody riparian recruitment, and limiting tule-cattail abundance is proving difficult and challenging. Since 2008, the MOU Consultants have continually emphasized the need to modify base flows. Flow modifications are needed to improve water quality and possibly control tule-cattail abundance and distribution. Since 2008, water quality conditions (mainly low dissolved oxygen) have been on a downward trend (see 2014 water quality adaptive management recommendations). This trend needs to be ammended and improved or the Lower Owens River will face serious challenges including declining fish health.

Justification

As stated before, the Lower Owens riverine-riparian system, under the past 8 years of LORP management, has produced and maintained valuable resources. Management now needs to make sure, through the adaptive management process, that these gained resources are maintained and improved. Over the past 45 years the Lower Owens River has continually experienced serious water quality problems. Because of this inherent water quality issue the river will require special attention and management in the future. Management changes will need to ensure that environmental gains are not diminished or lost.

In 2010 and 2013, the Lower Owens River experienced large-scale water quality problems. These environmental pre-warnings emphasize the need to alter future management practices to buffer and control this issue. It appears (from poorly documented evaluations) that over the past 45 years the Lower Owens River may have experienced 6 significant fish kills. The fact that 33% of these fish kills occurred in just the past 3 years (2010 to 2013), should be seen as a critcal early warning.

The 2008 to 2014 Annual RAS Reports (RAS 2014) demonstrate that the Lower Owens River riparian habitat is having difficulty recruiting woody riparian vegetation, especially tree willow. The MOU (1997) and the EIR (2004) require a healthy riverine-riparian ecosystem with diverse habitat to meet the needs of the designated indicator species. Woody riparian vegetation plays an important part in many habitat indicator species life requirements. The major effort at this time, however, is to enhance year around water quality conditions. The Lower Owens River over the past four decades has experienced continuous poor water quality conditions when river temperatures are high.

2013 Baseflow Recommendations

To release more productive base flows and provide additional water for improving seasonal habitat, seasonal pulse, and winter flushing flows, the MOU Consultants made the following adaptive management recommendations in 2013 (AMR 2013):

Recommendation 1 - The MOU Consultants recommend that all requirements in the MOU (1997) and respective Stipulation and Orders that dictate how the 40 cfs base flow must be applied be rescinded.

Recommendation 2 - The County, the City - with the assistance of the MOU Consultants - develop a new Lower Owens River base flow management strategy. This flow management strategy would be compatible with the requirement that the City release an annual average 55 cfs flow into the Lower Owens River at the Intake Control Station.

Recommendations 1 and 2, made in 2013, still stand and again have the MOU Consultants full support.

2014 Baseflow Recommendations

Recommendation 1 - The MOU Consultants recommend that their 2013 base flow adaptive management recommendations be implemented in 2015.

Recommendation 2 - The MOU Consultants recommend that the City's proposed base flows, as outlined in Figure 1 and documented in Table 1, be implemented in 2015. The City submitted their proposed base flows for review and comment to all Parties at the "2014 River Summit."

Recommendation 3 - The MOU Consultants recommend that the City's proposed base flows be implemented, monitored and evaluated to determine their effectiveness and needed refinement.

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT
1	40	30	25	25	30	30	60	70	82	75	65	55
2	40	30	25	25	30	30	60	70	98	75	65	55
3	40	30	25	25	30	30	60	70	122	75	65	55
4	40	30	25	25	30	30	60	70	153	75	65	55
5	40	30	25	25	30	30	60	70	184	75	65	55
6	40	30	25	25	30	30	60	70	200	75	65	55
7	40	30	25	25	30	30	60	70	200	75	65	55
8	40	30	25	25	30	33	60	70	184	75	65	55
9	40	30	25	25	30	40	60	70	184	75	65	55
10	40	30	25	25	30	48	60	70	153	75	65	55
11	40	30	25	25	30	58	60	70	153	75	65	55
12	40	30	25	25	30	69	60	70	122	75	65	55
13	40	30	25	25	30	82	60	70	122	75	65	55
14	40	30	25	25	30	98	60	70	98	75	65	55
15	40	30	25	25	30	118	60	70	98	75	65	55
16	35	30	25	25	30	142	65	80	82	70	60	45
17	35	30	25	25	30	170	65	80	82	70	60	45
18	35	30	25	25	30	184	65	80	75	70	60	45
19	35	30	25	25	30	220	65	80	75	70	60	45
20	35	30	25	25	30	176	65	80	75	70	60	45
21	35	30	25	25	30	141	65	80	75	70	60	45
22	35	30	25	25	30	113	65	80	75	70	60	45
23	35	30	25	25	30	91	65	80	75	70	60	45
24	35	30	25	25	30	73	65	80	75	70	60	45
25	35	30	25	25	30	60	65	80	75	70	60	45
26	35	30	25	25	30	60	65	80	75	70	60	45
27	35	30	25	25	30	60	65	80	75	70	60	45
28	35	30	25	25	30	60	65	80	75	70	60	45
29	35	30	25	25		60	65	80	75	70	60	45
30	35	30	25	25		60	65	80	75	70	60	45
31	35		25	25		60		80		70	60	

Table 1. Proposed LORP Daily Flow Regime by Month

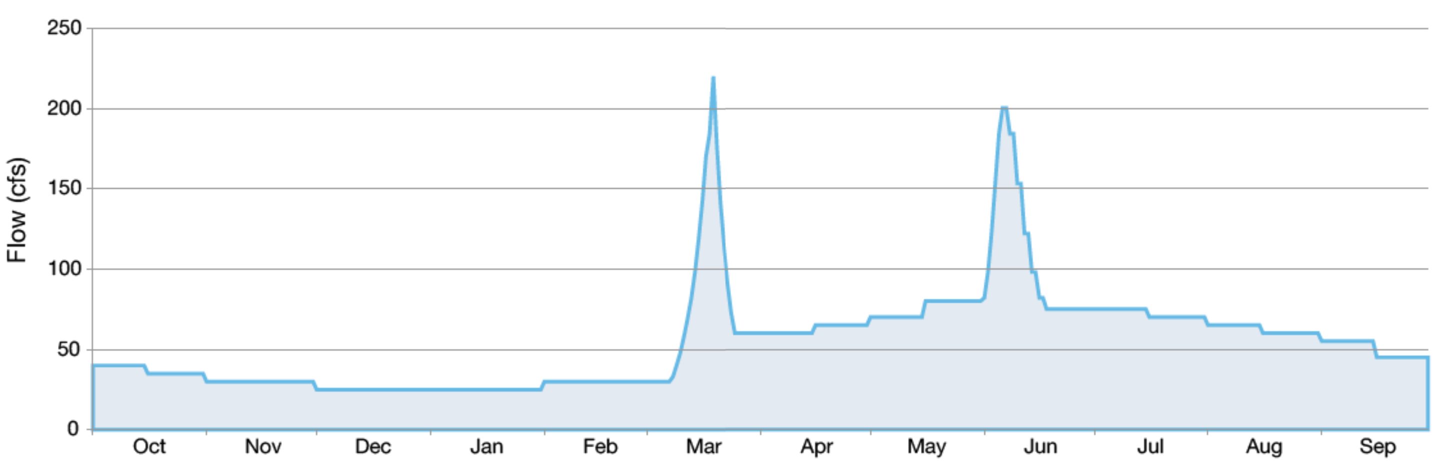


Figure 1. Proposed LORP Base and Seasonal Habitat Flow Regime

Seasonal Habitat Flows

Background

Six seasonal habitat flows have now been released into the Lower Owens River (Table 2) over the past 7 years. To date these flow releases (except 2008) have resulted in limited, if any, documented riverine-riparian beneficial effects that can be attributed to seasonal habitat flow releases. No seasonal habitat flow was released in 2014. Insignificant seasonal habitat flow volumes and duration were released in 4 of the 7 years (Table 2). Lack of consistent repeatable flow patterns in combination with no comparison controls has made it difficult to evaluate the effectiveness of these flows, if there were any.

Justification

The primary, legally mandated, purpose for applying the annual seasonal habitat flow is to create a natural disturbance regime (MOU 1997). A more natural disturbance regime should produce good water quality conditions, result in diverse riparian habitat, support and maintain productive ecological systems, and produce a healthy recreational warm-water fishery. The MOU (1997) also lists many other environmental accomplishments the seasonal habitat flow must attain. The EIR (2004) expands even further on the environmental accomplishments that must be attained.

Year	Volume (CFS)
2008	220
2009	110
2010	209
2011	205
2012	92
2013	58
2014	0

Table 2. Seasonal habitat peak flows released at the Intake Control Station by year and volume.

The average annual seasonal habitat flow peak, applied to date, is only 128 cfs. This average includes the 2008 flushing peak flow which was not a seasonal habitat flow. If this flushing flow peak is left out, the annual average seasonal habitat flow peak is only 112 cfs. This average annual flow peak is too small to meet the requirements of the MOU (1997). The average seasonal habitat flow peak (112 cfs) released is not much higher than the annual average high base flow (90 to 100 cfs). A river forced to function with the base flow average as high or about equal to the average seasonal habitat flow does not mimic a natural disturbance regime; rather it is an artificial flow pattern that will not allow all LORP requirements to be met.

2013 Seasonal Habitat Flow Recommendations

To implement more productive seasonal habitat flows the MOU Consultants made the following adaptive management recommendations in 2013 (County-City 2013):

Recommendation 1 - The MOU Consultants recommend that the County, the City, and with the assistance of the MOU Consultants develop during the winter of 2013-2014, a new Lower Owens River flow management strategy. This flow strategy would be compatible with the City releasing an annual average of 55 cfs into the Lower Owens River from the Intake Control Station.

Recommendation 2 - The MOU Consultants recommend a seasonal habitat peak flow of 300 cfs or more be released in 2014. (Note – This flow recommendation was made in case the other flow recommendations were rejected.)

The MOU Consultants 2013 adaptive management seasonal habitat flow recommendations still stand. These recommendations still have the MOU Consultants full support for implementation.

2014 Seasonal Habitat Flow Recommendations

Recommendation 1 - The MOU Consultants recommend that the City's proposed seasonal habitat flow be implemented in 2015 (see Figure 1 and Table 1 for details). This Lower Owens River flow management proposal was submitted by the City for review and comment to all Parties at the "2014 River Summit".

Recommendation 2 - The MOU Consultants recommend that the City's proposed base seasonal habitat flows be implemented, monitored, and evaluated to determine their effectiveness and needed refinements.

Flushing Flows

Background

The only significant, planned flushing flow released into the Lower Owens River since LORP implementation occurred in February of 2008. Although often counted as a seasonal habitat flow, this flow was only a flushing flow required by the Lahontan Regional Water Quality Control Board. The major purpose of this flow was to move muck out of the river system so future water quality conditions would be more favorable. Based on observed river conditions in 2008 and 2009, this flushing flow appeared to provide beneficial effects during the 2009-2010 water year (Platts, personal observations). By late 2010, however, the benefits derived from the flushing flow had faded away.

Justification

Via the adaptive management processes of releasing and evaluating flushing flows, the County and the City need to determine if flushing flows would be beneficial. If flushing flows are found to be beneficial, then the volume, the timing, and the pattern of release needs to be evaluated to determine what would be the most effective.

2013 Flushing Flow Recommendations

The MOU Consultants recommended in their 2013 adaptive management recommendations that a late winter to early spring flushing flow, similar to the flushing flow released in February 2008, be released during 2014. The MOU Consultants recommended flushing flows be evaluated to determine if benefits are received. Flow releases of this type could provide experience and information allowing future winter-spring flushing flows to be more effective.

These flushing flow recommendations made in 2013, still stand and again have the MOU Consultants full support.

2014 Flushing Flow Recommendations

Recommendation 1 - The MOU Consultants recommend that the proposed flushing flow submitted by the City be implemented in 2015 (see Figure 1 and Table 1 for details). This flushing flow proposal was presented for review and comment to all Parties at the "2014 River Summit".

Recommendation 2 - If the MOU Parties fail to accept and implement Recommendation 1, then the MOU Consultants recommend that a flushing flow exceeding a peak of 300 cfs be released in late spring of 2015. This flushing flow would be monitored and evaluated for effectiveness and refinement.

Recommendation 3 - The MOU Consultants recommend that all implemented flushing flows be monitored and evaluated to determine their effectiveness and needed refinement.

Combined Flow Management

Background

The MOU Consultants in this report have recommended changes in base, seasonal habitat, and flushing flows for the Lower Owens River. In their Adaptive Management Section on, "Releasing Three of the Delta Habitat Area habitat flows from the Intake," the MOU Consultants also recommended that three additional flushing flows, be released from the Intake Control Station. Figure 1 in this Adaptive Management section displays the flow patterns for recommended base, seasonal habitat, and flushing flows. Figure 2, below and described in the "Delta Habitat Area - Flow Release Changes" section displays the additional three flows the MOU Consultants recommend be released from the Intake Control Station. Figure 2 below displays the combined flow patterns the MOU Consultants are recommending be implemented in 2015.

Combined Flow Management Recommendation

Recommendation 1 - That MOU Consultants recommend that their final recommended combined flow pattern, displayed in Figure 2 in this report, be reviewed and evaluated by the Scientific Team and submitted for action in time to be implemented in 2015.

References

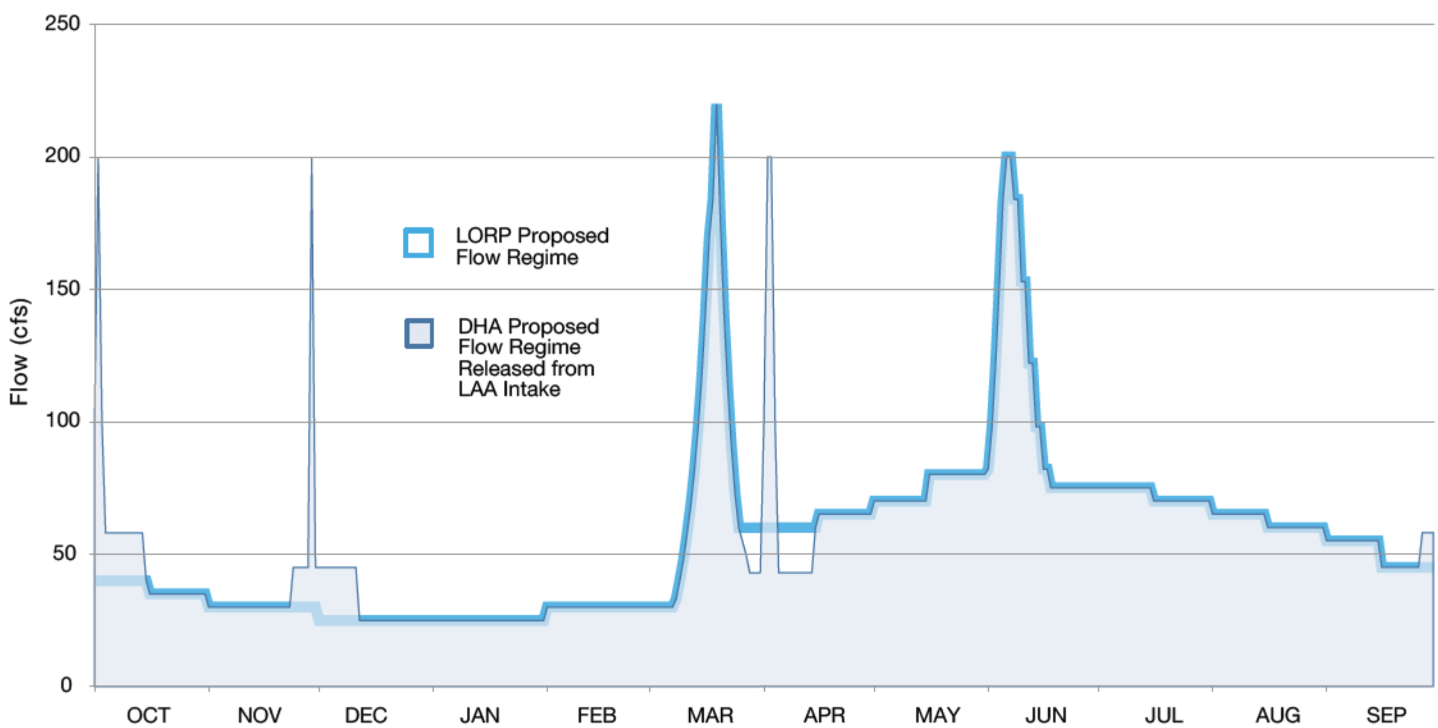
Ecosystem Sciences 2013. Lower Owens River Project Adaptive Management Recommendations. Ecosystem Sciences, Boise, ID.

RAS. City-County. 2014 Rapid Assessment Survey Report. Prepared by Inyo County and the City of Los Angeles, Bishop, CA.

MOU. 1997. Memorandum of Understanding. County of Inyo and City of Los Angeles, CA. Bishop, CA.

EIR. 2004. Final Environmental Impact Report (EIR) and Environmental Impact Statement (EIS), Lower Owens River Project.

Figure 2. Proposed LORP Combined Flow Regime for River and Delta Habitat Area Flows released from the LAA Intake.



Pumpback Station and Flow Limitations

Background

Yearly monitoring data combined with annual river observations have demonstrated that changes in river flow management are needed if all of the MOU (1997) goals and expectations are to be met. The MOU (1997), in its wisdom, did not restrict the amount of water the Pumpback Station can pump-out. The MOU (1997) also allows the MOU Parties to amend, delete, or add to any previously passed Stipulation and Order by agreement amongst the Parties.

Court approved Stipulations and Orders, under the authority of the MOU (1997), restrict the volume of water the Pumpback Station can pump out of the Lower Owens River. This added restriction decreases the opportunity to release higher river flows needed to improve river conditions. The restriction of a 50 cfs maximum pump-out has impeded management opportunities and improvements since the inception of the LORP. There is no scientific or biological reasoning or justification that supports the 50 cfs pump-out restriction.

Over the past 7 years the MOU Consultants have continually recommended that the Pumpback Station 50 cfs pump-out limitation be rescinded. As stated before, to place this handicap year after year on managers has no biological, scientific, or logical justification. To impede the LORP for other, extraneous purposes does not make good sense nor does it contribute to good LORP management. The 50 cfs limitation is a prime example of an inflexible policy restriction that stands in the way of effective river flow management. Another example is the 40 cfs mandated year-round base flow codified by Stipulation and Orders.

Recommendations

Recommendation 1 - The MOU Consultants recommend that all Pumpback Station restrictions appearing in Stipulation and Orders, or in any other related legal or policy form, be rescinded. No limitation should be placed on the amount of water that can be pumped-out by the Pumpback Station as long as it does not interfere with required flows that must go to the Delta Habitat Area.

Recommendation 2 - The County responded to the MOU Consultants 2013 Adaptive Management Recommendation to eliminate the 50 cfs pump-out limitation. The County called for this matter to be discussed for solution by the MOU Parties. The MOU Consultants recommend that the County follow their stated direction and make every effort possible to come up with a workable solution favorable to the Parties.

Recommendation 3 - If the MOU Parties cannot come to a consensus on eliminating the 50 cfs pump out limitation, then the MOU Consultants recommend that the Parties agree to a three year moratorium lifting the 50 cfs limitation and increase this limitation during this three year period to a 72 to 92 cfs pump-out. After the third year the pump-out authorization limitation of 50 cfs would go back into effect. This three year moratorium would help considerably in the design and implementation process to test, evaluate, and fine tune experimental habitat and flushing flows for the Lower Owens River.

LORP Pumpback Station

River Flow Augmentation to Improve Effectiveness

Background

Presently, river flow augmentation is occurring at selected sites in the Lower Owens River via required flow releases from the Los Angeles Aqueduct (LAA). These flow releases only amount to an average annual input of about 10 cfs. Although these flows are small they represent 25% of the Pumpback Station receiving flow and about one-sixth of the flow released from the Intake Control Station. This input is insignificant, however, as far as modifying and influencing river conditions. Especially when considering the full magnitude of flows required to gain and maintain riverine-riparian habitat benefits. These flows can be ignored when considering flow augmentation needs for down-river habitat benefits. Before the LAA, river flows were being augmented naturally by the streams flowing off the eastern face of the Sierras. Augmentation would again provide a more natural flow pattern once created by the tributary streams from the Sierras.

The MOU Consultants have recommended additional flow augmentation into the Lower Owens River over the past four years (See Adaptive Management Recommendations 2010 to 2013). The major reason, at this time, for Consultants recommending flow augmentation is for water quality improvement purposes. Improvement may require increasing flows in downriver reaches to compensate for the large drop in flow volume. Flow augmentation may be needed to increase flow in downriver reaches when Delta Habitat Area habitat flows are released at the Intake Control Station.

Flow augmentation, if needed and justified, can be implemented under present legal and policy mandates. Additional water for augmentation can also be gained by shortening pulse flow duration periods, changing points of water releases, and using additional water now available under a 2010 court approved Stipulation and Order. This Addendum to the EIR (2004) allows flow augmentation, when justified, up to a resulting 200 cfs river flow. Under the Stipulation and Order an additional 928 afy of water can pass into the Delta Habitat Area over flow volumes presently allowed. This Stipulation and Order augmentation flow is available if any of two following monitoring triggers are met:

Trigger 1 - Trigger 1 is met if riverine-riparian habitat goals in the MOU (1997) are not being achieved. Also, the Trigger is met if habitat is not achieving desired trends in characteristics relating to understory structure and composition. Not meeting habitat conditions important to habitat indicator species and special status wildlife species will also cause the Trigger to be met.

Trigger 2 - If habitat goals outlined in the MOU (1997) are not being achieved this Trigger is also met. To keep this trigger from tripping, flow pattern and duration must recruit riparian plants within the first five years or sustain them through the 15 year monitoring period. This goal pertains to those plants located in areas subject to out-of-channel flooding from seasonal habitat flows.

River Flow Volume Problems

Releasing a 24 hour 200 cfs peak flow from the Intake Control Station may only result in a corresponding 75 cfs peak flow reaching the Pumpback Station (Table 3). A large peak flow reduction occurs as the river flows from the Intake to the Pumpback Station.

Seasonal Habitat Flows released from the Intake Control Station lose effectiveness as the peak passes through downriver reaches. This decrease in effectiveness occurs because the peak flow has a short duration (24 hours) and results in a decrease in stream power as the river flows downstream. As a result, seasonal habitat flows have not been effective as the sole, or even major, action for improving water quality conditions and increasing riparian habitat diversity. As stated before, the reason is peak flow volume decreases as flow progresses downriver. This results in less inundation of floodplains and adjacent riparian habitats. Decreases also occur in river depths (Table 4) and stream power. River channel form causes some of the decrease in river depth and stream power must be compensated for by increasing down-river flow volume.

Table 5 shows the Lower Owens River after an 85 cfs flow augmentation released into the river at the Alabama Gates. This Alabama Gate augmentation flow was released to coincide with the arrival of the 200 cfs peak flow released earlier from the Intake Control Station.

As the results show, flow augmentation released only at the Alabama Gates does not compensate for the large peak flow loss occurring between the Intake Control Station and the Reinhackle Station. This river reach needs more study by the Scientific Team to determine how best to apply flow augmentations in this reach if it is determined that augmentation is justified. For example, channelizing flows from the Alabama Gates to the river below the Islands will result in higher flows passing through the reaches to the Pumpback Station (2010 to 2012 Adaptive Management Recommendations).

Justification

The MOU (1997) Action Plan and Concept Document calls for Lower Owens River flow augmentation when it can be justified. The Monitoring and Adaptive Management Plan also calls for river flow augmentation if needed. In their 2011 and 2012 Adaptive Management Recommendations, the MOU Consultants justified in detail the need to consider flow augmentation in lower river reaches. Some reasons discussed are to increase river power, increase flooded areas, and initiate and transport of suspended organic materials out of the system (County-City 2011 Annual Report). Flow augmentation would also provide higher down-river seasonal habitat flows that could increase seed fall survival rates.

In summary, flow augmentation released at key river sites will increase river depth, increase river power, increase seasonal habitat peak flows and increase pulse and flushing flows in downriver reaches. This will result in more floodplain inundation, more recharge of shallow water aquifers, move more muck, transport more sediments downriver, move colloidal and suspended materials out of the system, and possibly enhance riparian woody recruitment and survival.

Year	Intake Control Station	Above Pumpback Station
2009	110	69
2010	209	76
2011	205	78
2012	92	54
2013	58	43
2014	0	0

Table 3. Intake Control Station annual peak flow (cfs) releases and resulting peak flows arriving about a week later at the Pumpback Station.

River Location	Passing Peak Flow Volume	Depth Increase Over Previous Base Depth
Intake Control Station	200	4.4
Mazourka Station	125	1.8
Reinhackle Station	116	1.5
Keeler Station	76	1.2

Table 4. Increase in peak caused average river depth (ft.) from previous base flow depth as a 200 cfs peak flow released at the Intake Control Station passes by.

Location	Without Augmentation	With Augmentation
LAA Intake	200	200
Blackrock	190	190
Goose	180	180
Two Culverts	160	160
Mazurka	125	125
Reinhackle	116	116
Keeler	80	195
Pumpback	78	192

Table 5. Comparison of peak flows (cfs) passing by selected stations with and without flow augmentation from the Alabama Gates.

The four most important environmental benefits that may be gained are to improve water quality, establish more tree willow, increase bordering riparian habitat diversity, and better control tule-cattail distribution. Flow augmentation applied properly and at the right time may play an important part in buffering some of the Lower Owens River problems.

If the City's 2014 flow proposal (Also the MOU Consultants 2014 Adaptive Management Recommendation) is not accepted and implemented by the Parties or any other favorable flow pattern implemented, and flows continue to be dictated by the MOU (1997) and respective Stipulation and Orders, then there would be a definite need to augment flows in the middle and lower sections of the Lower Owens River. Otherwise flows will never be powerful enough to maintain a healthy river.

Recommendations

Recommendation 1 - The MOU Consultants are not recommending any additional flow augmentation for the Lower Owens River in 2015. The MOU Parties and LORP managers must first develop the capability of releasing more favorable flows and test these flows for effectiveness and improvement. Once this capability is gained, then flow augmentation can fine tune the process.

Recommendation 2 - The MOU Consultants recommend that the Scientific Team develop a flow augmentation management plan for the Lower Owens River. This plan should be able to adjust to whatever flow patterns the MOU Parties finally decide and implement for the Lower Owens River.

References

Ecosystem Sciences. 2013. Lower Owens River Project Adaptive Management Recommendations. Ecosystem Sciences, Boise, ID.

City-County. 2013. Annual Report. Prepared by Inyo County and the City of Los Angeles, Bishop, CA.

MOU. 1997. Memorandum of Understanding. County of Inyo and City of Los Angeles, CA. Bishop, CA.

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Delta Habitat Area - Managing Flows

Background

Many different flow patterns have been recommended for future management of the Lower Owens River over the past few years. Most of these flow recommendations, if implemented, could affect the flows being delivered to the Delta Habitat Area (DHA). Also, new flow recommendations for the DHA are now being considered to improve habitat conditions for LORP indicator species (House 2014). These flow patterns, if implemented in the DHA, are probably not compatible with needed future Lower Owens River flow changes because of flow diversion limitations at the Pumpback Station.

The MOU Consultants have discussed and proposed flow changes to the DHA over the past few years. The 2012 Adaptive Management Recommendations called for an analysis of proposals to gain benefits by adjusting future Lower Owens River flows. In the 2012 and 2013 Adaptive Management Recommendations it was recommended that three of the DHA habitat pulse flows be released at the Intake Control Station instead of the Pumpback Station. The implementation of these flows would have large effects on DHA stream flows. In 2014, the MOU Consultants again recommended that large flushing flows be released at the Intake Control Station that would put additional flows into the DHA. These flow strategies are in conflict with the present thinking to lessen DHA flow volumes during the warmer periods of the year. If improved flow management in the Lower Owens River and the DHA is to be successfully implemented, there must be some type of control on stream flow through the DHA.

Changes in DHA flow management to improve environmental conditions cannot take precedence over LORP goals and priorities. Especially if DHA flow changes interfere with the management of the Lower Owens River. Improving Lower Owens River environmental conditions must have high priority and not be constrained by downriver requirements. The needs of the Lower Owens River must be constantly considered as improved DHA flows are discussed, approved, and implemented.

Goals

The goal of the DHA is to maintain 755 acres of vegetated wetlands. The maintenance or enhancement of conditions to meet the needs of the DHA habitat indicator species is also part of this goal. Past releases of base and pulse habitat flows into the DHA by the City have resulted in the City meeting all MOU (1997) goals for the DHA to date. The Monitoring and Adaptive Management Plan (2008) and the MOU (1997) Action Plan call for Lower Owens River flow augmentation if LORP goals are not being met. The above goals conflict with each other as improving conditions in the Lower Owens River involves a flow regime that would increase flows into the DHA.

Problems

Delta Habitat Area: Proposals are presently being considered for improving DHA habitat conditions. These proposals are keyed towards improving conditions during seasonal periods used more heavily by habitat indicator species. Recent proposals call for improving habitat conditions by invoking hydrologic stress (mainly drought) on emergent vegetation (House 2014). Extreme drought conditions that would prevent further expansion of tules and cattails. Tule and cattail acreage has increased notably in the DHA since the inception of the LORP. While tules and cattails are wetland vegetation and have achieved the wetland acreage goal for the DHA, this large expansion of tules and cattails may not achieve the goal of creating or maintaining desirable diverse habitat for some DHA habitat indicator species (House 2014).

Lower Owens River: Biological Oxygen Demand (BOD) appears to be increasing in the Lower Owens River based on the decreasing trend over the past 7 years in dissolved oxygen (See the 2014 water quality adaptive management recommendation in this report). To date, low dissolved oxygen has not had a detectable impact on fish and other aquatic life when the Lower Owens River is at normal base flow during cold water conditions. This also applies, to some extent, to seasonal habitat flows released during cold river water conditions. BOD influences, however, are causing low dissolved oxygen and other stressful conditions from late spring through early fall. River BOD, dissolved oxygen, and other toxic conditions may worsen over time if corrective flow management actions are not taken. These flow corrections will probably not be compatible with improved DHA flows if some mechanism is not employed. Therefore, it is imperative that flows into the DHA be controlled.

Past and Present DHA Flow Management

Presently four seasonal habitat flows are released annually into the DHA (Table 6). The purpose of these flows is to ensure that adequate water and nutrients are available to support DHA resources.

The four habitat flows, in combination with base flows, produced large acreages of tules and cattails. These large acreages meet wetland goals, but are not the best flow pattern for developing and maintaining diverse habitat for some indicator species. Therefore, these flows as presently applied will probably be changed in the future. During the annual period that pulse habitat flows are not being released, required base flows are released (Table 7). Again, these base flows resulted in large acreages of tules and cattails, but may not be the best flow pattern for maintaining habitat for some indicator species. Therefore, base flow patterns will also likely be changed in the future. To accomplish this will require flow changes or control into and through the DHA.

Future DHA Proposed Flow Management

As previously covered, the City and the MOU Consultants are considering recommending different annual flow patterns that change existing stream flows into and through the DHA. These new flow patterns should produce more favorable conditions for DHA habitat indicator species by producing more open water and better controlling tule abundance and distribution. To implement these changes under existing flow constraints will require the DHA to control and manage its own stream flow.

Solutions

The Pumpback Station releases all flows going into and through the DHA. Once these flows are released from the Pumpback Station they free-flow all the way to the brine pool. Presently, no flow control facilities exist in the DHA. About 0.4 miles downstream of the Pumpback Station and prior to the divergence of the stream into two channels, an over-flow channel exists. This over-flow channel diverts high-flows to the west and into another basin (Figure 3).

The MOU Consultants believe that using this over-flow channel for water diversion and control purposes will allow managers to design and implement improved

Period	Dates	Flow and Duration	Purpose
1	March - April	25cfs for 10 days	Replenish water lenses
2	June - July	20cfs for 10 days	Meet high ET rates
3	September	25cfs for 10 days	Enhance migrant habitat
4	November - December	5cfs for 5 days	Benefit habitat and recharge groundwater lenses

Table 6. Annual Habitat flows to the DHA from the Pumpback Station, by date, time, and volume.

Date (Duration)	Flow (cfs)
October 1st to November 30th	4.0
December 1st to February 28th	3.0
March 1st to April 30th	4.0
May 1st to September 30th	7.5

Table 7. Required base flows for the DHA by seasonal time periods

flows for the DHA; flow management that will maintain better conditions for indicator species. Also, this flow control would allow needed flow management changes in the Lower Owens River to be implemented without affecting DHA resources.

Recommendations

Recommendation 1 - The MOU Consultants recommend that the City conduct a preliminary analysis that determines the feasibility and the cost to construct and operate a water control structure in the DHA stream channel. This structure would be located just below the west overflow channel. Excess water flow could then be diverted into the west over-flow channel. The structure would need to be designed to release the required flow into the DHA.

Recommendation 2 - The MOU Consultants recommend that the City evaluate the pros and cons of gaining additional wetlands and resulting wildlife in the west over-flow channel basin. This evaluation would also determine if this flow diversion would influence, if any, the operation of the Owens Lake Dust Control Project.

References

House, D. 2014. Lower Owens River – Delta Habitat Area proposed revised flow release schedule (Draft), October 14, 2014, Bishop, CA.

MOU. 1997. Memorandum of Understanding. County of Inyo and City of Los Angeles, CA. Bishop, CA.

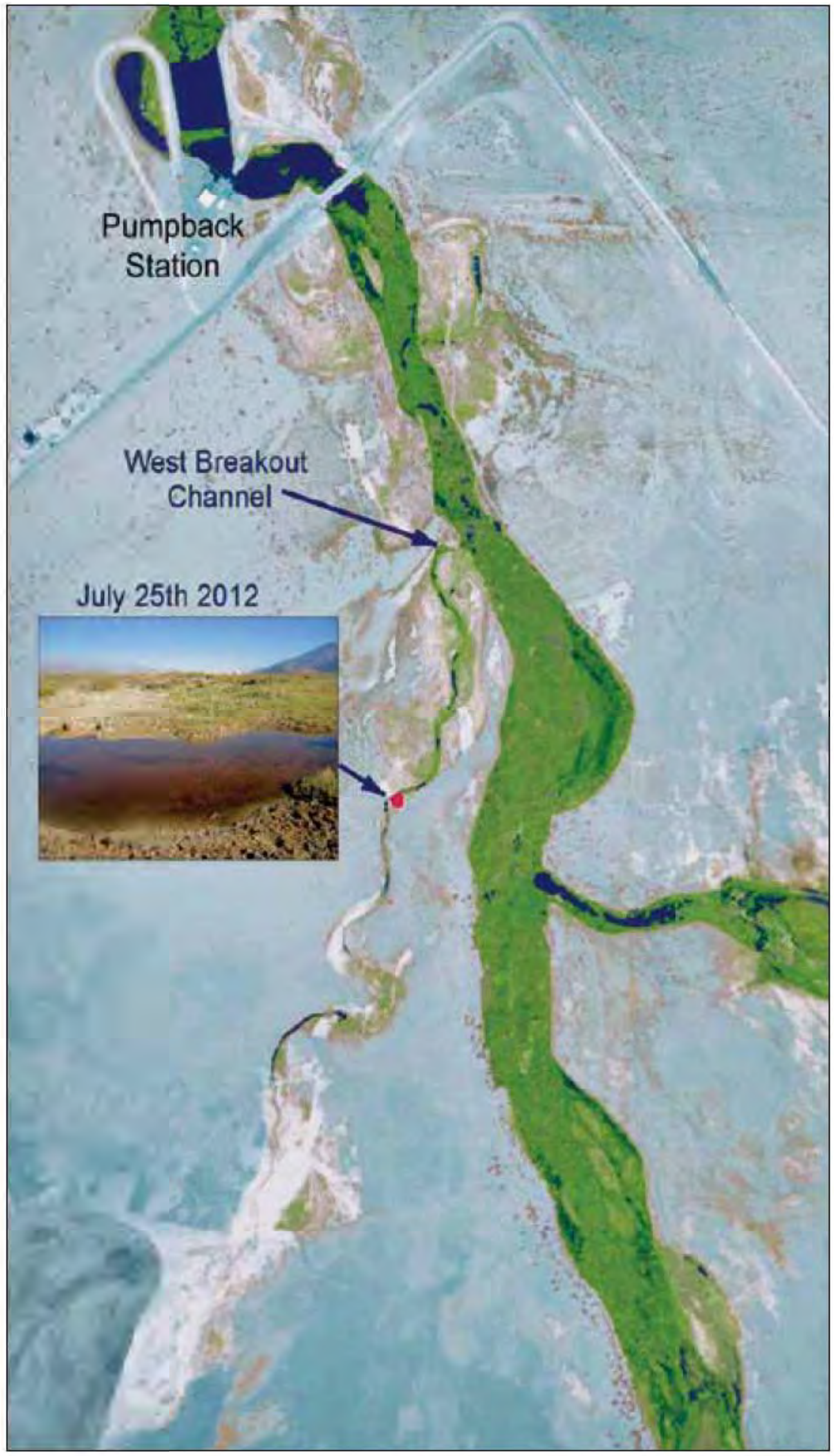

Figure 3. West Channel of the Delta Habitat Area

Delta Habitat Area - Flow Release Changes

Background

The MOU Consultants 2010 Adaptive Management Recommendations requested an environmental evaluation determining if benefits could be gained by changing a Lower Owens River flow point-of-release site as follows:

> *Prior to the Delta Habitat Area Period 1 habitat flow release scheduled for March-April, 2011, the City, the County, and the MOU Consultants analyze what benefits could be gained by changing the Delta Habitat Area (DHA) habitat flow point-of-flow-release-site from the Pumpback Station upstream to the Intake Control Station.*

In the 2012 and 2013 Adaptive Management Recommendations, the MOU Consultants recommended that three out of the four Delta Habitat Area (DHA) habitat flows be released from the Intake Control Station instead of the Pumpback Station. For more information on the justification, description and procedures and timing needed to gain environmental benefits refer to the 2010 through 2013 Adaptive Management Recommendations in the respective Annual Reports. These adaptive management recommendations provide information on how DHA habitat flows, presently released from the Pumpback Station, have the opportunity to improve water quality, aquatic habitat, and channel substrate conditions if released properly from the upstream Intake Control Station.

To date, few of the MOU Consultants Lower Owens River flow adaptive management recommendations have been implemented. As a result, needed changes in river flow management are in limbo and may remain in this status for a long time. Therefore, until time and understanding provides river flow solutions, releasing DHA habitat flows into the Lower Owens River at the Intake Control Station is one of the few ways progress can be made. Opportunity exists to improve river conditions and still be compatible with the needs of the DHA. If the Parties would eliminate all Pumpback Station restrictions, improving Lower Owens riverine-riparian conditions would be much easier because better flow management could be applied. Changing the present DHA flow requirements to allow for shorter flow duration flow periods to be applied would also make it more feasable for the City to manage river flows. To implement the MOU Consultants recommendations in this chapter will require modifying the DHA habitat flow release schedule.

Justification

During late fall, winter, and early spring, the downriver flow of the Lower Owens River is functioning in a near neutral "water loss" situation from river reach to river reach (Figure 4).

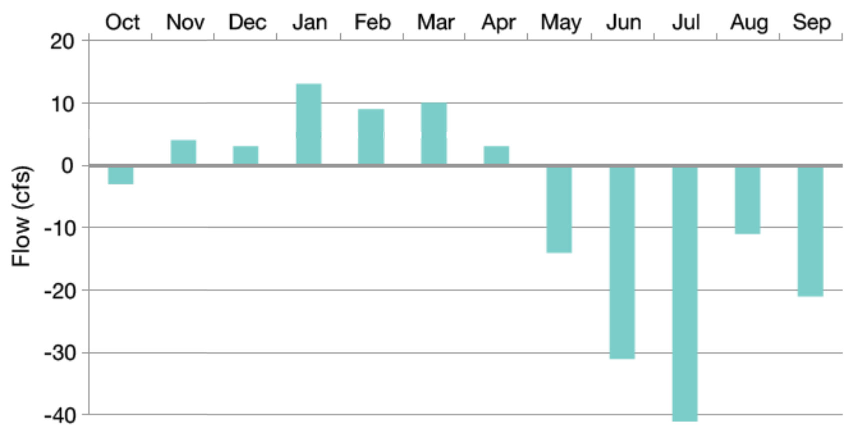

Figure 4. Lower Owens River flow gains and losses by month for water year 2013-2014.

Period	Date	Flow	Purpose
1	March-April	25 cfs for 10 days	Replenish water lenses
2	June-July	20 cfs for 10 days	Meet high ET rates
3	September	25 cfs for 10 days	Enhance migrant wildlife habitat
4	Nov-Dec	30 cfs for 5 days	Benefit habitat and recharge groundwater lenses

Table 8. Delta habitat flows scheduled for annual release by time, volume, and purpose (EIR 2008).

December through April are periods with low ET resulting in the river gaining water in the downstream direction from adjacent stored aquifers and other sources. Therefore, DHA habitat flows released at the Intake Control Station instead of the Pumpback Station during the periods recommended have little to no flow loss during these colder air and river water conditions. Therefore, DHA habitat flows released from the Intake Control Station could contribute dual environmental benefits (i.e., increase dissolved oxygen in the Lower Owens River and maintain DHA health) with little to no water loss. Dual environmental benefits could be gained by improving river health while still maintaining the DHA in a healthy condition.

Past DHA base and habitat flow releases have resulted in the City meeting all MOU (1997) goals for the DHA to date. Presently, fall-winter-spring required habitat flows (Periods 1, 3 and 4) released into the DHA are larger and of longer duration than is needed to maintain good winter conditions. This over-supply of water allows an opportunity to change the DHA habitat flow point-of-release without affecting DHA habitats. The MOU Consultants believe the DHA is receiving more water than needed during both the colder and warmer seasons of the year. Wetland DHA habitats are trending towards a more homogenous and unfavorable plant condition (House 2014). This unfavorable balance of wetland plant types and abundance, may not favor those habitat indicator species that need more diversity or more open water.

During the annual DHA habitat flow release Periods 1, 3 and 4, (October through mid-April) river dissolved oxygen levels do not significantly or knowingly impact fish and other aquatic life (Table 8). During these flow release periods the Lower Owens River is at required base flow. Therefore, during these three periods, there is a lower chance of increased fish kills than if flushing flows were released in summer or early fall. An important purpose for evaluating a change in a point-of-flow-release, is to determine if the present low dissolved oxygen levels can be improved.

Present Delta Habitat Area Flows

Presently four seasonal habitat flows are planned to be released into the DHA (Table 8). Flow requirements and the habitat purpose are described in the LORP-EIR (2004) in Section 2.4. Presently DHA habitat flows provides adequate wetland irrigation and nutrients to support required DHA habitats. The City has exceeded the required wetland acreages. Changing the flow release site must not interfere with the City's successes. The three proposed habitat flow releases from the Intake, will not interfere with the successes the City has already obtained in the DHA.

Past Delta Habitat Area Flows

Three DHA habitat flow releases at the Intake Control Station have recently been released (Tables 9 and 10). A lesson learned was that a small flushing flow increase over base flow results in very small and ineffective downriver flow increases. This resulting low river flow occurrs all the way from the Intake to the Pumpback Station. Another important finding was that the 2013 habitat pulse flow, released from the Intake, experienced insignificant downriver water loss. The most important lesson learned, however, is that if high flushing flows are not released from at the Intake Control Station, the flow volume necessary in downriver reaches to improve river habitat conditions will not be attained. Table 9 demonstrates that low flow releases produce even lower flows downriver.

Table 10 shows planned and unplanned DHA habitat flows released in 2013 and 2014. Again these habitat flows from the Intake Control Station (some were released to compensate for river water loss during summer-fall periods) provided insignificant downriver flow volume needed to benefit river conditions. During cold river conditions, the City did not release all recommended DHA flow pulses at the Intake Control Station. They released the required DHA habitat flows by reducing pump out volume. The City also used large unexpected winter river water gains, they had to bypass into the DHA, to substitute for the required DHA habitat flows.

Intake Station Flow Release	Respective Flow Arriving at Pump Back Station
59	53
64	56
63	58
66	59
66	59
63	59
66	60
65	59
63	58
63	56
51	54
45	53
46	51
46	52
Avg 59 cfs	56.2 cfs

Table 9. Daily average 2013 habitat flow (cfs) released from the Intake Control Station and the resulting flow arriving at the Pump Back Station.

As Table 10 shows, the City did not release all three MOU Consultants recommended annual DHA habitat flows from the Intake Control Station over the past two years. Required DHA habitat flows were released mainly from the Pumpback Station by reducing the amount of flow the Pumpback Station was pumping-out (See September 2013, April-May 2014, and July-August 2014). The August 2014 flow release is an example of unitneded river flows. These unintended flows more than made up for the respective, cancelled DHA habitat flows. During some periods, reduced ET rates in combination with large storm events produced an over-supply of downriver flow. The City had to pass this over-flow into the DHA because of pump-out restrictions. The DHA did not need this large volume of water.

The City plans to release the upcoming 2014 November-December and 2015 March-April DHA habitat flows from the Intake Control Station. This provides an opportunity to apply effective flows that can be evaluated. The City also is required to meet minimum base flows listed in Table 11. Thus, providing even more water than the DHA needs during certain periods of the year. The average flow into the DHA in water year 2013-2014 was 11.2 cfs. The average DHA total flow release requirement is only 6 to 9 cfs. The DHA needs less water from May 1 to September 30 to attempt to gain plant growth balance. The Period 3, 2014 September DHA habitat flow release was cancelled because large amounts of unexpected water spilled into the DHA in August (Table 10). The over-supply of water during certain periods is addressed in other adaptive management recommendations.

Date	Flow (cfs)
OCT 1 TO NOV 30	4.0
DEC 1 TO FEB 28	3.0
MAR 1 TO APR 30	4.0
MAY 1 TO SEP 30	7.5

Table 11. Required base flow minimums for the DHA by seasonal time periods

On March 14, 2013, the City increased the flow at the Intake Control Station from 45 cfs to 61 cfs for a 16 cfs flow increase. The required daily flow for Period 1 into the DHA is 25 cfs per day for 10 days. The base flow reaching the Pumpback Station was 48 cfs which was increased to a high of 59 cfs from the Intake Station flow release.

As shown in Table 12, although the 2014 August habitat flow was reduced, the additive spill flow into the DHA continued for a long period of time. The river was already flowing over the spill way into the DHA prior to the habitat flow release period because of high river "make" water. This resulted in a much larger volume of water flowing into the DHA than was released previously from the Intake Control Station.

Released DHA habitat flows at the Intake Control Station were lower than the required DHA 10 day habitat flow of 25 cfs and 30 cfs (Tables 12 and 13). The MOU Consultants are not concerned, at this time, with this decrease in the DHA pulse habitat flow applied by the City, because during those periods the

SEP 2013

Date	ICS	DHA	PO
12	67	7	42
13	67	19	28
14	66	25	24
15	66	25	23
16	67	25	23
17	67	25	22
18	67	25	21
19	67	25	20
20	67	25	20
21	67	25	19
22	66	25	20
23	61	13	33
24	57	7	37
25	60	13	22
26	61	8	35
27	64	8	36

JAN 2014

Date	ICS	DHA	PO
5	43	13	48
6	42	15	48
7	42	19	48
8	42	23	48
9	42	25	48
10	42	25	48
11	42	23	48
12	42	21	48
13	43	18	48
14	45	17	48
15	43	16	48
16	41	15	48
17	41	14	48
18	43	14	48
19	42	14	48
20	41	14	48

FEB-MAR 2014

Date	ICS	DHA	PO
28	43	20	48
Mar 1	42	11	32
2	42	20	47
3	41	15	47
4	41	16	47
5	42	16	47
6	42	15	48
7	41	15	48
8	42	14	48
9	43	15	48
10	45	15	48
11	43	16	48
12	42	16	48
13	43	16	48
14	43	15	48
15	43	14	48

APR-MAY 2014

Date	ICS	DHA	PO
19	43	4	48
20	43	20	29
21	44	20	29
22	42	25	23
23	40	25	22
24	42	25	22
25	42	25	22
26	42	25	22
27	42	25	23
28	42	25	23
29	42	25	22
30	41	11	34
1-MAY	42	7	45
2	43	8	41
3	43		41

JUL-AUG 2014

Date	ICS	DHA	PO
21	48	16	32
22	48	20	25
23	68	20	30
24	81	20	26
25	81	20	28
26	80	20	27
27	79	20	27
28	80	20	25
29	81	20	28
30	79	20	29
31	81	12	40
1-AUG	79	8	47
2	80	10	47
3	81	13	47
4	81	18	47
5	80	20	47

AUG 2014

Date	ICS	DHA	PO
4	81	18	47
5	80	20	47
6	81	22	46
7	81	27	47
8	80	31	47
9	81	36	47
10	80	40	47
11	81	33	43
12	80	29	46
13	79	17	46
14	80	17	46
15	79	16	46
16	81	17	46
17	80	36	46
18	79	34	46
19	80	32	45
20	81	35	46
21	79	33	46
22	80	29	47
23	79	23	47
24	81	17	47
25	81	19	47
26	72	17	47
27	67	14	47
28	68	15	46

Table 10. Intended and unintended pulse flows released into the Delta Habitat Area from the Pumpback Station compared to the influencing flow from the Intake Control Station (PO = Pump out, DHA = Delta Habitat Area, ICS = Intake Control Station)

DHA is receiving more water than needed to meet MOU (1997) requirements. The MOU Consultants are concerned, however, that the City is releasing low ineffective flushing flows to downstream river reaches and especially those downriver flushing flows reaching the Pumpback Station.

The Pumpback Station is limited by Stipulation and Order to pumping up to, but, no more than 50 cfs of the incoming river flow at any given time. This limitation makes it more difficult to apply viable DHA habitat flow releases at the Intake Control Station. Flows large enough in volume and duration to sufficiently benefit Lower Owens River environmental conditions are needed. Even under the present 50 cfs pump-out handicap, however, a better planned, implemented, and more effective series of DHA habitat flows can be released in 2015-16 from the Intake Control Station. These flows can then be evaluated to determine if they improve river conditions.

Releasing Higher Flows From the Intake Control Station

A 24 hour flow peak released from the Intake Control Station takes about 13 days to deliver a resulting peak flow at the Pumpback Station. A daily pulse block of water released from the Intake Control Station during cold river conditions decreases in the downstream direction. This results because of water column spreading, the large flow lag time, and other friction retarding influences which results in flow reductions as this block of water moves downstream. Over time, however, as the lag water catches up the gain-loss situation tends to equalize (Figure 4). A natural reduction in downriver block flow volume allows higher peak flows to be released from the Intake Control Station without sending more than the allotted flow into the DHA.

2013 Period 1 Habitat Flow			2014 Period 3 Habitat Flow			2013 Period 2 Habitat Flow		
Date	Released Habitat Flow	DHA RequiredFlow	Date	Released Habitat Flow	DHA RequiredFlow	Date	Released Habitat Flow	DHA RequiredFlow
27-Mar	5 (59)	25	6-Jan	15 (46)	7.5	22-Jul	20	7.5
28-Mar	8 (64)	25	7-Jan	19 (65)	7.5	23-Jul	26	20
29-Mar	10 (63)	25	8-Jan	23 (75)	30	24-Jul	20	20
30-Mar	11 (66)	25	9-Jan	25 (74)	30	25-Jul	20	20
31-Mar	11 (66)	25	10-Jan	25 (73)	30	26-Jul	24	20
1-Apr	11 (63)	25	11-Jan	23 (73)	30	27-Jul	36	20
2-Apr	12 (65)	25	12-Jan	21 (54)	30	28-Jul	44	20
3-Apr	11 (65)	25	13-Jan	18 (44)	7.5	29-Jul	45	20
4-Apr	10 (63)	25	14-Jan	17 (45)	7.5	30-Jul	39	20
5-Apr	8 (63)	25	15-Jan	16 (45)	7.5	31-Jul	28	20
6-Apr	6 (51)	4	16-Jan	15 (45)	7.5	1-Aug	24	20
7-Apr	5 (46)	4						
8-Apr	5 (46)	4						
9-Apr	5 (63)	4						
10-Apr	4	4						

Table 12. DHA habitat flows (cfs), by Period, released in 2013 and 2014.
( ) = respective flow release from the Intake Control Station.

Date 2013	Intake	Mazourka	Reinhackle	Above Pumpback	Delta Release
12-Mar	45	52	48	50	4
13-Mar	45	53	49	49	4
14-Mar	61	53	49	49	4
15-Mar	64	54	49	50	4
16-Mar	63	53	50	51	4
17-Mar	66	59	50	48	4
18-Mar	66	66	51	47	4
19-Mar	63	68	50	47	4
20-Mar	65	70	52	47	4
21-Mar	65	72	56	46	4
22-Mar	63	73	61	46	4
23-Mar	63	73	62	47	4
24-Mar	51	73	64	47	4
25-Mar	45	72	66	49	4
26-Mar	46	72	66	48	4
27-Mar	63	67	66	53	5
28-Mar	47	61	66	56	8
29-Mar	48	60	66	58	10
30-Mar	50	59	66	59	11
31-Mar	50	63	61	59	11
1-Apr	52	66	59	59	11
2-Apr	53	63	59	60	12
3-Apr	57	63	57	59	11
4-Apr	50	62	60	58	10
5-Apr	49	63	62	56	8
6-Apr	47	63	62	54	6
7-Apr	48	62	61	53	5
8-Apr	48	60	60	51	5
9-Apr	49	59	59	52	4
10-Apr	48	60	60	52	4
11-Apr	44	61	60	52	4
12-Apr	42	61	58	51	4
13-Apr	42	61	57	50	4
14-Apr	42	59	55	51	4
15-Apr	42	55	57	50	4
16-Apr	47	52	57	51	4
17-Apr	49	52	56	48	4
18-Apr	48	52	54	48	4
19-Apr	48	54	53	47	4
20-Apr	48	56	52	47	4
21-Apr	48	54	50	47	4
22-Apr	48	57	50	47	4

Table 13. Flows released at the Intake Control Station and resulting flows passing each stations in March-April 2013. DHA flows released for the 2013 Period 1 March-April are also presented.

During most seasonal periods, a 24 hour 86 cfs peak flow released at the Intake Control Station does not result in unallocated flow by-passing into the DHA. A yearly average of 7 cfs (11.2 cfs in 2014) is by-passed into the DHA to meet MOU (1997) and EIR (2004) requirements. Therefore, it would take a flow over 93 cfs before any additional unallocated flow is by-passed. A 10 day flow of 25 cfs is required to by-pass into the DHA during the March-April Period 1 habitat flow. This again increases the pulse flow that could be released from the Intake Control Station. This allows a pulse flow of 111 cfs before any by-pass flow exceeds required mandates during this period. A 111 cfs peak flow, however, is still not large enough to provide the needed benefits for the river to stay healthy. The above analysis does not include the augmentation water now available under the 2010 Stipulation and Order providing another 928 afy of augmentation water that can by-pass into the DHA.

As Table 14 demonstrates the MOU Consultants are recommending a double 157 cfs peak flow increase over base flow for DHA Period 1 as compared to the City's 21 cfs increase in 2013 and 0 flow increase in 2014. A double 200 cfs release peak flow is sufficient in size to monitor and evaluate and still allows the use of the 928 afy of water provided for in the 2010 Stipulation and Order if needed. This Addendum water cannot be used if the river flow resulting from the augmentation flows over 200 cfs. The following three recommended flow release patterns should be high enough in volume that monitoring and evaluation would be able to determine if the rivers' environmental health can be improved under this low of flow.

Suggested Flushing Flows - Period 1 DHA Habitat Flow (March-April)

The Period 1 March-April DHA habitat flow release calls for a daily 25 cfs flow over a 10 day period. This flow uses an additional 496 a/f of water. Waving the 25 cfs required daily 10 day flow allows 496 of water to be used to release higher river flows. This occurs

Flow Day	Proposed	City's 2013 Released Flow	City's 2014 Released Flow
1	43 (base)	45 (base)	43 (base)
2	43	59	43
3	43	64	44
4	43	63	42
5	100	66	40
6	200	66	42
7	200	63	42
8	100	65	42
9	43	65	42
10	43	63	42

Table 14. A comparison of the MOU Consultants proposed Period 1 (March-April) DHA habitat flow released from the Intake Control Station with the City's Period 1 released flows in 2013 and 2014.

by using the 496 af of water over a shorter duration period.

The required base flow during the March-April habitat flow Period 1 averages about 43 cfs. The Intake control Station proposed flushing flow covers 4 days using an additional 850 af of water. Over the 18 day flow period, 1,537 af is required to meet MOU (1997) base flow obligations. The Intake Control Station flushing flow adds 850 af of water for a total of 2,387 af (includes future lag water) over the 18 day period. Over the delayed corresponding 18 day period, the flow arriving at the Pumpback Station is 2,387 af with 716 af of water by-passing into the DHA. Of this 716 af of water, 560 af are required to be discharged into the DHA, this leaves 220 af of unallocated water required to make this flushing flow possible.

Suggested Flushing Flows - Period 3 DHA (September-October) Habitat Flow Release

The required base flow release during the September-October Period 3 averages about 58 cfs. The example flushing flow at the Intake Control Station covers 3 days using an additional 332 af of water. Over the 18 day flow period, 2,037 af is required to meet MOU (1997) obligations. The Intake Control Station flushing flow adds 332 af of water for a total of 2,223 af. Over the corresponding 18 day period the flow arriving at the Pumpback Station is 2,150 af with 467 af of this water by-passing into the DHA. Of this arriving 2,150 af of water, 560 af are required to be discharged into the DHA, leaving a water savings of 93 af.

Suggested Flushing Flows - Period 4 (November-December) DHA Habitat Flushing Flow Release From the Intake Control Station

The required base flow during the Period 4 (November-December) flow period averages about 45 cfs. The proposed flushing flow covers 1 day using an additional 312 af of water. Over the 18 day flow period, 386 af is required to meet MOU (1997) obligations. The Intake Control Station flushing flow adds 312 af of water for a total of 1,916 af. Over the corresponding 18 day period, the flow arriving at the Pumpback Station is 2,186 af with 233 af of water by-passing into the DHA. 386 af are required to be discharged into the DHA, leaving 53 af of water savings over allocated. 168 af of flow passing into the DHA results from the City's difficulty in accounting for "make" water during this flow period. This water does not count in the water allocation and as experience will allow the City to more closely manage flow in the future. Therefore, only 233 af of water passing the into the DHA can be allocated to this 1 day flushing flow release at the Intake Control Station.

To successfully release the three DHA habitat flushing flows from the Intake Control Station would only result in a loss to the City of 84 af of water. This 84 af of water can be taken out of the available 928 af of augmentation water available for this purpose by Stipulation and Order.

Flow Day ICS	Required ICS Base Pulse Flow	Required DHA Pulse Flow	Proposed ICS Flow	Flow Day PBS	PBS Arrival Flow	Additional bypass DHA
1	43	4	43	14	43	0
2	43	4	43	15	43	0
3	43	4	43	16	43	0
4	43	4	43	17	43	0
5	43	25	100 (113)	18	50 (14)	0
6	43	25	200 (312)	19	85 (83)	30 (60)
7	43	25	200 (312)	20	145 (203)	95 (189)
8	43	25	100 (113)	21	145 (203)	95 (189)
9	43	25	43	22	100 (113)	50 (99)
10	43	25	43	23	90 (93)	40 (79)
11	43	25	43	24	80 (73)	30 (60)
12	43	25	43	25	65 (49)	15 (30)
13	43	25	43	26	55 (24)	5 (10)
Acre Feet	1,537	560	2,387		2,387	716
Added pulse flow (af)		496	850		850	716

■ Table 15. An Intake Control Station flushing flow (cfs) example for Period 1 (March-April) DHA habitat flow with additional flow passing into the DHA recorded. ( ) = added volume in acre feet. Intake Control Station - ICS

Flow Day ICS	Required ICS Base Pulse Flow	Required DHA Pulse Flow	Proposed ICS Flow	Flow Day PBS	PBS Arrival Flow	Additional bypass DHA
1	58	4	58	14	46	0
2	58	4	58	15	46	0
3	58	4	58	16	46	0
4	58	4	58	17	46	0
5	58	25	100 (83)	18	60 (119)	10 (20)
6	58	25	200 (166)	19	150 (298)	100 (199)
7	58	25	100 (83)	20	125 (248)	75 (149)
8	58	25	58	21	100 (199)	50 (99)
9	58	25	58	22	50 (99)	0
10	58	25	58	23	46	0
11	58	25	58	24	46	0
12	58	25	58	25	46	0
13	48	25	58	26	46	0
14	48	25	58	27	46	0
15	58	4	58	28	46	0
16	58	4	58	29	46	0
17	58	4	58	30	46	0
18	58	4	58	31	43	0
Acre Feet	2,073	560	2,223		2,150	467
Added pulse flow (af)		496	332			467

■ Table 16. An Intake Control Station flow (cfs) release example for Period 3 (September-add October) DHA habitat flow with additional flow passing into the DHA recorded. ( ) = added volume in acre feet

Flow Day ICS	Required ICS Base Pulse Flow	Required DHA Pulse Flow	Proposed ICS Flow	Flow Day PBS	PBS Arrival Flow	Additional bypass DHA
1	45	4	45	14	56	0
2	45	4	45	15	56	0
3	45	4	45	16	56	0
4	45	4	45	17	56	0
5	45	4	45	18	56	0
6	45	30	200 (312)	19	56	0
7	45	30	45	20	100 (199)	50 (99)
8	45	30	45	21	90 (179)	40 (80)
9	45	30	45	22	70 (139)	20 (40)
10	45	30	45	23	57 (113)	7 (14)
11	45	4	45	24	56	0
12	45	3	45	25	50	0
13	45	3	45	26	56	0
14	45	3	45	27	56	0
15	45	3	45	28	56	0
16	45	3	45	29	56	0
17	45	3	45	30	56	0
18	45	3	45	31	56	0
Acre Feet	1,608	386	1,916		2,186	401
Added pulse flow (af)		298	312		630	233

■ Table 17. An Intake Control Station flow (cfs) release example for Period 4 (November-December) DHA habitat flow. ( ) = added volume in acre feet. ICS = Intake Control Station.

Period	Water Volume Required to Flow into the DHA	Water Volume used in the Intake Control Flushing Flow	Water Volume over Allotted Flow Prescriptions	Water Volume less than Allotted by Prescriptions
1	560	716	220	0
2	560	467	0	93
3	386	233	0	146
			Water Used over Allocated = 84 af	

■ Table 18. Water volume required for each DHA habitat flow compared with water volume required to release 3 flushing flows from the Intake Control Station.

Recommendations

Recommendation 1 - The MOU Consultants recommend implementing and evaluating three DHA habitat flows (Periods 1, 3, and 4) released from the Intake Control Station over a two year period (2015-2016). Results should help determine if Lower Owens River water quality and other environmental conditions can be improved via flow management. Results will also allow better predictions of how these flows pass downriver and when and how much of the flushing flows arrive in downriver reaches. The three DHA habitat flow periods recommended for release at the Intake Control Station are Period 1 (March-April), Period 3 (September and October), and Period 4 (November-December).

Recommendation 2 - The MOU Consultants recommend that during the winter of 2015, the Scientific Team review the MOU Consultants DHA three flushing flow examples presented in this report. The Scientific Team would then improve upon and refine the MOU Consultants flow release examples and present their final flushing flow recommendation to the Technical Group for early spring action.

Recommendation 3 - The MOU Consultants recommend that the Scientific Team develop a monitoring program to evaluate the effectiveness of the flow releases and their ability to buffer river limiting factors. The Scientific Team would then send the monitoring and evaluation package to the Technical Group for action.

Recommendation 4 - The MOU Consultants recommend that the County and the City eliminate the present programmed habitat flow release schedule into the DHA. The County and City would then instruct the Scientific Team to develop a new flow release program for the DHA. A flow pattern that that is compatible with flow needs of the Lower Owens River while still maintaining healthy DHA habitats meeting all MOU (1997) goals.

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Water Quality

Discussion of Main Findings

Lower Owens River base flows required under the LORP were initiated in December 2006. A base flow of at least 40 cfs was mandated throughout all reaches of the river. Therefore, the river over the past 8 years has functioned under steady-state conditions 11.5 months out of the year and even longer in drought years. This has resulted in the river being managed much like a canal.

Each year, large amounts of organic debris and other materials enter the river. This organic load and the resulting muck must be continually processed and eliminated annually from the river. If this annual process is not completed and eliminated, the river will continue on its path toward eutrophication.

The base and pulse flows applied over the past 8 years, if continued, cannot keep deteriorating water quality conditions from happening. Present base flow restrictions must be eliminated and new requirements developed in order to solve current water quality problems.

In 2010, the Lower Owens River experienced an observed large scale detrimental water quality event. These conditions were so severe that it stressed the warm water fishery and other aquatic animals to a critical point. Over the past few years, the river experienced very low dissolved oxygen conditions during late spring, summer, and early fall; this should have been viewed with concern and due attention. Three years later (2013), when a small augmentation flow was released during the summer into the Lower Owens River, aquatic conditions become so harsh that large fish kills resulted. These underlying conditions that caused this fish kill are indicators of worsening conditions and potential catastrophic fish kills. This experience alone justifies immediate changes in flow management and a high priority need.

Allocated water, already available under MOU (1997) and EIR (2004) guidelines and Court Orders, can be used to improve water quality conditions and help prevent fish kills. Changes made to the MOU (1997) and the FEIR (2004) and Stipulation and Order guidelines can help prevent these fish kills in the future, and ameliorate water quality conditions.

Conditions and Issues

LORP Technical Memorandum #7 and the Final Environmental Impact Statement both concluded that the 40 cfs base flow and seasonal habitat flows could degrade water quality and adversely affect fish due to the depletion of oxygen and the possible increase in hydrogen sulfide and ammonia. LORP's exemption from the Lahontan Regional Water Quality Basin Plan expires July 14, 2015. The Lahontan Regional Water Quality Basin Plan was amended in 2005 such that dissolved oxygen (DO) objectives for the LORP include a 30-day mean of 5.5 mg/l, 7-day mean of 4.0 mg/l, and 1-day minimum of 3.0 mg/l (Alternative DO criteria is percent saturation shall not be depressed by more than 10 percent, nor shall the minimum DO concentration be less than 80% of saturation). As noted in the FEIR, DO levels at or below 1.0 mg/l are lethal to fish. Long-term data shows that on numerous occasions since 1989 DO levels have dropped well below the minimum standards resulting in fish kills as well as the death of other aquatic animals (Jackson, 2014). DO levels well below the Basin Plan criteria of 3.0 mg/l are common in summer months.

Initial planning for the project as well as the FEIR was most concerned with DO as the limiting chemical parameter. Jackson (2014) reported that in-situ DO concentration is the constituent making up the majority of the LORP water quality data, which, as he points out, is essential to maintain aerobic conditions in surface water and is a key indicator of the ability of surface water to support aquatic life.

LADWP has conducted long-term water quality monitoring from January 2007 to April 2013 (Clayton Yoshida, Environment and Efficiency, LADWP, Los Angeles). Sampling stations included the crossing at Mazourka Canyon Road, Lone Pine Station Road, Keeler Bridge, and the Pump Station Forebay. Figure 5 exhibits dissolved oxygen data taken for all these years. We performed regression analysis on the data to illustrate the change over time and by river reach. A more detailed look at the data shows, as one might expect, high levels, near super saturation, in most winter months but extremely low concentrations in summer months, particularly in June and July. Filtering out periods of low levels of DO from the data set show that in the summer months the average DO at Mazourka Canyon Road was 2.3 mg/l; 2.0 mg/l at Lone Pine Station Road; 2.2 mg/l at Keeler Bridge ; and 2.3 mg/l at the Pump Station Forebay. All of these DO measurements are well below basin water quality criteria. Fish kills occur when DO drops below the lethal threshold of 1.0 mg/l, which has occurred at various times in the river.

Either lentic or lotic ecosystems that function at the edge of suitable water quality conditions are destined to fail from time to time because the margin of safety is too narrow to accommodate sudden change (Hynes, 1979). Allowing the Lower Owens River to function at the very edge of acceptable DO levels runs the risk of not only future fish kills, but a constant drumbeat of poor oxygen conditions that impacts the entire aquatic ecosystem and food web. First, understanding how DO functions in the Lower Owens River is critical to finding solutions.

Most streams exhibit a diurnal variation in oxygen content. The solubility of the gas varies inversely with the temperature, and this would lead to low values (in terms of concentration but not, of course, in percent saturation) in the daytime and higher values at night; but the daily variation is more usually in the other direction - high in the daytime, usually highest in the afternoon, and lowest at night, shortly before dawn (Hill, 1993). It is, therefore, clearly related to photosynthesis and to respiration.

In narrow, sluggish streams, low levels of oxygen will occur at night not only because of respiration by phytoplankton and rooted plants, but also because of oxygen demand in the bottom sediments (Hynes, 1979). The oxygen demand of silt and muck in the bed of sluggish rivers like the Lower Owens can be quite considerable. So, in the case of the Lower

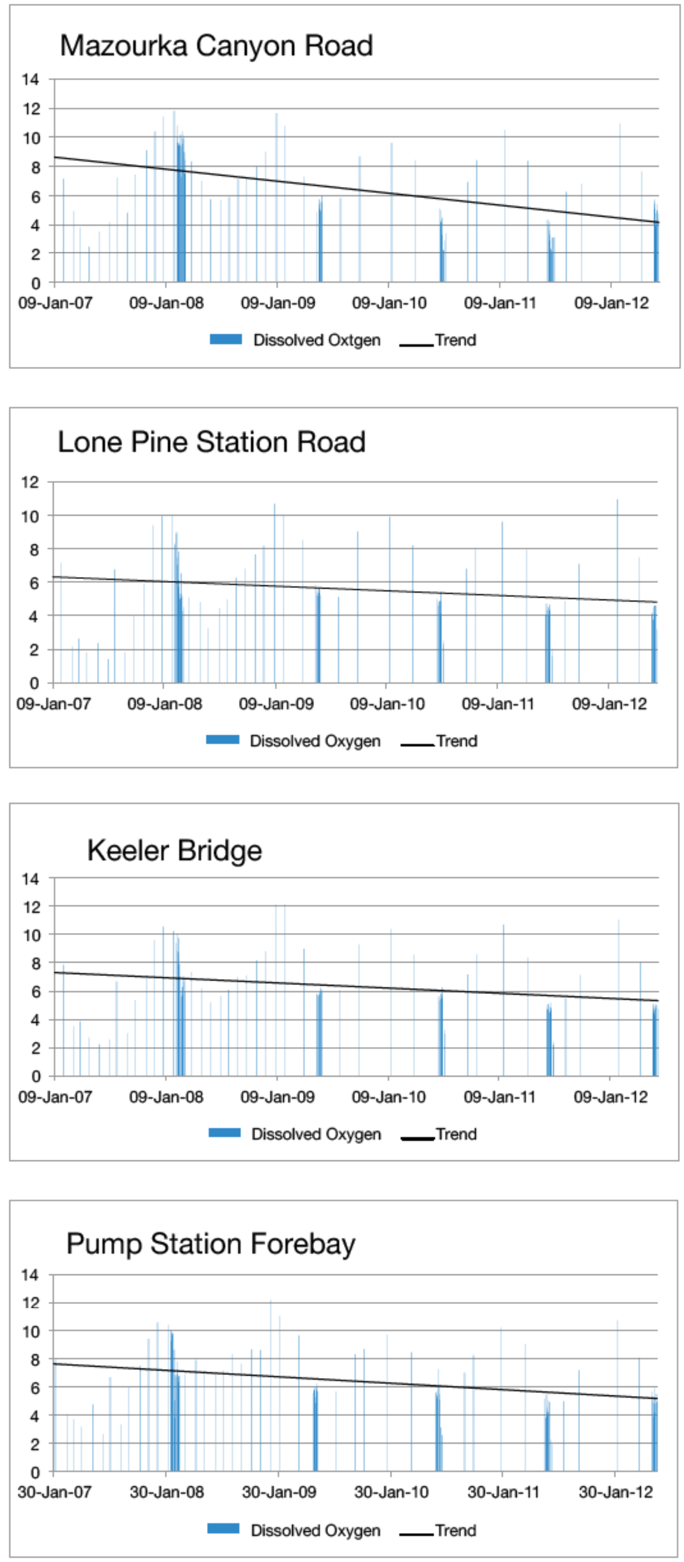

Figure 5. DIssolved Oxygen in the LORP.
Data collection taken by LADWP for long-term water quality monitoring from January 2007 to April 2013 indicating diminishing DO levels over time

Owens, respiration by phytoplankton and tules, combined with lack of photosynthesizing benthic vegetation, and oxygen demand from silt and organic sediments result in low oxygen levels. Aquatic plants, particularly macrophytes , have a higher rate of oxygen consumption than algae, animals, or bacteria because their biomass is usually greater (Hynes 1979, Swingle 1968).

The amount of DO consumed at night is extremely important to fisheries because survival, growth, and reproduction may be impacted if the total daily oxygen demand exceeds oxygen production (Boyd, 1971). Weithman and Haas (1984) studied the effects of DO depletion on fish in Lake Taneycomo, Missouri. A decrease of 1 mg/l DO (between concentrations of 6.l and 2.4 mg/l) reduced catch rates by 0.1 fish/hour. Coble (1982) demonstrated that the number of fish and the percentage of sport fish species were highest at sites in the Wisconsin River when DO exceeded 5 mg/l. It is the results of these classic research studies and others that form the basis for LRWQCB Basin Plan DO criteria of a 30-day mean of 5.5 mg/l and a minimum of 3.0 mg/l.

The oxygen demand from dissolved and particulate organic carbon accounts in large measure for oxygen concentrations of less than 100 percent saturation (Davis, et al., 1979). Clearly then dissolved organic carbon (DOC) and particulate organic carbon (POC) are important components that impact dissolved oxygen in the Lower Owens River at times. When plant cells (photosynthetic material) die, the cells release organic acids, complex carbohydrates, sugars, amino acids, peptides, enzymes, proteins, sugars, pigments, even bacteria and viruses into the water; this is called autolysis (Wetzel, 1975). Decomposition of all this organic matter is transformed into DOC as well as POC, which collectively are key consumers of oxygen. Combined, this is TOC or total organic carbon.

Larsen (2014) suggested that the mobilization of organic carbon into the water column, where it can be decomposed aerobically, or mobilization of nutrients that trigger the production and subsequent decomposition of algal material, are the primary events that trigger organic matter respiration. The optimal flow management strategy to avoid excess nutrient mobilization may differ from that to avoid excess carbon mobilization. Water quality data from 2007-2013 indicates orthophosphate averages 0.15 mg/l and nitrogen as nitrate averages 0.24 mg/l. Basin water quality objectives for orthophosphate ranges from 0.32 to 0.56 mg/l, and nitrogen as nitrate ranges from 0.9 to 1.5 mg/l. This would imply that nutrient loading is currently not a trigger.

There are two sources of carbon in the LORP; allochtonous and authochtonous. Allochtonous sources are terrestrial carried by over land flow into the stream and include organic material such as vegetation and cattle waste. LORP management includes grazing strategies that limit cattle grazing near the stream and promotes effective vegetation buffers with short duration-low intensity grazing (OVLMP, 2008); while the biomass of tules is extreme by comparison (a good comparison is in the Middle Owens River where these are more irrigated pastures hence greater chance of organic loading from cattle waste, but in fact water quality is not an issue. (Personal communication, John Hays, LADWP range conservationist)). Consequently, the amount of allochtonous generated organic material is small compared to the authochtonous sources.

The authochtonous carbon sources come from within the river and adjacent floodplains supporting tules. Tules are the dominant and densest vegetation and along with leaf litter, this is the greatest carbon source. DOC and POC result from the decay of autochthonous organic material. This material combined with sediments is deposited on the bottom as silt, muck and flocculants. Some material, particularly flocculants, is re-suspended at higher flows and microbial respiration in the aerobic water column accounts for additional oxygen demand (Larsen, 2014).

River "flushing" occurs with high spring flows generated by snow-melt; essentially nature's way of removing accumulated material. Flushing flows (Hynes, 1979) occur at different magnitudes and duration each water year. In regulated streams like the Lower Owens the goal is to use flushing flows that emulate natural stream flows to transport sediments and flocculants downstream or vortices this material on stream banks (MOU, Appendix A). CDFW attributed the substantial 1989 fish kill to DO levels as low as 0.2mg/l caused by disturbance of accumulated organic material and the lack of flushing flows (Jackson, 2014). Early studies reported high loadings of "muck" from Mazourka Canyon Road to the Pumpback in the range of 1,100 to 21,000 mg/kg with a mean BOD value of 6,910 mg/kg (Groenveld, 1988 per Jackson, 2014). More accurate cross-sectional data indicated a total estimated 123,100 cubic yards in this lower reach of the river (Groenoveld, 1988 per Jackson, 2014).

The question of how much stream flow is required to transport organic material out of the Lower Owens River and improve DO, especially during summer daylight, is unknown. However, the recommendation to initiate a two-year study of a dual-peak flow regime with appropriate monitoring is the first step toward understanding how best to flush the river and improve DO conditions.

Several ideas of how to better understand the link between suspension of fine sediment, carbon and drops in DO, and the potential for fish kills were discussed at the LORP River Summit. If the flow regime is allowed to be modified for a two-year experiment, as the MOU Consultants recommended, this presents the opportunity for the type of monitoring that would give us a better understanding of how river flows affect DO. We do know from water quality data DO remains high, at or near saturation, in late winter and early spring and that seasonal habitat flow releases in 2009, 2012, and 2013 did not cause fish kills from low DO because releases occurred when water temperatures were cool, and/or flow releases were small. However, we do not know with certainty what is the optimum flow periodicity, magnitude, and duration to achieve flushing of organic material, stimulate riparian vegetation growth, and avoid stressing or killing fish and aquatic organisms.

Without such knowledge, we can only warn that more fish kills, of varying magnitudes, will occur in the LORP. Every fish kill represents a setback in establishing a healthy fishery as required in the MOU. Continued poor water quality with DO levels generally below the basin standards diminishes the health of fish, which will be seen in time as a lower catch rate, smaller fish, more diseased fish and overall lowered condition factor. It must also be understood that poor water quality conditions reverberate through the aquatic food chain. Macroinvertebrates (insects), crayfish, amphibians, etc. all suffer in stream conditions like the Lower Owens in summer.

Recommendations

Recommendation 1 - The River Summit focused on water quality and the need for different flow management to reduce the threat of fish kills and, hopefully, reach compliance with LRWQCB standards. Our recommendations remain the same as in previous years to modify or remove the Stipulation and Order that codifies a 40 cfs base flow and the MOU language that limits the pumpback station to 50 cfs. The section in this chapter on flow management describes in detail the experiment needed to test a dual flow release (late winter and early spring), lift the restrictions on pumpback capacity, and modify base flows.

Recommendation 2 - Water quality monitoring during a two-year flow experiment was discussed at the River Summit. LADWP (David Livingston, draft concept paper for evaluating flushing flows on organic material in the Lower Owens River) suggested multi-site sampling of dissolved oxygen, changes in organic material storage following flushing flows, transport rates of organic material during flushing flows, and identifying organic versus non-organic composition of transported material. The details of water quality monitoring will be elucidated in the event a two-year experimental flow program is approved by MOU Parties.

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Fisheries

Creel Census

Between July 22 and July 25, 2013, in response to a sudden and extreme storm event throughout the Owens Valley as well as aqueduct construction, water was diverted out of the Alabama Gates to the Lower Owens River. The diversion reached a peak of 111 cfs. Water flowed in a laminar fashion across soils before reaching the river, which decreased oxygen. The water reaching the river at and below the Islands area was deoxygenated and combined with warm, low-dissolved oxygen, typical of the river in July, caused a significant fish kill downriver.

The size or number of fish killed at that time could only be estimated. An unscheduled creel census was performed in May 2014 to better assess the consequences of the fish kill, residual effect on the fishery, and change in the abundance and distribution of fish compared to 2013. Results indicate that both catch rate and numbers of fish did not change materially. From which it is concluded that the fish kill was small in comparison to the total fish population in each area of the river.

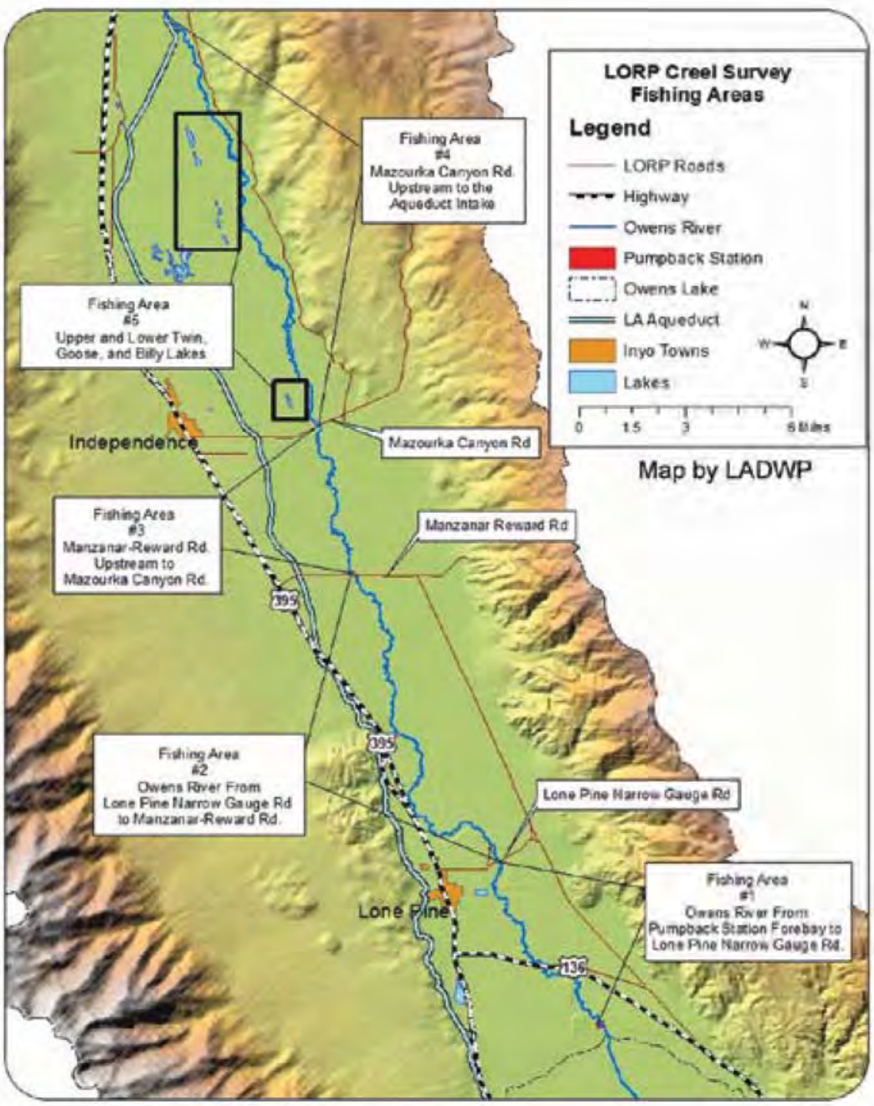

Figure 6. Creel Census, Fishing Areas Map.
Map by LADWP.

The principle "kill zone" was in Area 2 (Figure 6) from the end of the Islands five miles downstream to Lone Pine Narrow Gage Road where dissolved oxygen was lowest. As noted in the annual report (Morgan, 2014) approximately 400 to 500 dead bass were observed in the forebay of the pumpback station and probably more upstream were captured in tules during downstream drift. How many fish died in the forebay or in Area 1 because of low DO also cannot be estimated, but dissolved oxygen undoubtedly improved below the initial kill zone.

A more in depth analysis of changes in abundance and distribution of fish can be seen from the 2013 and 2014 creel census data of the number of fish observed in areas. Observation data is qualitative data. Qualitative data is a valid way of "discerning, examining, comparing, and contrasting, and interpreting meaningful patterns and themes" (National Science Foundation 1997). The interesting thing about the observational data collected during the creel census is the extreme difference between census areas. This is particularly interesting in view of the minuscule differences between the number of fish caught and the catch per unit effort.

A number of studies show that fish evacuate an area in response to sudden water quality changes such as loss of oxygen, temperature change or pollution (Coutant 1985, Nolan et al. 2009, Dauble et al. 1985). Fish rapidly move up or downstream to avoid lethal areas, generally downstream is the fastest and most often used evacuation route. Fish will also return to the affected areas in time providing the conditions that caused evacuation ameliorate quickly (Schaffler et al. 2002, and Olmstead et al. 1974) . This means that slow recovery of dissolved oxygen in the kill zone of Area 2 will slow the return of fish to the areas they were displaced from.

Figure 7 illustrates the displacement of fish from Area 2 to Areas 1 and 3 as the percent change in observed abundance. Fish moved from Area 2 downstream to Area 1 and to a lesser degree upstream to Area 3. There are limits to interpreting these data because of "noise" in the methodology itself, unqualified observers failing to estimate the magnitude of the kill, lack of similar data from census years prior to 2013, even weather plays a factor, thus we cannot estimate the number of fish killed.

The conclusions which can be made are:

- The number of fish observed was higher in Area 1 in 2014 than in 2013.
- The number of fish observed was lower in Area 2 in in 2014 than in 2013.
- The number of fish observed was higher in Area 3 in 2014 than in 2013.

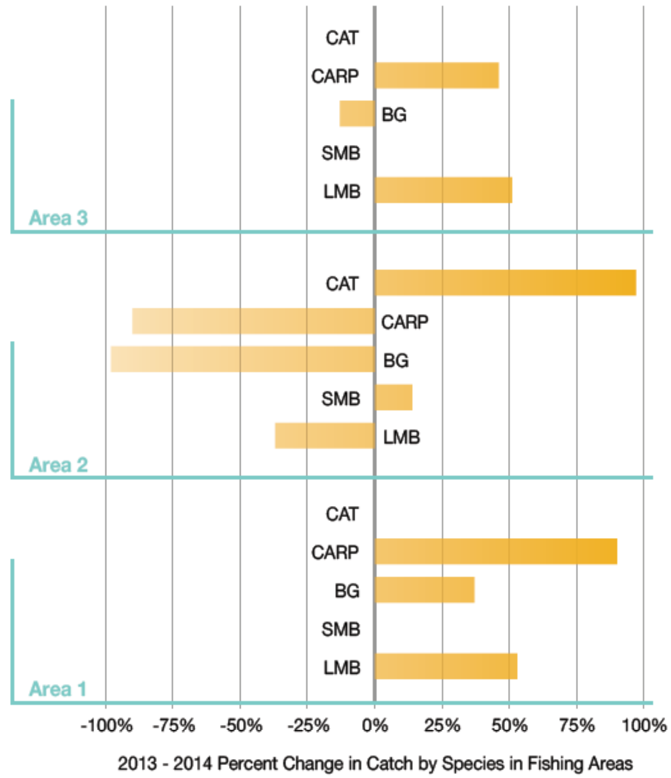

Figure 7. Percent Change in Catch from 2013 to 2014 by Species within Fishing Areas 1, 2, 3. Data from ICWD and LADWP based on Creel Census conducted in 2013 and 2014.

Recommendation

Recommendation 1 - One question to be answered with the next creel census scheduled for 2015 is whether fish have repopulated Area 2 by emigration from Area 1 and/or Area 3. As suggested by Morgan (2014), this next census should be conducted in the same manner as with past surveys to obtain a uniform data set.

Recommendation 2 - It is also recommended that the same anglers fish in Areas 1, 2, and 3 because the reliability of observational data is improved when the individuals making the observations are the same (NSF, 1997).

Fish Corridor / Goose Lake Connection

When LORP was initiated in 2006, start-up plans included building a corridor from below the Grass-Goose Lake complex to the upper reach of the river at the old East of Goose Lake measuring station. The purpose of the corridor was to allow migration of fish from the off-channel lakes into the river as a way to naturally introduce warmwater game fish acclimatized to the local ecosystem. The corridor is approximately one-half mile long and conveys about 1 cfs continually. Since construction the corridor is mowed frequently to maintain its ability to hold water. Currently the banks are in unstable condition and the frequent mowing and other maintenance is a source of warm water and sediment input to the river.

The corridor has served its original purpose as a fish conduit. Warmwater game fish from the lakes have adequately populated the river and it is unlikely that fish use the corridor to move from the river to the lakes because of a lack of shading, temperature, and sediment movement.

Recommendation

The corridor is neither useful as a fish conveyance nor as a water conveyance. The corridor should be discontinued and water shutoff.

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Blackrock Waterfowl Management Area

There have been no known changes at the Blackrock Waterfowl Management Area (BWMA) over the past year. To this point, no monitoring data as to flooded extent or open water has been reported. LADWP intends to develop a plan for cycling and improving habitat and submit that to the Scientific Team and to the adaptive management process. LADWP has not completed this plan in time for this report; therefore, the discussion and recommendations below are essentially the same as those made in 2013, with a few updates and modifications.

Background

As in past years, due to the run-off year and the Annual Report timing, it is difficult to make full recommendations for the BWMA until the runoff forecast is available on April 1. Recommendations made below are based on the current available information and should be updated when the run-off forecast is available and the target number of acres is known.

It is likely that the Drew unit currently provides adequate wetted acreage to meet the requirements for this year. If the forecast is similar next year, it may be able to meet requirements over the next run-off year as well. However, there is no current information on the status of the Drew unit's wetted acreage or ratio of open water to marsh vegetation. The Drew unit has supplied sufficient habitat acreage for a number of seasons. The percentage of open water to marsh vegetation would provide managers with valuable information as to the current utility of the habitat in the Drew unit. On-the-ground observations are of little use in making an accurate determination. High resolution imagery or photographs from the FLIR-equipped LADWP helicopter would provide high quality imagery that would enable managers to determine with greater accuracy the ratio of open water to marsh.

In the absence of this information, Ecosystem Sciences acquired Landsat-8 satellite imagery (15M resolution) and utilized the near-infrared band to map the open water in the Drew unit from an image taken June 14, 2013. Using remote sensing software and professional judgment, the analysis identified 122 acres of open water in the Drew unit. Based on the 278 acre wetted area reported by DWP for June 3rd, 2013 mapping (LORP Annual Report 2013), the 2013 wetted area was approximately 44% open water. In 2014, Ecosystem Sciences examined 2014 aerial imagery and determined that 2014 conditions are generally similar to 2013 conditions. The Drew unit still contains large areas of open water, a matrix of marsh vegetation and islands.

The BWMA was designed to utilize wetting and drying cycles to meet annual acreage requirements, as determined by the Standing Committee, as well as to create habitat for LORP indicator species. The MAMP established the criteria of roughly 50% open water and vegetation as the point to drain one wetland cell and flood another. Based on species observations the habitat in Drew is valuable. However, based on the data available, and in the absence of an alternate plan, the current management guidelines indicate it is time to drain the Drew unit and begin a new cycle at either the Winterton or Waggoner unit.

The wetting and flooding schedule has been modified through the flexibility of adaptive management. For example, the Drew unit has provided high quality habitat for indicator species as well as meeting requirements for wetted area for several years even though the 50% standard was not used to guide decision making and the MAMP schedule was modified. If monitoring data indicate that high quality habitat with sufficient open water is still present at Drew, as a cursory examination of 2014 aerials indicate, managers could maintain the Drew unit as a base and utilize the other units to supplement the needed acreage in wet years. This strategy would enable the current fishery in Drew to remain and if monitoring data indicates marsh vegetation has reduced open water levels in future years then it could be drained at a future time.

Given our knowledge of tule and cattail growth within the LORP system, the BWMA provides an opportunity to treat one or part of these units with one or more treatments in an attempt to maintain open water cover through time. Excavating deep holes in several local locations will provide persistent open water habitat and likely improve diversity over time. Such treatments could preserve open water through time and provide refugia for fish that colonize flooded units.

Units have been prepared in the past with controlled burns. Local treatments with herbicide and excavation would provide additional tools for managers to learn how to create longer lasting, preferred habitat conditions into the future.

Recommendations

Recommendation 1 - Monitor and report on wetted acres and open water within the BWMA.

Recommendation 2 - Managers should develop a plan to prepare the next unit for flooding. A plan that includes multiple treatments, including excavation, burning and experimental use of herbicides at localized areas within the unit is recommended. The plan should consider the merits of keeping the Drew unit flooded for an extended period of time. The MOU Consultants should provide input on this plan prior to submission to the Scientific Team.

Recommendation 3 - The Drew Unit should remain flooded until a plan is approved to flood additional cells.

Recommendation 4 - When the run-off year is known, make an informed decision about flooding the newly prepared unit (Winterton or Waggoner) and the utility of retaining water inflows into the Drew unit based on the characterization of Drew habitat quality, the number of target acres, and the preparation made to the new unit.

Indicator Species

This section was written by Debbie House, LADWP, and the MOU Consultants. Recommendations in this section are the MOU Consultants.

Introduction

Almost 20 years have lapsed since a group determined the Habitat Indicator Species (HIS) for each physical feature of the Lower Owens River Project (LORP): Lower Owens Riverine-Riparian System, Delta Habitat Area, Off-River Lakes and Ponds, and Blackrock Waterfowl Management Area. This HIS list was developed not completely understanding how LORP management would influence changes in water, wetland, riparian and land condition. Monitoring, evaluation, and observations show that some HIS reacted very favorably to environmental changes (e.g. largemouth bass and waterfowl). Some HIS could not adapt to or occupy these changing environments (e.g. Owens tui chub and Owens pupfish). Other HIS are not effective to use as indicator species because they are rare or uncommon regionally or locally, or difficult to detect or monitor. The list is now outdated and warrants re-evaluation to better match each HIS to each of the four physical features of the LORP.

This Chapter lists the present HIS by the four physical features of the LORP, evaluates and provides justification for the retention or elimination of these species, and recommends an updated HIS list to guide LORP managers and decision makers.

Background

MOU (1997)

The 1997 MOU identified that the overall goal for all four physical features of the LORP was to establish and maintain diverse, riverine, riparian, and wetland habitats in a healthy ecological condition (MOU 1997). More specific goals were developed for each of the four physical features to help guide management. For reference these are:

Lower Owens River Riverine-Riparian System – Create and sustain healthy and diverse riparian and aquatic habitats and a healthy warm water fishery with healthy habitat for native fish species.

Owens River Delta Habitat Area – Enhance and maintain existing habitat consisting of riparian areas and ponds for waterfowl, shorebirds and other animals.

Off-river Lakes and Ponds – Maintain and/or establish off-river lakes and ponds to sustain diverse habitat for fisheries, waterfowl, shorebird and other animals

Blackrock Waterfowl Management Area - Provide the opportunity for the establishment of resident and migratory waterfowl populations and to provide habitat for other native species.

For all components, the MOU (1997) requires that to the extent feasible, diverse natural habitats consistent with the needs of the HIS be created through the application of flow and land management. The MOU (1997) defines "feasible" as capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, legal, and technological factors. LORP habitats will also be as self-sustaining as possible (MOU 1997). Furthermore, the MOU (1997) calls for the Ecosystem Management Action Plan and Concept Document (EMPACD) to be modified as necessary so its direction will be consistent with the goals of the LORP. The MAMP and Technical Memorandums can also be modified through adaptive management. The LORP EMPACD 1997, attached by reference to the 1997 MOU, identified HIS for the four different physical features of the LORP (Table 19).

LORP Technical Memorandums

Technical Memos were developed for each of the four areas subsequent to the MOU and EMPACD and contained additional information and analysis regarding the biological setting and expected responses of indicator species. Technical Memorandums call for all HIS to be enhanced via developments and flows prescribed in the MOU (1997). Technical Memorandums are subject to constant review and revision. Some Technical Memorandums address HIS that are designated in the MOU (1997). Species addressed are largemouth bass, smallmouth bass, blue gill, channel catfish, Owens pupfish, and Owens tui chub. Technical Memorandum #14 (April 2001) states that habitat suitable for Owens pupfish and Owens tui chub will be created and maintained as a result of LORP management.

Riverine-Riparian System
Fish
Largemouth bass
Blue gill
Channel catfish
Smallmouth bass
Owens sucker
Owens pupfish (Receive proper consideration)
Owens tui chub (Receive proper consideration)
Owens speckled dace (Receive proper consideration)
Wildlife
Owens valley vole
Yellow-breasted chat
Warbling vireo
Tree swallow
Long-eared owl
Northern Harrier
Marsh wren
Yellow warbler
Blue grosbeak
Tree Swallow
Belted kingfisher
Swainson's hawk
Rails
Wood duck
Willow flycatcher
Yellow-billed cuckoo
Belted kingfisher
Nuttall's woodpecker
Red-shouldered hawk
Least bittern
Great blue heron

Off River Lakes and Ponds	
Fish	
Largemouth bass	
Blue gill	
Channel catfish	
Smallmouth bass	
Owens pupfish	
Owens tui chub	
Wildlife	
Resident migratory and winter waterfowl	
Resident, migratory and wintering wading birds	
Northern harrier	
Marsh wren	Least bittern
Osprey	Rails

Blackrock Waterfowl Management Area	
Fish	
Owens pupfish	
Owens tui chub	
Wildlife	
Resident migratory and winter waterfowl	
Resident, migratory and wintering wading birds	
Resident, migratory and wintering shore birds	
Northern harrier	Marsh wren
Least bittern	Rails

Delta Habitat Area
Fish
Owens pupfish
Owens tui chub
Wildlife
Resident migratory and winter waterfowl
Loons, grebs, pelicans and cormorants
Resident, migratory and wintering wading birds
Rails and Bitterns
Resident, migratory and wintering shore birds
Gulls and terns

Table 19. Habitat Indicator Species for each of the Four Physical Features of the LORP - Ecosystem Management Plan and Concept Document (1997)

Technical Memorandum # 14 anticipated that in time threatened and endangered fish species will recolonize suitable habitat throughout the Lower Owens River. This may have been an unrealistic prediction (Platts personal observations only). The memorandum also stated that native fish will find refuge, spawning needs, nursery requirements, and rearing in wildlife-fish corridors that are relatively predation and competition fish free. Observation has shown that this may not happening (Platts personal observation only).

EIR (2004)

The EIR (2004) calls for natural habitats to be created and enhanced consistent with the needs of HIS through the application of appropriate LORP flow and land management practices.

Monitoring and Adaptive Management Plan (2008)

According to the MAMP (2008) habitat assessments and population monitoring that focuses on all species in a given area is neither time nor cost effective. The MAMP (2008) recommends the wildlife indicator guild concept to minimize the cost and time to make the evaluations more effective. Because all species in a 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.

Justification for HIS Rentention or Removal by Species

Today's distribution of native and non-native fish in the Owens Basin demonstrates that native fishes cannot survive in most habitats occupied by exotic fish (USFWS 1998). Habitats no longer occupied by native Owens Basin fishes are now habituated and controlled by predatory fish such as largemouth bass, blue gill, and catfish (USFWS 1998). Owens Basin native fishes are highly mobile and rapidly invade vacant favorable habitats (USFWS 1998). Native fish species have a high reproductive capacity and each species is a habitat generalist. Therefore, native fish could occupy and sustain populations in almost all habitats if it were not for the dominating populations of superior predatory and competitive animals that already exist. Native fish have occupied all habitats in the LORP that they are going to occupy under present management until the HCP provides a mechanism that will let native fishes to successfully occupy selected habitats.

The abundance, diversity, or specific occurrence of some wildlife species can be used to evaluate whether project or land management objectives are being achieved, or to determine the response of wildlife species to particular ecological conditions and thus apply adaptive management as needed. Wildlife indicator species should be selected in accordance with the objectives and include species that are known or expected to respond to the habitat conditions or ecosystem processes desired (Chase and Geupel 2005, Landres et al 1988).

In order to be able to detect change and response to land management actions, wildlife species selected as indicator or focal species should be ones that are easily and efficiently monitored (Chase and Geupel 2005). The use of habitat specialists, rare or listed species should be avoided because these species may occur at low densities and create statistical sampling problems, be difficult to survey due to regulatory restrictions, or not be a desirable focal species because they occur in habitats that are less diverse (Chase and Geupel 2005, Landres et al, 1988).

Riverine Riparian System

The goal for the Riverine-Riparian System is to create and sustain healthy and diverse riparian and aquatic habitats, and a healthy warm water recreational fishery with healthy habitat for native fish species (MOU 1997).

Fish

Attempts to recover and delist Owens Basin native fish have been going on for decades. The USFWS (1998) considers neither named tributaries to the Owens River nor the main-stem of the Owens River as potential areas for listed native fish assemblages to survive. Their reasoning is that non-native fishes and other dominant predatory and superior competitor animals (e.g. fish) that dominate populations are distributed throughout the system. The difficulty and expense of rehabilitating any of these habitats, limits the likelihood for any successful native fish introductions in these sites. Native fish introduced into this system (Lower Owens River) would not be self-sustaining (USFWS 1998).

Owens Pupfish *(Cyprinodon radiosus)* – The Owens pupfish is listed as a Federal and State Endangered Species throughout its native range in the Owens Basin. The pupfish population is reported to be declining in numbers (USFWS 1980). No known population of Owens pupfish presently survive in the Lower Owens River proper (Ganda 2000 and Platts personal observation). Although LORP Technical Memorandum # 14 (Ecosystem Sciences 2001) and the EIR (2004) calls for Owens pupfish to be considered in the HIS process in the Lower Owens River, we now know they cannot survive in these environments in their present states. The EIR (2004) did not include any actions to create sanctuaries in the river for this species. Also LORP management documents do not include any deliberate actions to introduce this species into the Lower Owens River. Establishing new populations of Owens pupfish will require reintroductions to occur in locations where non-native predators do not exist or can be managed (USFWS 2009). The Riverine Riparian System does not meet this requirement.

Abundant suitable diverse habitat has been developed for the Owens pupfish in the Lower Owens Riverine Riparian system, but superior predatory and competitive species (e.g. bass and mosquito fish) are so dominant that Owens pupfish cannot survive in sustainable populations. Therefore, Owens pupfish do not warrant being listed as a HIS for the Riverine-Riparian System.

Owens Tui Chub *(Siphateles bicolor synderi)* – The Owens tui chub is listed as a Federal and State Endangered Species throughout its native range in the Owens Basin. The Owens tui chub population is reported to be stable or slowly declining (USFWS 1998). Pure Owens tui chub only exist in habitats where introduced Lahontan tui chubs (Gila bicolor obesa) or already hybridized tui chubs do not occur. No known populations of pure Owens Tui Chub presently occur in the Lower Owens River.

If pure Owens Tui Chub did gain access to the river and survive they would probably hybridize with Lahontan Tui Chub. Dienstadt et al, (1985 and 1986) found hybridized tui chubs in fish assemblages in Long Valley and the northern Owens Valley. Therefore, pure Owens tui chub would have direct access to assemblages of Lahontan or hybridized tui chub in the Lower Owens River if they were ever to occupy it.

Owens tui chub have been extirpated throughout most of their range by introgression with introduced Lahontan tui chubs (Chen et. al. 2006-B). Habitats occupied by Owens tui chubs should remain isolated from the Owens River (Chen et. al. 2006-B). Hybrid tui chubs are so abundant and widespread throughout the Owens River Basin that eradication is unrealistic (Chen et. al., 2006). Habitats of pure Owens tui chub should remain isolated from the potential gene flow from the Owens River.

In summary, abundant suitable habitat for the Owens tui chub has developed in the Lower Owens Riverine-Riparian System. Superior predatory and competitive species (e.g. bass and mosquito fish) are so dominant, however, that Owens tui chub cannot survive in sustainable populations. Therefore, this species does not warrant being listed as a HIS for the Riverine-Riparian System.

Owens Speckled Dace *(Rinichthys oculus spp)* – The Owens speckled dace is classified as a “species of concern” by CDFW. No known populations of Owens Speckled Dace now survive in the Lower Owens River. Distributional studies conducted in the 1980s found that speckled dace no longer occupy habitats in the Owens River (Sada et al. 1989). According to CDFW’s Natural Diversity Data Base there are no sites currently containing Owens speckled dace in the LORP.

Suitable abundant habitat for the Owens speckled dace has been developed in the Lower Owens Riverine-Riparian System, but, superior predatory and competitive species (e.g. bass and mosquito fish) are so dominant that this dace cannot survive in viable sustainable populations. Therefore, Owens speckled dace do not warrant being a HIS for the Riverine-Riparian System.

Owens Sucker *(Catostomus fumeiventris)* – Owens suckers are present in the lower and upper Owens River and adjoining tributaries (Deinstadt et al. 1986). The Owens sucker is a State of California "species of special concern", but, is thought to be doing well throughout most of its range (CDFG 1997). Owens suckers presently occupy the Lower Owens River and may be surviving quite well with the abundant game fish population (MAMP 2008). It is believed that that the Owens sucker is not presently doing very well in the Lower Owens River because of heavy competition with exotic fishes (Platts personal observation only).

The EIR (2004) states that the Owens sucker is thriving in the Owens River and is not adversely affected by the presence of game fish. The EIR (2004) goes so far to state that the Owens sucker is the only fish native to the area that can successfully compete with introduced species. According to Moyle (1976), this sucker seems to thrive in the valley despite human perturbations. Moyle (1995) did not recommend any protective measures for the Owens sucker population. Presently, we do not know how well the Owens sucker is doing in the LORP. It may not be doing all that well (Platts personal observations). The Owens sucker does, however, warrant being listed as a HIS for the Riverine-Riparian System.

Largemouth Bass *(Mieroperus salmoides)* – Largemouth bass are presently doing very well in the Lower Owens River. Because bass requires good aquatic habitat conditions to support high healthy populations, bass warrants being listed as a HIS for the Riverine-Riparian System.

Smallmouth Bass – Smallmouth bass occupy the Lower Owens River in relatively small numbers. They do, however, survive in sufficient numbers that anglers catch them occasionally in the recreational fishery. In the West, it is not common to have high numbers of largemouth bass and large numbers of smallmouth bass occupying the same habitat at the same time because of their different habitat and needs preferences. Therefore, smallmouth bass do not warrant being listed as a HIS for the Riverine-Riparian System.

Blue Gill *(Lepomis macrochirus)* – Blue gill are abundant in the Lower Owens River and contribute to the recreational fishery. They are very capable of sustaining large population numbers if river conditions remain healthy. Therefore, blue gill do warrant being a HIS for the Riverine-Riparian System.

Channel Catfish *(Lotalurus spp)* – Channel catfish are presently doing well in the Lower Owens River and contribute to the recreational fishery. Catfish are very capable of sustaining healthy populations over time in this area if aquatic habitat conditions remain healthy. Therefore, channel catfish warrant being listed as a HIS for the Riverine-Riparian System.

Wildlife

The HIS list for the Riverine Riparian System found in Table 19 is composed of primarily of riparian obligate or wetland species. Special status species are a large component as the list includes six California State Species of Special Concern, one State Threatened Species, two State endangered, and one Federally-endangered Species. Many of the remaining species on the list are either difficult to survey for (e.g. rails), or generally occur at low abundances in the project area (e.g. Red-shouldered Hawk, Wood Duck) as to make any statistical inferences or conclusions regarding trend or response to management action based on the monitoring data unlikely. The Owens Valley Vole is a California Species of Special Concern. Surveys for this species require special permitting from the California Department of Fish and Wildlife. Owens Valley Voles or indication of their presence has been observed throughout the Riverine-Riparian System following project implementation (House personal knowledge).

In order to evaluate whether healthy, diverse riparian and aquatic habitats are being created and sustained with regard to the wildlife community, the diversity and abundance of bird species using riparian and aquatic habitat in the riverine-riparian system should be evaluated. The use of particular focal groups should be used as well as individual focal species whose abundance in LORP allows for the determination of trend.

The following indicator focal groups and species may be used as indicator species for the riverine-riparian system:

- Focal Group 1: Riparian-Aquatic Species – all bird species that use or require LORP wetland, riparian, or aquatic habitats
- Focal Group 2: Waterfowl and Wading Birds – these species typically require diverse open-water, productive habitats
- Focal Species 1: Song Sparrow – Abundant in LORP, resident breeding species that utilize riparian, marsh and adjacent scrub-meadow habitats; a California Partners in Flight Focal Species
- Focal Species 2: Marsh Wren – Common in LORP; breeding species restricted to emergent marsh habitats
- Focal Species 3: Common Yellowthroat – Abundant breeding species in LORP; neotropical migrant utilizes marsh and riparian habitats

Delta Habitat Area

The goals for the DHA are to maintain a minimum of 755 acres of vegetated wetlands, and create or enhance conditions consistent with the needs of Indicator Species. Diverse natural habitats will be created and maintained through flow and land management (MOU 1997).

Fish

Technical Memorandum #8 (Ecosystem Sciences 1999) called for habitat suitable for Owens pupfish and Owens tui chub to be maintained or created in the Delta Habitat Area. Technical Memorandum # 14 (Ecosystem Sciences 2001) and the EIR (2004) also call for Owens pupfish to be considered as a HIS in this area. As explained, predatory and competitive species in the Delta Habitat Area will not allow native fish to survive successfully over time.

Owens Pupfish *(Cyprinodon radiosus)* – Suitable habitat for Owens pupfish survival has developed in the Delta Habitat Area, however superior predatory and competitive species (e.g. bass and mosquito fish) are so dominant that Owens pupfish would not survive in sustainable viable populations. Therefore, the Owens pupfish does not warrant being listed as a HIS for the DHA.

Owens Tui Chub *(Siphateles bicolor synderi)* – Suitable habitat for Owens tui chub survival has developed in the Delta Habitat Area, superior predatory and competitive species (e.g. bass and mosquito fish) are so dominant that Owens tui chub would not survive in sustainable populations. Therefore, the Owens tui chub does not warrant being listed as a HIS for the DHA.

Wildlife

The Habitat indicator species list for the Owens River Delta Habitat Area as it appeared in the MOU and EMPACD included resident migratory and wintering waterfowl, wading birds and shorebirds. Technical Memo #8 incorrectly cited the MOU indicator list, and included a number of other species that were not waterfowl, wading birds or shorebirds such as loons and grebes, cormorants, pelicans, bitterns, rails, gulls and terns.

The Owens River Delta Habitat Area is a flat alluvial fan consisting of numerous shallow braided channels, small ponds, and large expanses of marsh, wet, and dry meadow habitats. Most of the open water areas mapped in DHA are small. Only one pond exists in the DHA that is over one acre in size at 1.4 acres, and three other areas greater than 0.5 acres. All other open water areas are less than 0.5 acres in size, and the majority are <0.1 acre (2013 LORP annual report). The Delta currently only supports a very small acreage of deep-water habitat, and more deepwater habitat is not expected to develop in the area. Species associated with this habitat type are therefore not appropriate to have as habitat indicator species for the Delta. Loons, grebes, pelicans, cormorants, diving ducks, gulls and terns do not warrant being HIS. Rails (e.g. Virginia Rail and Sora) are secretive marsh birds that often remain hidden in dense vegetation, and vocalize infrequently. Rails also tend to be rare to uncommon on the landscape. Playback call surveys are effective at increasing the detection rate of these species over passive surveys (Virginia Rail 657%, Sora 103%, Conway and Gibbs, 2005), but species-specific surveys can add significantly to the cost of a monitoring program. Rails do no warrant being HIS for the DHA. This list provided in Technical Memo #8 also includes two species for which there are currently no accepted records of the species in Inyo County (e.g. Black Rail and Wandering Tattler, Heindel, pers. comm 2014).

Therefore, it is recommended that the wildlife HIS for the Delta Habitat Area remain unchanged from that which appeared in the EMPACD and 1997 MOU.

Off-River Lakes and Ponds (ORLP's)

The goal for ORLP's is to maintain and/or establish diverse habitat for fisheries, waterfowl, shorebirds and other animals. These 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" (MOU 1997).

Fish

A LORP goal is to manage ORLP's to sustain diverse habitats for fisheries, waterfowl, shorebirds, and other animals consistent with the needs of HIS. No native fish presently occupy the ORLP's (Ganda 2000). Technical Memorandum # 8 (1999), calls for habitat suitable for Owens pupfish and Owens tui chub to be created and maintained in the ORLP's as part of the LORP. Technical Memorandum # 14 and the EIR (2004) also call for Owens pupfish habitat to be created. Suitable habitat for these species has been created, but as explained, the habitat is not conducive to native fish permanent survival under present water management. These habitats are already occupied by predatory and competitive species that do not allow native fish to survive in viable populations.

Owens Pupfish *(Cyprinodon radiosus)* – Suitable habitat for Owens pupfish survival has developed in the ORLP's, however superior predatory and competitive species (e.g. bass and mosquito fish) are so dominant in these waters that Owens pupfish cannot survive in sustainable populations. Therefore, the Owens pupfish does not warrant being listed as a HIS for ORLP.

Owens Tui Chub *(Siphateles bicolor synderi)* – Suitable habitat for Owens tui chub survival has developed in the ORLP's, superior predatory and competitive species (e.g. bass and mosquito fish) are so dominant in these waters that Owens tui chub cannot survive in sustainable populations. Therefore, the Owens tui chub does not warrant being listed as a HIS for ORLP.

Largemouth Bass *(Mieroperus salmoides)* – Largemouth bass are presently doing very well in the ORLP's. Because bass requires healthy permanent aquatic habitat conditions to support abundant populations, bass warrants being listed as a HIS for ORLP.

Smallmouth Bass – If smallmouth bass occupy the ORLP's it would be rare. In the West, it is not common to have high numbers of largemouth bass and large numbers of smallmouth bass occupying the same habitat at the same time because of their different habitat and needs requirements. Therefore, smallmouth bass do not warrant being listed as a HIS for ORLP.

Blue Gill *(Lepomis macrochirus)* – Blue gill occur in the ORLP's and contribute to the recreational fishery. They are very capable of sustaining their populations over time in these waters if aquatic habitat conditions remain healthy. Therefore, blue gill do warrant being listed as a HIS for ORLP.

Channel Catfish *(Lotalurus spp)* – Channel catfish are present in ORLP's and contribute small numbers to the recreational fishery. Catfish are capable of sustaining themselves over time in this area if aquatic habitat conditions remain healthy. Therefore, channel catfish warrant being listed as a HIS for ORLP.

Wildlife

The only specific management objective for ORLP's is to maintain existing water levels and the ORLP's are managed primarily as a recreational fishery. Creel censuses are conducted to evaluate the status of these sites as recreational fisheries. There is no monitoring of ORLP's for wildlife. In addition, management objectives are not conducive to maintaining wetland productivity required to support significant populations of resident migratory and wintering waterfowl and wading birds. Therefore it is recommended that there are no wildlife HIS for the ORLP's.

Blackrock Waterfowl Management Area (BWMA)

This waterfowl management area was developed, as directed by court order, to enhance habitat for migrating waterfowl, shorebirds, and other wildlife species (MOU 1997). The MOU (1997) goal for the area is to provide diverse natural habitat for migratory waterfowl populations, other native species, and HIS. The area, however, under present management does not provide compatible habitat for permanent native fish survival. The required constant wetting and drying out process to favor migrating waterfowl and other wildlife does not allow permanent fish population survival. Also, all management units, within this area, receive water from the LAA, via the Blackrock Ditch. They both contain predatory and competitive fish. Native fish could not presently survive under the combination of these conditions.

Management flooded units do provide large temporary areas of aquatic habitats. Because these areas become dominated by carp, bass, and mosquito fish (*Gambusia affinus*), and continually go through long dry-out periods, these large areas are not conducive for the permanent survival of native fish (Ecosystem Sciences 2012).

Fish

The BWMA water management regime will not provide viable sustaining habitat for Owens pupfish or Owens tui chub (EIR 2004). Although LORP Technical Memorandum # 14 and the EIR (2004) calls for Owens pupfish to be considered as a HIS in this area, presently required water management is not conducive for native fish survival. The BWMA is also not compatible for the introduction of this species, or in the event they would attempt to colonize the area, they would not permanently survive (EIR 2004).

Owens Pupfish *(Cyprinodon radiosus)* – Temporary suitable aquatic habitat for Owens pupfish has been developed in the BWMA. Superior predatory and competitive species (e.g. bass and mosquito fish) are so dominant, however, that Owens pupfish would not survive in sustainable populations in this area under these conditions. Permanent suitable aquatic habitat will not exist. Therefore, Owens pupfish do not warrant being listed as a HIS for the BWMA.

Owens Tui Chub *(Siphateles bicolor synderi)* – Temporary suitable aquatic habitat for the Owens tui chub has been developed in the BWMA. Superior predatory and competitive species (e.g. bass and mosquito fish) are so dominant, however, that Owens tui chub would not survive in sustainable populations in this area under these conditions. Permanent suitable native fish habitat does not exist. Therefore, Owens tui chub do not warrant being listed as a HIS for the BWMA.

Wildlife

Northern Harrier – The Northern Harrier is a California Species of Special Concern. This species can be found in BWMA year-round, and is a probable nesting species. Raptors typically occur in low densities on the landscape and can be difficult to census due to their wide-ranging nature. The Northern Harrier does not warrant being a HIS for the BWMA

Least Bittern – The Least Bittern is a California Species of Special Concern. This is a secretive species whose abundance is difficult to determine and likely underestimated (Shuford and Gardali 2008). Conducting species-specific playback calls for this species requires special permitting from the California Department of Fish and Wildlife, therefore the Least Bittern does not warrant being a HIS for the BWMA.

Marsh Wren – The Marsh Wren is a species that has occurred in all four BWMA units when the units were active. While this species is easily monitored, and in some areas abundant, the habitat conditions it favors (e.g. dense marsh), are not in accordance with those required by the majority of the other indicator species. The Marsh Wren does not warrant being a HIS for the BWMA.

Osprey – Temporary suitable foraging habitat has been developed in BWMA, as at least three of four management units have ponds of sufficient depth when flooded, and support non-native fish species. Single birds have been observed in the Drew Slough area, generally in spring and fall. Osprey does not warrant being a HIS for BWMA due to their low abundance and infrequent occurrence.

Recommendations

Recommendation 1 - The MOU Consultants recommend that the species listed in Table 20, under the four physical features of the LORP, form the new LORP updated HIS list. This HIS list should become the habitat indicator species list for input into guiding future LORP management.

Recommendation 2 - Perform avian surveys in the riverine-riparian area in 2015. Perform CWHR in conjunction with mapping and avian survey results.

Recommendation 3 - Identify appropriate metrics to be used in evaluating indicator species population dynamics and change.

Recommendation 4 - Evaluate the efficacy of revised indicator species lists after two cycles of monitoring and census data is completed.

Riverine-Riparian System	
Fish	
Largemouth bass	Channel catfish
Blue gill	Owens sucker
Wildlife	
Focal Group 1: Riparian-Aquatic Species – all bird species that use or require LORP wetland, riparian, or aquatic habitats	
Focal Group 2: Waterfowl and Wading Birds (herons, egrets, ibis)	
Focal Species 1: Song Sparrow	
Focal Species 2: Marsh Wren	
Focal Species 3: Common Yellowthroat	
Blackrock Waterfowl Management Area	
Fish	
None	
Wildlife	
For tracking the response of species to management actions and habitat changes in the BWMA, all species in the following focal groups that use BWMA should be considered:	
Focal Group 1: Resident, migratory and wintering waterfowl species	
Focal Group 2: Resident, migratory and wintering wading birds	
Focal Group 3: Resident, migratory and wintering shorebirds	
Off-River Lakes and Ponds	
Fish	
Largemouth bass	Channel catfish Blue gill
Wildlife	
None	
Delta Habitat Area	
Fish	
None	
Wildlife	
For tracking the response of species to management actions and habitat changes in the BWMA, all species in the following focal groups that use DHA should be considered:	
Focal Group 1: Resident, migratory and wintering waterfowl species	
Focal Group 2: Resident, migratory and wintering wading birds	
Focal Group 3: Resident, migratory and wintering shorebirds	

Table 20. Updated and new habitat indicator species recommended list in the four physical features areas of the LORP

For the evaluation of habitat availability, the following list of species most commonly occurring in the region may be used:

Common Name	*Scientific Name*	Common Name	*Scientific Name*
Snow Goose	*Chen caerulescens*	Killdeer	*Charadrius vociferus*
Canada Goose	*Branta canadensis*	Black-necked Stilt	*Himantopus mexicanus*
Gadwall	*Anas strepera*	American Avocet	*Recurvirostra americana*
American Wigeon	*Anas americana*	Greater Yellowlegs	*Tringa melanoleuca*
Mallard	*Anas platyrhynchos*	Willet	*Tringa semipalmata*
Cinnamon Teal	*Anas cyanoptera*	Lesser Yellowlegs	*Tringa flavipes*
Northern Shoveler	*Anas clypeata*	Whimbrel	*Numenius phaeopus*
Northern Pintail	*Anas acuta*	Long-billed Curlew	*Numenius americanus*
Green-winged Teal	*Anas crecca*	Marbled Godwit	*Limosa fedoa*
Great Blue Heron	*Ardea herodias*	Western Sandpiper	*Calidris mauri*
Great Egret	*Ardea alba*	Least Sandpiper	*Calidris minutilla*
Snowy Egret	*Egretta thula*	Dunlin	*Calidris alpina*
White-faced Ibis	*Plegadis chihi*	Long-billed Dowitcher	*Limnodromus scolopaceus*
Black-bellied Plover	*Pluvialis squatarola*	Wilson's Snipe	*Gallinago delicata*
Snowy Plover	*Charadrius nivosus*	Wilson's Phalarope	*Phalaropus tricolor*
Semipalmated Plover	*Charadrius semipalmatus*		

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Tule and Cattail Management

Background

For several years the question of tule and cattail management has been a source of much debate, confusion, and conjecture. Tules and cattail (marsh vegetation) are a natural part of the LORP system and current flow management only promotes their expansion. What is unclear is what the goals are for managing marsh vegetation and where those goals apply. The most commonly cited goal is the achievement and maintenance of hemi-marsh conditions; hemi-marsh conditions are loosely defined as a 50/50 ratio of open water to emergent vegetation in inundated areas. This goal does not account for woody recruitment and development, wet meadow habitats, or other habitat or diversity goals.

As with many other resource areas of the LORP, the most influential driver of the location and extent of marsh vegetation is hydrology. Modifying the current flow regime to bring more variability to the hydrograph and providing more flexibility to managers, will be the best tool for managing marsh vegetation on the LORP at a project scale. A review of the literature and techniques available to control marsh vegetation was provided as an attachment to the 2012 LORP Monitoring and Adaptive Management recommendations (Ecosystem Sciences 2012). Nutrient concentrations may also affect marsh vegetation on the reach and project scale (Ecosystem Sciences 2012) and water quality testing does indicate elevated levels of nutrients (e.g., phosphorous) for at least temporary time periods (unpublished Inyo County water quality data). For LORP management purposes, both hydrology and water quality are likely interrelated as flow management is the main tool to influence water quality at this time.

Flow management could be used to reduce the vigor of marsh vegetation through creating a more variable flow environment. Researchers have found that tules and cattails are highly competitive in stable hydrologic environments, are controlled by a more natural hydrograph, and are intolerant of drought (Toth 1988, Urban et al. 1993, Newman et al. 1996, King et al. 2004). In a long a long term study of a marsh system,

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Seabloom et al. (2001) found that marsh vegetation declined during both flooding and drawdown periods and then increased during stable flooded conditions. This research reinforces the hypothesis that cattails and tules are better adapted to a steady hydrologic regime than to fluctuating water levels, such as a more natural hydrologic regime.

Modifications to hydrology, nutrient loads, land use patterns, invasive species, have all been shown to influence wetland species distribution and abundance (McCormick and Gibble 2014). The complex interaction of many factors, along with the understanding that there is no one treatment that will meet project objectives, creates a substantial challenge to managers seeking to determine management actions to control tule and cattail vegetation.

In 2014, LADWP performed tule control treatments in localized areas to evaluate the effectiveness of cutting, using herbicide and biological control. The herbicide treatment appeared to be the most effective method followed by cutting and lastly by biological control in the plots they treated. However, no report or data has ever been produced to document the results of this investigation. Treatments appear to have been applied in February. The literature indicates that when applying a cutting treatment, the most effective timing is late summer and early fall (preferably then followed by inundation). Clipping early in the spring can stimulate increased growth (Nelson and Dietz 1966, Apfelbaum 1985). Cuttings are also most effective if done repeatedly (2-3 times) and below the water line (Timons 1952, Martin 1953, Stodola 1967).

The most important action required is to establish site specific goals for tule and cattail management. A goal to simply "control tules and cattails" does not provide specificity or short term objectives from which to make management prescriptions. Reach and project scale goals may include increased water conveyance rates and habitat diversity measures while decreasing evapotranspiration and organic matter accumulation rates. Marsh vegetation management on the reach and project scale will be achieved primarily through flow management.

There are many reasons to develop site-specific goals for managing marsh vegetation and more options at managers at the site scale. For example, if there are goals and objectives that only apply to certain limited areas, then there may be treatments that would be appropriate. If shoreline access is important only at 5 specific locations, then a proper treatment may be herbicide or cutting at designated locations; if a reach with a continuously open channel for floating is desired then specific occlusions of marsh vegetation could be targeted for control methods each season. Treatment methods appropriate for specific locations (cutting, herbicide, etc.) are not appropriate for reach and project scale goals. Therefore, it is important that managers establish where, when, how and why to manage marsh vegetation throughout the LORP. It should be noted that the use of explosives to manage marsh vegetation is not a recommended option at this time, for a number of reasons detailed in (Channel Clearing section under Proposals and Ideas).

Recommendations

Recommendation 1 - LADWP and Inyo County should prepare a specific set of goals pertaining to each reach and the entire LORP area. Within each reach, site specific locations should be identified where fine scale control is needed (e.g., recreational access points). This report is to be presented to the Scientific Team. In conjunction with the Scientific Team, the appropriate list of recommended actions to address each goal should be determined.

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Rapid Assessment Survey and Woody Riparian

Rapid Assessment Survey

The RAS methodology has changed through time, its usefulness has been called into question, and it gathers information that has not been used to inform management decisions. Other monitoring efforts (e.g., landscape scale mapping, site-scale mapping, and indicator species habitat analysis) have not been performed as mandated by the MAMP. Consequently, the information collected in the RAS, land management and hydrologic monitoring provide the most recent and pertinent data to make management decisions relating to woody species and habitat. Data from the RAS have been used successfully to locate invasive species, woody riparian recruitment, recreation impacts and tamarisk resprout and seedling sites. The RAS is a qualitative assessment; its results should not be used to categorize river conditions or be the basis for broad management decisions. Rather, the RAS should inform managers about river conditions and indicate where additional monitoring should be targeted.

Overall, the 2014 RAS data collected and results are similar with past efforts. Notable results include observing the lowest number of woody recruitment sites since project implementation (8), new perennial pepperweed sites (8), indicators of possible increases in recreation impacts and the documentation of the ongoing need to control tamarisk.

Salt Cedar

Salt cedar remains an ongoing management challenge and is the most abundant noxious weed in the LORP. This year's effort made further changes to the RAS protocol; this makes comparison to previous years observations problematic. Resprouts and seedlings were recorded at 220 sites, but mature plants were not included in the survey, as they were in previous years. Regardless, the overall trend reported by the RAS report indicates that salt cedar is increasing in reaches 4 and 5 and the delta, but decreasing in all other reaches. However, the results of the salt cedar portion of the survey are difficult to interpret. BWMA only had 5 observations (but it is noted that it is so infested that recording individuals is not practical). Therefore we view reports of increases and decreases of salt cedar with skepticism. Whether from seed recruitment or resprouts, salt cedar continues to reproduce and regenerate throughout the LORP.

The LORP is heavily infested with salt cedar and control of salt cedar is currently not realistic given the funding allocated to this effort. Controlling salt cedar has posed a challenge to land managers throughout the west and the LORP is no exception. Proper control and management of salt cedar will require diligent and continual application of resources.

Noxious Weeds

Perennial pepperweed is a significant management challenge in the LORP. Noxious weeds continue to be a persistent problem, but monitoring and control measures are proving effective. This year's RAS detected 25 populations of this noxious weed, a reduction from 33 observed in 2013. The number of pepperweed sites declined in all reaches except for reach 3, where the number of new and significant sites increased by 6. Reach 3 had only one recorded site in 2013, but now has 6 sites, two of these with >100 individuals. These high population sites in Reach 3 should be targeted for treatment as soon as possible and re-treated. Reach 1 has the most pepperweed sites, as it has in recent years. Because only five of the 25 sites appeared to observers to have been treated with herbicide, additional treatment of pepperweed sites to control this dangerous weed is warranted.

Recreation

Recreation impacts are concentrated in the Lone Pine area. The number of observations increased to 75 in 2014 from 50 in 2013. These impacts are concentrated near roads (Figure 8). The impacts include litter, fire rings, shotgun shells, etc. This may indicate that recreation use is increasing. Increased management priority to managing recreation in the Lone Pine area may be warranted.

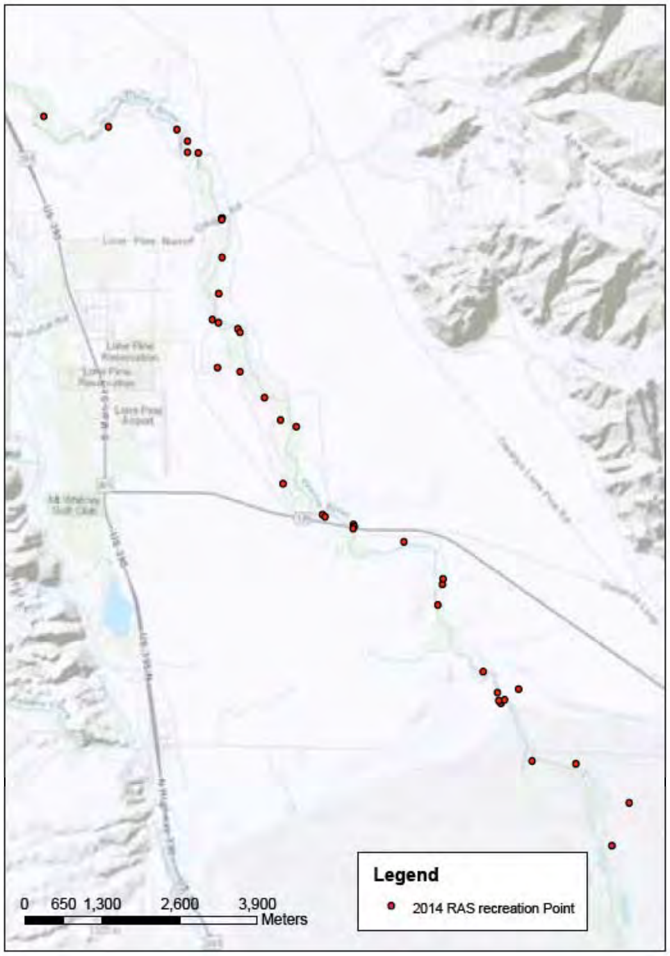

Figure 8. RAS Recreation Locations

Year	Recruitment Sites	% Change from previous year	% Change from 2011
2011	92		
2012	46	50% less	50% less
2013	41	11% less	55% less
2014	8	80% less	91% less

Table 22. Number of recruitment sites by year, % change from previous year and % change since 2011.

Woody Recruitment

Woody recruitment is a subject of interest and discussion in the LORP. As stated in this year's RAS report the number of non-clonal woody recruitment sites detected by the RAS has declined each of the last four years since 2011, when a total of 92 sites were observed. In 2014, only 8 sites were located - the lowest number ever recorded by the RAS. It is not uncommon for systems to experience low recruitment and high mortality in drought years (McBride and Strahan 1984), but recruitment rates likely reduced due to the flow regime. The number of recruitment sites recorded by RAS has declined in recent years (Table 22).

The change in distribution and abundance of these woody recruitment sites between 2011 and 2014 is illustrated in Figure 9.

The flow regime, stochastic nature of woody riparian recruitment, and the availability of suitable sites all contribute to these results. The region has experienced drought over the past few years and therefore the LORP has had reduced or eliminated spring habitat flows that promote establishment. This reduction in flow events and timing coupled with the summer base flows that exceed spring run-off flows are likely contributing to the decline in woody recruitment that has been observed to in recent years.

In addition to recruitment sites where seedlings are establishing from seed, coyote willow has been increasing throughout the LORP through clonal reproduction (65 instances of clonal recruitment of Salix exigua - coyote willow). This expansion of shrub willow provides an additional woody component to LORP habitat. Clonal riparian shrubs provide structure and habitat for many species.

Woody riparian species, including willow and cottonwood trees, provide structural diversity and varied habitats that are critical to the restoration of riverine-riparian conditions. Woody riparian trees are essential to attracting key avian species that are indicators of overall ecological health. In 2014 tree willow recruitment was found at six sites, shrub willow

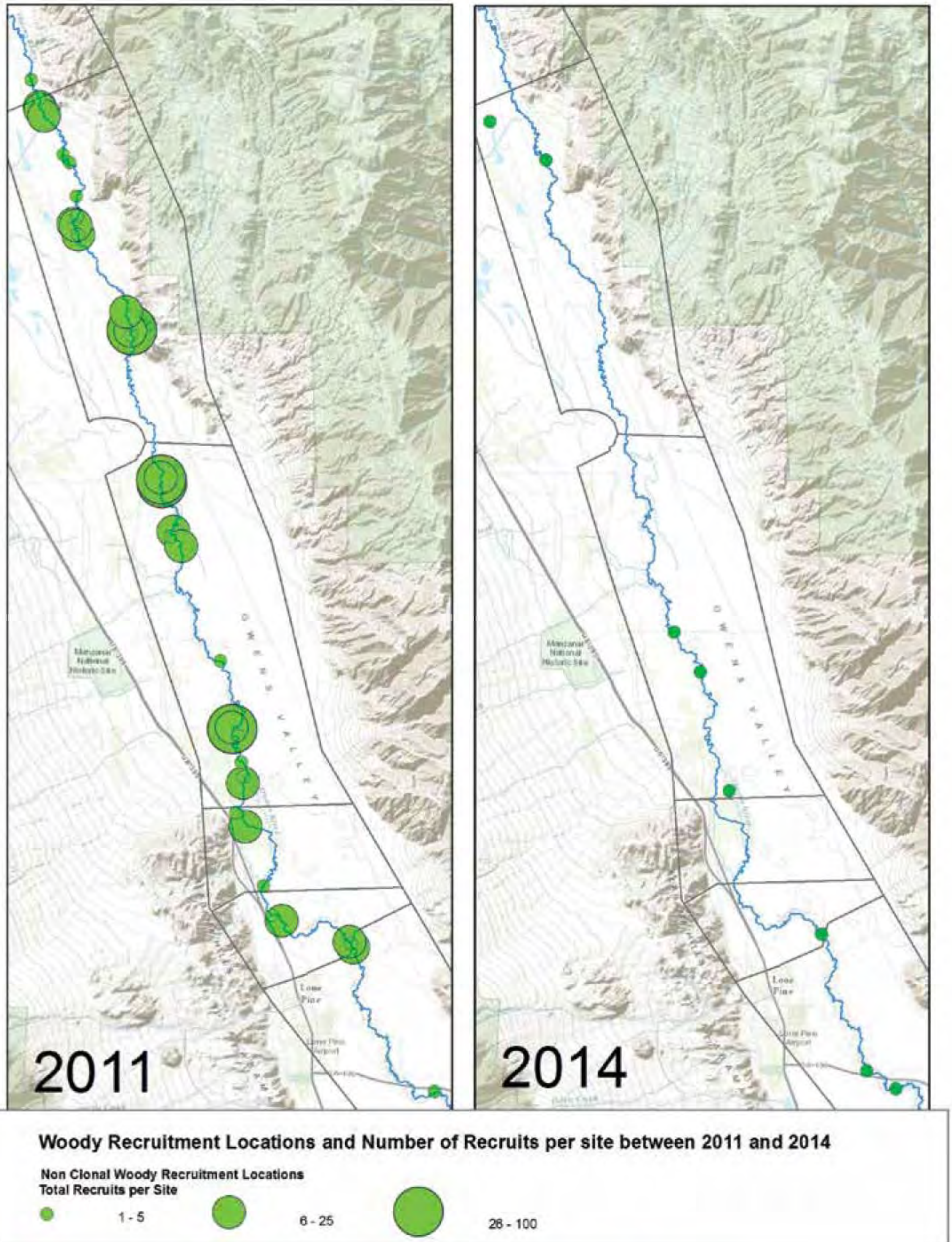

Figure 9. Woody Recruitment Locations and Number of Recruits; 2011 and 2014.

seedlings were not observed at all and two cottonwood recruitment sites were located. The distribution of recruitment sites was sporadic and the low total numbers throughout the LORP do not indicate a trend in any particular river reach.

Woody Species Establishment and Survival

While the RAS data is the best indicator for recruitment, the Streamside Monitoring for Woody Species (SMWS) (reported within the Land Management section of the Annual Report) data is the best information on establishment and survivorship of woody recruitment patches available to mangers at this time. The RAS does provide some establishment information through revisit sites. Woody recruitment sites from the 2013 RAS were revisited in 2014. Of the 43 sites revisited, woody species persisted on 66% of these sites, a decline from the 85% persistence recorded in 2013. The establishment and survival rates have varied from year to year as expected. However, over the RAS history of revisiting woody recruitment sites, the data has shown that woody recruitment sites are persisting for at least one year in the majority of cases (Table 23). However, no inventory of sites older than one year has ever been performed. The RAS only revisits sites from the previous year and does not track woody species through time or provide browse or height measurements as the SMWS effort does.

The SMWS was originally designed in 2010 to examine woody species recruitment, vegetation composition and the impact of browse on seedling survival. Changes have been made to the protocol over the years; sites without willow seedlings have been eliminated, additional sites with seedlings have been added, and height and browse level have been added or modified. The protocol now serves to track establishment and survival of woody species and examine the influence of cattle and elk browse on woody species development by measuring the number of each woody plant species, age/size class, average height and browse intensity. The 2014 monitoring effort evaluated 13 sites (12 of the original sites remain, 20 have been dropped and new sites have been added) which were sampled in both spring and fall. These 13 sites were selected because they had more than 10 juvenile trees. The application of this site selection criterion is unclear, as a site such as TWN_3b was dropped, but it was reported to have 21 juvenile and 3 seedlings in fall 2013. Eight sites were in the Blackrock Lease, two in Twin Lakes, and Island, and one in Thibaut. Two of these sites were dropped because the trees had grown above 6 feet in height.

Year	Reported revisit information
2009	River: Survival was noted at "About 2/3 of the sites." Wetland areas: "mixed but generally poor." However, it appears that there was survival at 3 of the 4 sites.
2010	68% survival at woody recruitment sites.
2011	Of the 73 locations revisited: 59% unchanged (full survival), 18% absent (no survival), 15% increasing (new recruits present), 8% decreasing (partial survival)
2012	72% of revisit sites has seedlings present.
2013	85% of revisit sites has seedlings present.
2014	67% of revisit sites has seedlings present.

Table 23. Survival information for woody recruitment revisits sites from historical RAS efforts. Often new seedlings were noted at old recruitment sites.

The SMWS effort measured the characteristics of 1108 juvenile trees on the 13 plots. The plots sampled experienced some die-off from 2013 levels, as is expected in recruitment cohorts. There was no new recruitment at any of the plots measured in 2014. Overall, trees grew an average of 13 cm. Heavy browse, predominantly by cattle but also by elk, have impaired woody species growth in the sample plots. At sites that experienced heavy browse at least once in the past three seasons, growth was suppressed (LADWP Land Management Chapter Figure 12). LADWP concludes that it may take longer than a year and a half for willow seedlings in the LORP to recover from heavy browse. Further, when browse does occur, it generally exceeds 25% of the plant (LADWP Land Management Chapter Figure 11).

The evidence from the SMWS monitoring that browse by cattle and other ungulates, like elk, inhibits woody riparian species development is well established within the literature. A dramatic change in compositional and structural diversity of vegetation has been associated with grazing riparian forests and shrubs (Case and Kauffman 1997, Kauffman et al. 2000, Shultz and Leininger 1990). Grazing can affect not only vertical and horizontal physical structure, but age structure of the plant community as well. Cattle tend to trample and graze seedlings, resulting in an even-aged non-reproducing vegetation community (Kauffman et al 1983). Therefore if managers wish to maximize woody riparian establishment and development, excluding ungulates from recruitment sites until woody species reach at least 6 feet in height is preferred.

Fundamentally, providing appropriate hydrologic events is paramount to creating a functioning and "self-sustaining" riverine-riparian system.

LADWP has proposed to perform an experiment in which the effectiveness of using intensive grazing to remove herbaceous vegetation and disturb substrate to promote woody recruitment would be evaluated. Techniques to promote recruitment in systems that currently lack the proper hydrology through artificial disturbance have met with some success in other systems (Tiedeman 2011). Site selection, study design, monitoring and reporting will determine if meaningful information can be garnered from such and experiment.

Hydrology and Woody Species Recruitment and Establishment

It is widely accepted among riverine ecologists that hydrologic conditions are likely the largest driver of the type of wetland that can be established and which processes can be achieved (Hupp and Ostercamp 1985, Salo et al. 1986, Junk et al. 1989, Naiman et al., 1993, Mitch and Gosselink 2007, Walker et al. 1995, Hughes 1997, Bendix and Hupp 2000). Specifically, designing successful recruitment flows with the correct timing, magnitude and recession rates is critical (Rood and Mahoney 2000, Rood et al. 2003). Current habitat flows in the LORP do not achieve the magnitude and recession rates to maximize recruitment potential of willow and cottonwood. In natural systems, these riparian tree populations are multi-aged cohorts that established in years with large floods (Bradley and Smith, 1986, Everitt 1995, Scott et al. 1997, Merigliano 1998). In regulated river systems, seedlings typically establish lower on the banks and suffer higher overwinter mortality (Rood et al. 1999, Johnson 2000, Stillwater Sciences 2006) and in the case of the LORP, seedlings established on lower surfaces often become inundated by increasing base flows throughout the summer (LADWP Land Management Chapter 2014). Over the long term, flow regulation (as is currently seen in the LORP) will lead to a dominance of species less dependent on disturbance for establishment (Busch and Smith 1995). This phenomenon is currently being experienced in the LORP with the increase in marsh vegetation and limited woody recruitment.

Ideally, flows could be designed to capture the timing, magnitude, and recession rates required for establishment. These flows have been designed and implemented successfully in other regulated systems (Rood and Mahoney 2000, Rood et al. 2003, among others). In these cases, managers had the flexibility to design flows without the restraints currently being imposed on the LORP by the governing documents that require a constant base flow to be maintained (Stipulation and Order) and the maximum habitat flow of 200 cfs and the recession rate (MOU). Ideally, following peak discharge which inundates landforms above the streambank, the flow recession rate will be sufficiently gradual to ensure that willow and cottonwood root systems will be able to stay in contact with the water table and capillary fringe. These flows will not be required on a yearly basis; research on riparian forests in North America indicates that recruitment events are associated with 5 to 10 year (or greater) flood events (Bradley and Smith, 1986, Stromberg et al. 1991, Stromberg et al. 1993, Scott et al. 1997, Rood et al. 1998).

Researchers have suggested that willow and cottonwood recruitment flows be designed for release only in wet years (Stillwater Sciences 2006) where sufficient water is available to create a significant flood event with a gradual enough recession limb for seedlings to maintain contact with the water table. In normal and below normal years, flow management would focus on maintaining young seedlings from past recruitment events. In 2014, with a peak flow of less than 80 cfs, this was essentially what the LORP experienced; there was very little recruitment. In future low water years, seasonal habitat flows could be targeted for water quality or some other purpose rather than utilizing precious water resources in an attempt to create conditions suitable for woody recruitment.

Large recruitment events are predominantly a result of the infrequent, large flow events that create the stream power, landform inundation, sediment transport, and hydrology necessary to have large recruitment events.

Under current flow management, seasonal habitat flows do not sufficiently inundate landforms at elevations high enough above summer base flow levels to prevent mid-summer flooding of these sites. Over the past several years, the hydrograph has increased through the summer months, rather than a slow decline as would occur in natural systems.

Providing flexibility to managers that would enable them to change the timing, magnitude and recession rate of recruitment flow events will provide the best chance of increasing woody recruitment and establishment in the LORP. The ability to create a more natural hydrograph, exceeding the 200cfs limit, and design flows for specific reaches of the LORP will bring the most beneficial system-wide response. To accomplish this, each year seasonal flows would be designed to inundate specific landforms in specific reaches (likely most frequently one of the reaches above the islands), rather than the existing approach to habitat flows. This would require knowledge of landform elevations and required releases to inundate those landforms. This information could be extrapolated from the NHC Hydraulic model, Lidar data acquisition, or an updated landform map, among other sources. It is widely accepted among riverine ecologists that hydrologic conditions are likely the largest driver of the type of wetland that can be established and which processes can be achieved (Hupp and Ostercamp 1985, Salo et al. 1986, Junk et al. 1989, Naiman et al., 1993, Mitch and Gosselink 2007, Walker et al. 1995, Hughes 1997, Bendix and Hupp 2000). Specifically, designing successful recruitment flows with the correct timing, magnitude and recession rates is critical (Rood and Mahoney 2000, Rood et al. 2003).

Current habitat flows in the LORP do not achieve the magnitude and recession rates to maximize recruitment potential of willow and cottonwood. In natural systems, these riparian tree populations are multi-aged cohorts that established in years with large floods (Bradley and Smith, 1986, Everitt 1995, Scott et al. 1997, Merigliano 1998). In regulated river systems, seedlings typically establish lower on the banks and suffer higher overwinter mortality (Rood et al. 1999, Johnson 2000, Stillwater Sciences 2006) and in the case of the LORP, seedlings established on lower surfaces often become inundated by increasing base flows throughout the summer (LADWP Land Management Chapter 2014). Over the long term, flow regulation (as is currently seen in the LORP) will lead to a dominance of species less dependent on disturbance for establishment (Busch and Smith 1995). This phenomenon is currently being experienced in the LORP with the increase in marsh vegetation and limited woody recruitment.

Ideally, flows could be designed to capture the timing, magnitude, and recession rates required for establishment. These flows have been designed and implemented successfully in other regulated systems (Rood and Mahoney 2000, Rood et al. 2003, among others). In these cases, managers had the flexibility to design flows without the restraints currently being imposed on the LORP by the governing documents that require a constant base flow to be maintained (Stipulation and Order) and the maximum habitat flow of 200 cfs and the recession rate (MOU). Ideally, following peak discharge which inundates landforms above the streambank, the flow recession rate will be sufficiently gradual to ensure that willow and cottonwood root systems will be able to stay in contact with the water table and capillary fringe. These flows will not be required on a yearly basis; research on riparian forests in North America indicates that recruitment events are associated with 5 to 10 year (or greater) flood events (Bradley and Smith, 1986, Stromberg et al. 1991, Stromberg et al. 1993, Scott et al. 1997, Rood et al. 1998).

Researchers have suggested that willow and cottonwood recruitment flows be designed for release only in wet years (Stillwater Sciences 2006) where sufficient water is available to create a significant flood event with a gradual enough recession limb for seedlings to maintain contact with the water table. In normal and below normal years, flow management would focus on maintaining young seedlings from past recruitment events. In 2014, with a peak flow of less than 80 cfs, this was essentially what the LORP experienced; there was very little recruitment. In future low water years, seasonal habitat flows could be targeted for water quality or some other purpose rather than utilizing precious water resources in an attempt to create conditions suitable for woody recruitment.

Under current flow management, seasonal habitat flows do not sufficiently inundate landforms at elevations high enough above summer base flow levels to prevent mid-summer flooding of these sites. Over the past several years, the hydrograph has increased through the summer months, rather than a slow decline as would occur in natural systems. This has inundated recruitment sites and increased seedling mortality (Figure 16 and 17, near end of this report).

Providing flexibility to managers that would enable them to change the timing, magnitude and recession rate of recruitment flow events will provide the best chance of increasing woody recruitment and establishment in the LORP. The ability to create a more natural hydrograph, exceeding the 200cfs limit, and design flows for specific reaches of the LORP will bring the most beneficial system-wide response. To accomplish this, each year seasonal flows would be designed to inundate specific landforms in specific reaches (likely most frequently one of the reaches above the islands), rather than the existing approach to habitat flows. This would require knowledge of landform elevations and required releases to inundate those landforms. This information could be extrapolated from the NHC Hydraulic model, Lidar data acquisition, or an updated landform map, among other sources.

Expectations and Timeframe

There are a wide range of expectations surrounding woody species development in the LORP. The most concrete goals were the predictions made in the Final EIR (LADWP 2004) and identified in the MOU (1997), based on the 40 cfs base flow and the 200 cfs seasonal habitat flow (it should be noted there has been a drought cycle in which seasonal habitat flows have been mostly absent):

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. However, given the extensive existing and future flooding and the absence of streambars necessary for establishing new riparian forest in the Lower Owens River, these estimates may be optimistic. These would be considered wetlands under the Holland classification system. If hydric soils and wetland hydrology and vegetation are present, they would also be considered wetlands under the Corps of Engineers' wetland definition. (LADWP FEIR 2004)*

The vegetation goal for the Riverine-Riparian System from the MOU is to "…create and sustain healthy and diverse riparian and aquatic habitats…" To meet the requirements of the MOU, the habitats must be as self-sustaining as possible. Increased flows in the Lower Owens River are expected to increase the productivity of wetland and riparian vegetation types, and cause type conversions. The new flows are expected to increase plant productivity due to greater moisture availability. In addition, natural disturbance from the seasonal habitat flows will promote natural reproduction and recruitment, as well as facilitate natural vegetation succession through physical disturbances that encourage species colonization and cause turnover of nutrients and carbon. Hence, a "healthier" riparian system is anticipated, as required under the MOU. (MOU 1997)

One of the problems associated with utilizing the prediction of creating over 800 acres of riparian forest as a restoration target is that the mapping methods have changed throughout the project. A specific example includes the 2010 Annual Report on 2009 landscape scale mapping conditions reported a reduction of 189.6 acres of riparian forest. Practically, this large decline in riparian forest was not real. LADWP reported that this was due to improvements in mapping technology. This discrepancy likely is the result of inconsistent minimum mapping units and changes in the prevalence of inclusions within specific mapping units. The flow regime has not been implemented as intended, and the proper timeframe has not been established. Passive restoration seeks to restore process. The current flow regime has not restored process, but has created a static system that lacks the diversity of flow conditions and disturbance regime required to restore function to the LORP. Refer to the sections on flow management changes for more detail and description on the recommended flow regime changes.

In a managed system such as the Lower Owens River Project, large recruitment events are predominantly a result of the infrequent, large flow events that create the stream power, landform inundation, sediment transport, and hydrology necessary (Stillwater Sciences 2006). Fundamentally, providing appropriate hydrologic events is paramount to creating a functioning and "self-sustaining" riverine-riparian system. The active restoration techniques presented in subsequent sections, including pole planting, do not fulfill this goal, and therefore are not in accordance with the MOU or the FEIR requirements.

Even with a proper flow regime, riparian forests are difficult to create and take time to develop, significantly more time than marsh or other wetland types. As systems recover from disturbance (in this case complete de-watering of the stream channel), richness, diversity, and hydrophytic indicator status often become similar to natural wetlands within a typical 10 year monitoring period (Confer and Niering 1992, Kentula et al. 1992, Brown 1999, Balcombe et al. 2005, Spieles et al. 2006, Brown and Veneman 2001). While colonization and succession in marsh communities can occur quickly, tree establishment can be more difficult to achieve. Creating functioning riparian and wetland systems, even when successful, may take decades to begin to resemble natural systems (Kusler 1986, Mitsch and Gosselink 2007).

The expectations for the quantity of woody riparian habitat and the timeframe within which to achieve that quantity must be established. These expectations should be dependent on whether or not the recommended flow regime changes are implemented.

Recommendations

Recommendation 1 - Perform a RAS database clean up and organization. There are many inconsistencies through the years. The focus should be to locate the woody recruitment sites in space and time and normalize that data values to accommodate for changes in RAS methodology (e.g. clonal vs. seedling, etc.). The revisit data for those points should be merged into the recruitment site to create a point for each recruitment site that contains all the RAS data for that site. A memo to the MOU parties with all recruitment sites recorded by year, number of seedlings, species and revisit results should be completed.

Recommendation 2 - All past recruitment sites documented during the life of the project should be revisited and evaluated. The sites that are being monitored under the SMWS protocol may be omitted. If resources are not available for a specific effort, this should be performed during the 2015 RAS.

Recommendation 3 - Based on a review of the recruitment sites, the SMWS protocol should be expanded to include additional recruitment sites identified by the RAS as resources allow. The largest sites and those that are geographically isolated from other sites should be prioritized.

Recommendation 4 - Woody recruitment is occurring on the LORP, but management decisions could increase recruitment rates. Flow management is the most powerful tool that managers can use to increase recruitment. Further, the flow regime has affected establishment as well by flooding past recruitment sites due to the increasing base flow levels. The flow regime changes should be undertaken with the goal of increasing high flows and decreasing base flows. Recruitment flows should be designed to target specific reaches and elevations in high water years. See figures 16 and 17 near the end of this report.

Recommendation 5 - Treat and re-treat perennial pepperweed sites as resources permit.

Recommendation 6 - Browse, from either cattle or elk impairs woody species growth rates. In an effort to maximize the woody species growth and development, temporarily fencing should be installed at recruitment sites with the highest value until the mean height exceeds 6 ft in height, when they likely will be able to sustain browse without impairing growth significantly. Sites such as ISL_4B in the Islands lease should be considered for fencing due to the site location near some of the only shade in the area. This site has experienced heavy browse for several seasons. Temporary exclusion fences would be a much better use of resources than planting a grove of trees (as has been proposed and is discussed in section X), which would then require cattle exclusion and possibly irrigation – when naturally reproducing woody species already exist. A management goal of maximizing establishment and rapid development of naturally reproducing woody species should be a high management priority.

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Rare Plants

Background

For a number of years the rare plant monitoring of Owens Valley (OV) checkerbloom has shown apparent declines in plant populations (LADWP, Land Management Figure 2). Some populations have declined precipitously (e.g., Robinson 1EX has declined from 78 plants in 2009 to 10 plants in 2014). The reasons for the decline are unclear. However, water regime, grazing, exotic plant competition and land conversion to agriculture have been cited as factors in the decline of Owens Valley checkerbloom (DeDecker 1978, Manning 1993, Halford 1994, Manning 1995, USFWS 1998). Grazing is the most frequently mentioned threat in the CNDDB records (CDFG 2012 in Dudek 2012), but groundwater management and hydrology are likely key considerations when managing to conserve this species (Dudek 2012).

LADWP recommends maintaining current management for another year to better assess trends. The water management at each site could be a confounding factor. In general, grazed sites appear to be sustaining populations better than ungrazed sites. Introducing grazing at the proper time of year (e.g., OV cherkerbloom flowers between April and June) may benefit certain populations through reducing competition from other species or some other mechanism. However, a close examination of the water regime at each site may provide key insight into the apparent decline of checkerbloom in exclosures.

Recommendation

Recommendation 1 - Evaluate the water regime within grazed and ungrazed sites. OV checkerbloom cannot withstand extended dry soil moisture conditions.

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Elimination of Smotherweed Biomass

Background

During 2010, LADWP initiated a study to determine if heavy cattle hoof trampling could decrease and/or eliminate Fivehorn smotherweed (*Bassia hyssopifolia*) biomass. The City contended and used to justify the study that high hoof trampling of vegetation and soils by livestock can be a productive management tool if done properly. The study was to cover a multi-year effort using RAS vegetation mapping and annual on-site evaluation to determine cattle hoof trampling effectiveness. The test began the following grazing season (2010) in the White Meadow Riparian Pasture in the Blackrock Grazing Lease. Livestock forage utilization within the riparian pasture containing the smotherweed test was increased to allow heavy grazing plant utilization in 2010 and apply a 57% utilization rate in 2011. The grazing lease maximum standard for this pasture was 40% utilization on riparian herbaceous vegetation.

Some streamside areas in the White Meadow Riparian Pasture, after undergoing fire, were dominated by 2010 from the quick establishment of invasive smotherweed. The City wanted to test if concentrated heavy hoof action churning the soils and breaking up smotherweed plants would reduce standing biomass and cause the mass to decompose faster. As mentioned before, for the City to get the necessary intensity of hoof trampling, it was necessary to wave the lease vegetation grazing utilization standard for the White Meadow Riparian Pasture during the tenure of the study. Under Adaptive Management, short-term management interventions like this one can be implemented, but, to compensate for all the additional time and money spent requires careful evaluation and reporting of study results. To date the MOU Consultants do not know of any evaluation report that documents the results of the city's experimental study. Also, it is very possible that drought and time have much more effect on reducing smotherweed biomass than by using heavy hoof action by livestock. The study could determine if this was true or not.

Recommendation

Recommendation 1 - The MOU Consultants recommend that the City complete and report on its study on the Fivehorn smotherweed livestock heavy hoof trampling experiment. All study results and follow-up recommendations need to be documented in the County-City 2015 LORP Annual Report.

Range Condition and Grazing Effects on Recruitment

Background

In 2010, at the MOU Consultant's requested as a contingency monitoring program, streamside monitoring study plots (belts) were added to the LORP monitoring program to better determine willow-cottonwood recruitment and survival along the Lower Owens River. This additional monitoring request was made because Range Trend Monitoring does not determine the effects of livestock grazing on streambank condition or streamside vegetation. Nor does it provide adequate information on the survival, diversity and condition of streamside woody vegetation. Study plots were located and referenced by the City in each riparian pasture on both sides of the Lower Owens River within the LORP. In 2010, the first data was collected and in 2011 the first evaluation of the 16 study plots (32 transects) took place. The major goal for justifying the additional monitoring was to determine the success or failure of recruitment and survival of willow and cottonwood trees.

To date, the study plot transect monitoring method has provided good information on willow-cottonwood recruitment (little recruitment) and on juvenile and mature woody plant survival. The study plot analysis also determined streambank stability condition and intensity of willow use by cattle, elk, and beaver. Streamside monitoring has been conducted annually. Over the period of the study, additional study plots have been added and some study plots eliminated to concentrate efforts on evaluating those plots containing high numbers of juvenile willow.

In 2013, determining the status of in-channel woody vegetation was discontinued because of low repeatability caused by poor observer cross-channel visibility. Another major monitoring method modification was to eliminate all study plots that did not contain seedlings or juvenile willow or cottonwood. The only study plots remaining then were those study plots with more than one woody seedling or juvenile tree. The result was that about 12 of the original study plots now remain and about 20 plots previously analyzed were dropped. Additional plots (19) were added to the original remaining plots to better evaluate willow recruitment. Thirty-one study plot transects were evaluated in 2013. The streamside monitoring study also examined the interaction between the combined browsing of elk and livestock and the interaction of elk browsing alone on woody riparian juvenile and mature woody vegetation.

Understanding To-Date

Study plot survey evaluations to-date determined that annual woody plant recruitment along the Lower Owens River is very low (County-City 2014 Annual Report). The survey also determined that cattle and elk grazing does not cause significant streambank instability or erosion problems. Ungulate browsing within most study plots where willow is establishing is slight. High forage grazing intensity was only found in a few isolated locations. A data correlation test showed that as ungulate grazing intensity on perennial grasses increases, browsing on nearby juvenile willow also increases.

Problem

Streamside study plots were NOT randomly selected, but were selected with bias (County-City 2014 Annual Report). Therefore, the results from this study should not be statistically extrapolated to represent conditions over the entire 124 miles of the Lower Owens River streamside environments. Study results have been informative, but the biased plot selection and low plot numbers limits the ability to provide an accurate statistical evaluation of willow-cottonwood recruitment and survival in the LORP (County-City 2014 Annual Report).

A very significant study finding is that 33% of juvenile trees (willow) sampled in the study plots in 2013, were submerged in water during high summer base flows periods. The plant submerged period lasted 2 to 3 months. Most submerged trees showed visible signs of stress. The consistent 2014 (and probably 2013) summer high base flows may have contributed to the lowest recruitment (mainly willow) recorded during the

2014 LORP RAS surveys to date. Willow recruitment is extremely low appearing only on 0.17% of the total streamside area (County-City 2014 Annual Report). To date, given current flow management conditions, the Lower Owens River is not developing into a woody riparian dominated river system (County-City 2014 Annual Report).

The County and City in their 2014 Annual LORP Report covering the streamside woody vegetation monitoring results provided the following recommendations:

1. Livestock should be removed from the river (streamside areas) before juvenile willows break dormancy in the spring on those areas experiencing heavy grazing use in prior years.
2. Prescribed burns should be conducted along the river and surrounding floodplains to remove dense non-willow shrub communities. This shrub removal will provide more river access points for livestock watering, which in turn, will reduce the present watering concentration funneling effect.
3. Willow browsing by livestock and elk in small isolated areas is influencing tree vigor and survivability. What needs to take precedence at this time, however, is addressing the current Lower Owens River flow management policies. Flow management is having a much larger impact on willow vigor and survivability across the majority of the project area than other sources. If flow management continues, as it has during the last several years, most study plots currently monitored will either be permanently flooded or woody vegetation out-competed by tules and cattails as the Lower Owens River expands these species further into the floodplains.
4. Current river flow management is having a far greater impact on the health and abundance of juvenile tree willow stands than any other management action. If not corrected present flows will eventually eliminate the willow stands, regardless of changes made in timing of and vegetation utilization by livestock or manipulating the plant community structure through fire.
5. LADWP recommends that data collection and analysis continue on the streamside study plots to improve understanding of juvenile woody riparian vegetative growth rates and their tolerances to browsing by large ungulates. Tracking both the timing of plant use and grazing intensity on these plants by livestock is contributing to a deeper understanding of when young trees are targeted or avoided by cattle and elk.

Recommendation

Recommendation 1 - The MOU Consultants support LADWP 's Recommendation 1. This livestock grazing timing and removal policy should be implemented in 2015.

Recommendation 2 - As documented in our past adaptive management recommendations, the MOU Consultants fully support LADWP's Recommendation 2. Controlling non-willow dense shrub community invasions along the river should be a primary management goal as long as control does not interfere with or cause mortality on present or future willow-cottonwood recruitment or survivability.

Recommendation 3 - The MOU Consultants fully support LADWP's Recommendations 3 and 4. The MOU Consultants river flow recommendations in their 2014 Adaptive Management Section in the Annual Report provides flow management direction that, if implemented, will help solve the concerns expressed by LADWP.

Recommendation 4 - The MOU Consultants support LADWP's Recommendation 5 calling for continuing the streamside woody recruitment and survivability evaluation study. The study is providing information that will help guide future livestock grazing management. The MOU Consultants do, however, also recommend that the City's Staff, during the winter of 2015, develop a proposed study plan that addresses and solves the problem of data being collected and findings being determined that cannot be transferred across the entire Lower Owens Riverine-Riparian system. RAS and the Streamside woody vegetation evaluations are not providing all the necessary information and understanding needed to determine what is going on ecologically over the entire riverine-riparian system as related to willow-cottonwood recruitment and survival. The City should be prepared to submit this proposed contingency monitoring document to the scientific team by the spring of 2015 for their evaluation and action, if any.

Lower Owens River Channel

Scientific Evaluations and Adaptive Management

Background

The MOU Consultants Adaptive Management Chapter in the 2013 Annual Report (Inyo County and LADWP 2013) recommended major changes in Lower Owens River flow management. Flow management changes that are needed if MOU (1997) goals are to be met. Important recommended actions include implementing different base, seasonal habitat, Delta Habitat Area, pulse, and flushing flows. Major changes were also recommended in flow magnitude, flow timing and flow duration. These management changes were recommended for implementation in 2014. None of the MOU Consultants' Lower Owens River 2013 adaptive management flow recommendations were implemented by the County or the City in 2014. The City, in response to these adaptive recommendations, however, proposed favorable Lower Owens River flow management changes. The City submitted their flow proposal to the MOU Parties for review, comments, and evaluation at the "River Summit". Their proposal, to-date, has not made it through the MOU Parties evaluation process.

In the 2013 Annual Report response, Inyo County expressed the need for major river flow changes. The County, however, challenged the MOU Consultants for making adaptive management flow recommendations that lacked scientific backing and scientific justification (See Table 24). MOU Consultants adaptive management recommendations were also challenged by the County for not being supported by research and analysis. Inyo County clearly emphasized that they would not accept or approve any adaptive management recommendations that do not have supporting research, scientific data, and supportive quantifiable information. The County maintained it was difficult for them to act on such vague proposals by the MOU Consultants with weak justification of environmental benefits. The County stated that it is possible that the MOU Consultants proposed planning effort will result in adaptive management recommendations the County could not support.

The MOU Consultants understand the difficulty the County is having and hope it can be corrected. MOU Consultants could use more supporting scientific understanding, more improved and reliable scientific data, and more thorough scientific evaluations, in their responsibilities in implementing the LORP. The MOU Consultants in this chapter are proposing a solution to the perceived lack of scientific information that may exist.

Table 24. Inyo County Response to some of the 2013 Adaptive Management Recommendations.

RECOMMENDED BASE FLOWS

MOU Consultants Recommendation:
The MOU Consultants recommend that all requirements in the MOU (1997) and respective Stipulation and Orders that dictate how the 40 cfs base flow is applied be rescinded.

Inyo County Response:
This effort should be informed by quantitative information and analysis to determine revised base flows that would further project goals.

RECOMMENDING RELEASING AN AVERAGE ANNUAL FLOW OF 55 CFS FROM THE INTAKE CONTROL STATION

MOU Consultants Recommendation:
A new Stipulation and Order be submitted to the Court for approval requiring the city to release an average annual flow of 55 cfs from the Intake Control Station into the Lower Owens River.

Inyo County Response:
No specifics how Lower Owens River flows should be managed through the year were provided by the MOU Consultants. It is unclear whether the MOU Consultants recommendation of the 55 cfs average flow is based on an assessment of the biologic and hydrologic requirement to accomplish the LORP goals or is simply trial and error to preserve water neutrality. It is difficult for the County to act on these vague proposals with such weak justification of the environmental benefits. MOU Consultants lack of specifics on how flows through the year should vary and the environmental benefits expected is sufficient reason for the County not to endorse this recommendation.

Table 24. Continued

RECOMMENDING THE DEVELOPMENT A NEW LOWER OWENS RIVER FLOW MANAGEMENT STRATEGY

MOU Consultants Recommendation:
The County and the City develop a new Lower Owens River flow management strategy during the 2013-2014 winter.

Inyo County Response:
MOU Consultants provide no evidence that increasing the base flow from 40 cfs to 55 cfs would better accomplish any of the LORP flow related management objectives.

RECOMMENDED SEASONAL HABITAT FLOW MODIFICATIONS

MOU Consultants Recommendation:
A seasonal habitat peak flow of 300 cfs or more be released from the Intake Control Station during 2014.

Inyo County Response:
The County supports experimenting with flow, including the seasonal habitat flow. At this point the MOU Consultants recommendation lacks sufficient explanation on how specific flow changes will benefit the project.

Legal Responsibility

The MOU (1997) requires that the MOU Consultants, while conducting their LORP responsibilities, to work under the direction of Inyo County and the City of Los Angeles. Under this direction, The MOU Consultants work is further directed via restrictive Task Orders with allowable work hours not to be exceeded. These Task Orders are approved by Inyo County and the City of Los Angeles. No Task Order allows the MOU Consultants to conduct scientific research, collect scientific data, or related scientific methodologies.

The MOU Consultants utilize the scientific research, scientific data, scientific evaluations, and scientific direction that appear in the County-City Annual Reports, or are otherwise provided in interim reports or data. The MOU Consultants base their adaptive management recommendations on the LORP monitoring and evaluation results provided in County-City Annual Reports. The MOU Consultants also inject their experience and expertise in making recommendations. The Monitoring and Adaptive Management Report (2008) outlines MOU Consultants responsibilities along with those for the City and County.

The MOU (1997) also requires the County and City to assist the MOU Consultants in conducting their LORP responsibilities. Therefore, if the County believes there is some missing point or needed piece of information that is lacking the County has the responsibility to provide credible scientific research, scientific data, and related scientific evaluations to the MOU Consultants for consideration. Making this information available prior to the MOU Consultants making their annual adaptive management recommendations will make LORP implementation more successful. If the County cannot conduct these tasks then they should specify the needed work to be done in Task Orders from which the MOU Consultant can work.

For the MOU Consultants to fulfill their legal responsibilities in implementing the LORP and making valid adaptive management recommendations, they must have adequate scientific data and evaluations to assist them. The County seldom provides any assistance to the MOU Consultants that relates to scientific needs. The County-City Annual Reports may be lacking in quantifiable scientific data and evaluations, as expressed by the County. This lack of scientific input needs to be determined and provided.

The MOU Consultants believe, as the County does, that there should be adequate available scientific research studies and resulting quantifiable proven evaluations to guide LORP management. But, it needs to be emphasized that it is not the lack of scientific information and understanding that is holding back LORP progress. It is legal and policy restrictions combined with the lack of effective management actions that are holding back LORP progress at this time.

Also, it should be understood that adaptive management is not a research program with the intent of making new discoveries. However, if the County thinks research is a missing component to LORP knowledge, then the following recommendations apply.

It is not the lack of scientific information and understanding that is holding back LORP progress. It is legal and policy restrictions combined with the lack of effective management actions that are holding back LORP progress.

Recommendations

Recommendation 1 - The MOU Consultants recommend that Inyo County prepare a comprehensive "LORP Scientific Research, Data, and Evaluation Needs" document. This document must display the quantifiable scientific information and scientific evaluation the County believes is lacking. This document would specify in detail all scientific research, scientific understanding, and the missing quantifiable data the County believes is available and not being used by the MOU Consultants. The document should also define the needed scientific data and evaluation that is not available, and future needs to be attained to properly implement the LORP. This document will provide the justification for its preparation, the cost required to produce, and how this cost would be paid. A preliminary planning document should be prepared first that would develop the time frame for document completion and who would be responsible for conducting the necessary research, data collection, and evaluation that is not currently available.

Recommendation 2 - The MOU Consultants recommend that during winter of 2014-2015, Inyo County prepare a "draft" of their document. This "draft" would then be submitted by mid-winter to each member of the Scientific Team for review, comment, corrections, changes, additions, and updates. The Scientific Team would then meet within one month of receiving the document and make the necessary changes and additions that would allow their approval of the document. The Scientific Team would then send a "final draft" to the Technical Group for processing. The Technical Group would then, once it was evaluated, updated, and approved, send the "final proposal" to the Standing Committee for action. Standing Committee approval would then allow the document work requirements and needed budget to be included into the County-City 2015-2016 Work Plan.

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Start of the Lower Owens River

The Lower Owens River is controlled by the headgates of the LA Aqueduct intake structure and the river release gates. The river channel begins below the release gates, and flow is dependent upon relaeases from the control structure.

Proposals / Concepts 4

Should the LORP Explore New or Different Tactics?

Some interested parties have inquired as to why more active restoration techniques are not being employed in the LORP. In particular, Inyo County Water Department has asked the MOU Consultants to research and appraise the efficacy of several alternative restoration techniques for use in the Lower Owens. This section discusses and analyzes the reasoning and feasibility of these suggested proposals and ideas.

The MOU Consultants recognize that there is both impatience and apprehension over lack of progress in the LORP; ranging from lack of habitat development and channels filling with tule/cattail to poor water quality conditions. Whether these issues are real or perceived, it is likely worth taking time to describe why certain restoration approaches are utilized and why many are not adequate or relevant to this project.

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.

LORP Restoration Philosophy

Since project inception it has been understood that 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. The overarching goal expressed in the MOU is for the LORP to be a natural, self-sustaining ecosystem to the extent possible.

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.

The LORP emphasizes 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.

> *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 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.*** (LORP FEIR, 2004)

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.

LORP Restoration Reality

The trajectory of ecosystem recovery has come into line with river flow regime and land management conditions. The past and current flow management regime for the river is causing ecological stagnation and limiting the ability of the river to achieve original goals, expectations, improve overall health and develop a balanced ecological system. The flow regime for the Lower Owens River, as currently configured, is problematic yet it is the key to whether the LORP will succeed or fail. The current flow regime is managed to attain policy and compliance obligations first and foremost. If these prescribed river flows happen to benefit the riverine ecology it is secondary to the need to meet fixed legal obligations. As such the current river baseflow is confounding and recent seasonal habit flows are so small as to be completely ineffective. The Lower Owens River is degrading because it is fixed in place by legal stipulations dictating flow regimes that do not conform to any ecological or natural process. Compliance restrictions are inhibiting the LORP's potential and are affecting it negatively.

Discussion

There are three generalized approaches to restoring a disturbed riverine-riparian environment:

(1) rely completely on passive (spontaneous succession)

(2) exclusively adopt active, technical measures

(3) or a combination of both passive and active techniques toward a target goal (Hobbs and Prach 2008). Passively restored sites exhibit robust biota better adapted to site conditions with increased natural value and wildlife habitat than do actively restored sites alone (Hobbs and Prach 2008)

Ecological restoration involves assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed, typically as a result of human activities (Sala et al., 2000). Ecological restoration is based on the view of ecosystems as biological communities established on a geophysical substrate that can develop into alternative stable states rather than into a single climax state (Lewontin 1969). As a consequence, the idea of the balance of nature has been replaced with the flux of nature (Wu and Loucks, 1995; Pickett and Ostfield, 1995; Wallington et al., 2005), and ecosystems are thought to be mostly in non-equilibrium. Their dynamics are not only complex but also dependent on the spatial context and the history of natural disturbance and human influence (Hobbs and Cramer, 2008). The main implication of this conceptual model is that ecosystems that have been altered by human activity may not revert back to its original state if left alone. On the contrary, these altered ecosystems could reach a different stable state defined by the actions of human management on them (i.e. soil alteration and erosion, invasive species, loss of native species, changes in hydrological regime, etc.). The goal of ecological restoration is therefore the reestablishment of the characteristics of an ecosystem, such as biodiversity and ecological function that were prevalent before degradation (Jordan et al., 1987), and that will not be reached (or if so, in very long time scales) by the ecosystems if left alone.

The persistence of undesirable functional states is an indication that the system may be stuck and will require active intervention to move it to a more desirable state (Hobbs and Prach 2008). Understanding when passive versus active restoration approaches are warranted can increase chances of success and reduced project costs.

Conclusion

The MOU Consultants believe that there are several feasible solutions that can positively affect the LORP. These recommendations are discussed in Section 6 of this document. These solutions are neither draconian nor outlandish. Each recommendation is based in reality, on scientific principals and expert judgment, and can be attained through mutual cooperation and diligence by all responsible parties.

The proposals evaluated in this section do not all have a reasonable chance of success, nor are worth investing time or funding. However, they do increase all stakeholders understanding of inherent limitations and conditions that exist in the LORP.

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Woody Riparian Pole Plantings

Introduction

This proposal presented by Inyo County staff for consideration would involve a few 1-acre plots of plantings. To get these plantings to establish would require background research identifying the proper sites. Then the sites would need to be visited and final sites selected. Shallow groundwater wells would need to be installed with a transducer to measure groundwater levels at selected sites, which would involve heavy machinery, amongst other options (see the next section on shallow groundwater monitoring).

Next the planting consultants would design the planting technique based on soils and groundwater conditions, and finally they would plant the site. Fences would be required to keep out elk and cattle. A monitoring and adaptive management program would need to be implemented. This would be a strategy to create a seed source for future establishment, or a pilot project. Based on results of the pilot study, more efforts would be designed at a later date. These efforts are intensive, but are far superior in design and success rates than haphazard planting of willow cuttings along the stream, as has been employed in the past.

The likelihood of successful establishment of willow trees utilizing this technique appears to be greater than past techniques and represents the current active restoration techniques utilized within the industry.

Evaluation

There are several factors to consider with the application of such a technique to the LORP. Such active restoration techniques should be applied only as a last resort. The LORP plan is one that relies on passive restoration techniques. Monitoring and evaluation and adaptive management at the proper time scale are required for passive restoration success. Sufficient time has not passed, sufficient monitoring has not been performed, and many other less costly and less invasive adaptive management actions have not yet been employed. Creation of such woody riparian stands through this method of pole plantings would not fulfill the requirements of the MOU or the LORP FEIR that habitats be self-sustaining (for more information see the Woody Recruitment section of this report).

The first thing to consider is what has the recruitment and establishment success been in the LORP to date? What would the proper evaluation of success be and what would be the best metrics to evaluate that success? This idea is discussed in detail in the section of this report on woody recruitment and establishment. Without the landscape scale mapping, site scale mapping, or the woody recruitment and establishment effort recommended in this year's report, there is insufficient monitoring data to justify such a change in restoration philosophy and expense. As cited in the woody recruitment section, developing forested wetlands can require an extended time period (10 to 50 years). When considering the cost and justification, mangers must ask themselves: why should we plant trees and then fence them from grazing when naturally reproducing seedlings are not being fenced and their development is being inhibited by browse pressure (LADWP Land Management Report 2014)? Further, the reasoning for creating a seed source for recruitment is flawed; there are ample seed sources above, below, and within the project area. If there were areas where landforms were inundated by high flows and bare scour areas with no recruitment, there would be evidence of a seed source problem. However, that is not the case. Woody recruitment and establishment in the LORP is more likely tied to flow and land management than the lack of a seed source.

In addition to being extremely costly this proposal does not merit consideration for application in the LORP at this time in the project.

Shallow Groundwater Monitoring

Introduction

This proposal was presented by Inyo County staff for consideration in conjunction with pole plantings (see previous section). The shallow groundwater system adjacent to the Lower Owens River is vital to woody riparian persistence and groundwater-dependent alkali meadow habitat (Brothers 1981; Danskin 1998; Hill et al. 2002). Shallow groundwater within the Owens Valley is closely interconnected to surface water and historically was a major source of water to the Lower Owens River (Danskin 1998). A groundwater study by Hollett et al. (1991) generally defined the hydrogeologic boundaries, water flow paths and water budget of the Owens Valley aquifer system. However, impacts from water diversion and groundwater pumping are ongoing, and more recent groundwater studies have not been performed. Shallow groundwater monitoring could be implemented to better understand the current state of the groundwater system and its impact on woody vegetation recruitment.

Monitoring Types

There are many types of shallow groundwater monitoring systems; this section investigates the following:

- Open boreholes
- Monitoring wells
- Standpipe piezometers
- Drive point piezometers

Open Boreholes

An open borehole is a cylindrical hole drilled vertically into the ground, usually of relatively small diameter. Surface casing and seal caps are often installed to protect against surface contamination and caving (Keller 2013). Unless the borehole is drilled into competent rock, casing must be installed within the borehole to support the walls in unstable conditions (Keller 2013), at which point the borehole highly resembles a well and the terms are often used interchangeably.

Open boreholes are prone to sloughing or collapsing of rock material and tend to be unstable (Keller 2013).

However, they may be necessary when studying horizontal flow movement and chemical transport within fractured rock (Keller 2013; Shapiro 2007). If the right soil or rock conditions are present, an open borehole could be installed for preliminary groundwater monitoring purposes before investing in more costly components.

An open borehole can also be used on a one-time basis to monitor the water table near the surface, such as within a wetland area. In this case, the borehole can be hand augured. It may be necessary to scarify the sides of the hole in improve infiltration and sufficient time is needed for water levels to stabilize at the water table (Minnesota BWSR 2013).

Monitoring Wells

A monitoring well is a perforated pipe set vertically into the ground to access groundwater. Water levels inside the pipe result from the integrated water pressures along the entire length of well screen (perforations) that extends from just below the soil surface to the bottom of the pipe (Sprecher 2000, 2008). In non-disturbed soil, water levels within the well generally represent the elevation of the water table. A monitoring well is useful for determining the depth, duration, and frequency of near-surface saturation, and fluctuations within the water table (Minnesota BWSE 2013; Sprecher 2000, 2008).

A monitoring well for shallow groundwater consists of 1 inch diameter Schedule 40 PVC pipe with 0.01 inch slots, known as a well screen, from about a half foot below the ground surface to the bottom of the pipe, a riser made of solid PVC pipe about 12 inches above the surface, vented well cap at the top and a cap at the bottom of the well screen (Sprecher 2000). Silica sand is placed around the well screen and a bentonite seal is installed around the riser to prevent the infiltration of surface water. Lastly a bentonite/soil mixture is placed at the top at an angle to direct surface flows away from the well (Sprecher 2000).

Standpipe Piezometers

A piezometer is designed to detect the presence of groundwater at a precise depth; specifically it measures the static water pressure of groundwater and can be used to better understand the depth and movement of the water table (Sprecher 2000). Because piezometers can detect groundwater at a precise depth, they can be used to identify and monitor perched groundwater systems and deeper groundwater systems that would not be detected by a monitoring well (Sprecher 2000, 2008). Also, piezometers can be used to determine whether the groundwater is rising or falling, also known as a discharge or recharge system (see "water levels within piezometers" below).

A standpipe piezometer is similar to the construction of a well except the zone of perforation is located only at the bottom of the pipe. A piezometer typically consists of the following: a 1 inch diameter Schedule 40 PVC pipe with the well screen located along the bottom 6 inches containing 0.01 inch slots; a solid cap at the bottom; a riser made of PVC pipe that extends about 12 inches above the surface; and a vented cap at the top (Sprecher 2000). Silica sand is placed around the well screen and 12 inches of bentonite clay is placed above the perforated zone to prevent water flowing down the outside of the pipe. Soil backfill can be used above the bentonite seal until 4 inches to the surface in which another bentonite seal must be installed to prevent infiltration of surface water. Lastly a bentonite/soil mixture is placed at the top at an angle to direct surface flows away from the well (Sprecher 2000).

Water levels within piezometers

Water levels inside the piezometer do not necessarily equate with the actual water table but result from the water pressure over the zone of perforation at the bottom of the pipe. Consequently, piezometers installed at different depths can have varying water level elevations within the pipe even if they intercept the same body of groundwater (Sprecher 2000). These differences can be significant if the groundwater is moving upward or downward. For example, when groundwater is moving upward, as in artesian flow, water pressure is greater at depth than it is near the groundwater surface resulting in higher water level elevations in deep pipes than in shallow pipes (Sprecher 2000). The opposite is true for piezometers installed where groundwater is moving downward. In this case, water level elevations are lower in deep pipes and higher in shallow pipes. For this reason, both shallow and deep piezometers need to be installed at each monitoring station when there is uncertainty regarding the groundwater system.

Drive point piezometers

Drive point piezometers use newly developed direct push technology (DPT) to perform monitoring investigations by driving, pushing, and/or vibrating small-diameter hollow rods with sampling devices into the ground (EPA 2005). Drive point piezometers can be a cost-effective alternative traditional well and piezometer installation methods, especially when a large number of piezometers are needed.

Benefits of using drive point piezometers for groundwater monitoring are as follows (EPA 2005):

- Faster installment and sampling capability that helps to provide more data
- In general, lower cost when greater data density is needed
- Greater variety of equipment and methods allowing for more flexibility and customization
- Better vertical profiling capability for generating three-dimensional profiles
- Less investigation-derived waste and exposure potential

However, direct push technology may not be able to penetrate bedrock or unconsolidated layers with significant amounts of cobble or gravel. Also, traditional piezometers and wells are able to access deeper layers and allow for collection of larger sample volumes (EPA 2005). Soil conditions need to be assessed prior to using direct push technology, as there is little or no space for the conventional filter pack to be installed around the well screen, which can lead to monitoring errors.

Drive point piezometers are typically constructed of 1-2 inch PVC or steel pipe that contains a slotted or screened section at the bottom to access groundwater (EPA 2005). These devices can be constructed by hand or purchased from a manufacturer.

There are two main methods for installing drive point piezometers: exposed screen well installation and protected screen well installation. In exposed screen well installation the piezometer typically is installed using driving rod that is placed within the piezometer and pounded into the ground. More sophisticated methods use a system of exterior rods to drive the piezometer into to place, which can protect the piezometer from damage (EPA 2005). As its name suggests, the screen is exposed to the surrounding soil material which acts as the “filter pack” installed in regular monitoring wells. Shallow, sandy materials are ideal for exposed screen drive point piezometers, whereas as predominant silt or clay soils can plug the piezometer as it is advanced into the ground (EPA 2005). Exposed screen well installation should not be used in areas where there is suspected contamination or they should be installed upgradient of potential contamination sources (EPA 2005). In protected screen well installation, the outer driver rod has already been driven to the target depth and the piezometer is then lowered into place to protect the screen during installation; if there is sufficient clearance, a filter pack and annular seal may be installed around the exterior of the piezometer (EPA 2005).

For both methods, the top of the piezometer is sealed using the same techniques for conventional wells to prevent surface contamination, except when being installed within the water column or when used temporarily.

Depth of Wells and Piezometers

Prior to well and piezometer installation, a detailed soil profile that includes horizon depths and information about texture, induration, bulk density, redoximorphic features, and roots must be performed (Sprecher 2000). This will identify differences in permeability and the presence of soil strata that can alter water flows, such as an impermeable layer (aquitard), and the appropriate depth can be determined.

Monitoring wells should be installed above aquitard layers at a depth that answers desired monitoring questions (Sprecher 2008). If the objective is to determine if the water table is present at a particular elevation, or to determine the duration and frequency of near-surface saturation, then a shallow monitoring well is sufficient; to measure fluctuations within the water table, a deeper well should be installed (Sprecher 2008; Minnesota BWSR 2013).

Since piezometers are depth-specific they can be installed above, below and even within aquitard layers; they are often used to identify and monitor different groundwater systems and the vertical component of ground water flow (Minnesota BWSR 2013). Any time there is uncertainty regarding the groundwater system, such as degree of perching or whether it is a recharge or discharge system, both shallow and deep piezometers need to be installed at each monitoring station (refer to "water levels within piezometers" in the standpipe piezometer section) (Sprecher 2000, 2008).

For shallow groundwater systems, piezometer depths typically range from around 15 inches to 10 feet, but can be installed at the depths of hundreds of feet depending on monitoring objectives (Sprecher 2000). Determining the proper well and piezometer depths required to meet monitoring objectives must be carefully considered prior to installation in order to select the correct instrumentation and to avoid gathering meaningless data.

Selection of Monitoring Sites

To accurately monitoring groundwater flows, an array of wells or piezometers need to be located within the area of interest. The overall number of wells/ piezometers and location of monitoring sites will depend on monitoring objectives.

For example, to determine water flow paths, piezometers should be located both up- and down-gradient along suspected water flow paths (Sprecher 2000). To determine boundary between wetlands and non-wetlands, wells or piezometers should be placed perpendicular to expected wetland boundary (Sprecher 2000). Monitoring wells and piezometers can also be placed within the river channel and situated perpendicular to the river along transects. Statistical methods can be employed to design monitoring arrays using hydrogeological information to determine well placement (Rosen 2003, Prakash and Singh 2000).

An array can consist of any number of monitoring stations. Recent studies involving groundwater monitoring along rivers tend to be between 5 and 30 monitoring sites (Allen et al. 2010, Horner 2005, Hunt and Nylen 2012, Bobbi and Gurung 2006, Simonds and Sinclair 2002, Coultier et al. 2014); in these cases monitoring was performed within a specific area of interest of within a representative reach of the river. Along the River Leith in the United Kingdom 88 piezometers have been installed along an 850 foot reach of the river (Binley et al. 2010). A recent groundwater study in the Sierra Nevada employed 10 drive point piezometers along 3 transects to determine timing, duration and depth of groundwater (Hunt and Nylen 2012).

Monitoring Devices

For all of these monitoring systems, water levels can be checked manually using either a commercial water-level sensor or a steel measuring tape marked with chalk or a water-soluble marker (Sprecher 2008, USACE 2005). Automatic monitoring devices tend to be more accurate and add credibility to the monitoring effort. These automatic data loggers have a pressure transducer or capacitance-based sensor to measure the water level and a memory circuitry to record and store the levels at specified times (Minnesota BWSR 2013, Sprecher 2008). The upfront cost of an automatic device can be significant but may offset the travel and labor costs involved in manual monitoring techniques, depending on the site and available personnel.

If using a manual system, water levels should be monitored at least weekly, while automated systems should be visited on a monthly basis (Minnesota BWSR 2013). In highly variable systems, both manual and automated system may need to be checked more frequently. Statistical approaches can be used to determine optimal sampling frequencies for groundwater networks (Zhou 1996).

Cost

For traditional installation methods, such as for wells and standpoint piezometers, the cost depends almost entirely on the boring technique employed, which varies significantly depending on site geology and desired depth. A hand auger can cost as little as $50 but can only be used in relatively soft soils and at shallow depths, whereas a basic, portable drilling system that can penetrate rock and go to greater depths can cost $5,000 to $10,000 (Holmes et al. 2001). Also consider that most counties require special licensing and permits to perform drilling and labor costs wil be a major factor to consider.

Monitoring well and standpoint piezometers can be constructed by hand using common materials, such as PVC pipe, for less than $100. Commercial units are available from manufacturers such as Solinst®, Geokon® and RST Instruments® for around $200 for all of the components. Commodity prices for silica sand and bentonite cost around $49.60 and $65.00 per ton, respectively (USGS 2014), but can cost less if bought in large quantities from mining suppliers.

Depending on monitoring needs, a simple drive point piezometer can be constructed by drilling holes into the bottom of a steel pipe or PVC pipe with a screw-on cap for less than $50. Drive point piezometers systems are available commercially (e.g. Solinst®, Geokon®) and cost anywhere from $100 to $500. The pushing/ driving technology is often sold along with the unit. For example, the manual slide hammer and drive head assembly from Solinst® is sold for $295 (forestry-suppliers.com).

Automated loggers (e.g. Solinst®, Hobo®, Global Water®, and Campbell Scientific®) typically range from $1,000 to $3,000 (USGS 2012; forestry-suppliers.com, Kane and Beck 2000).

There are also the ongoing monitoring costs associated with data collection and analysis.

Discussion

Nearly all of the recoverable ground water in the Owens Valley is in unconsolidated to moderately-consolidated sedimentary deposits, intercalated volcanic flows and pyroclastic rocks that fill the basin (Hollett et al. 1991). Average depth to groundwater is around 3 to 15 feet along the valley floor (Danksin 1998). The mostly unconsolidated underlying material and shallow depth to groundwater should allow for the installation of drive point piezometers, which are far more cost effective than traditional well and standpoint installation methods. However, the size and scale of the Lower Owens River Project, makes the implementation of a comprehensive groundwater monitoring network costly, regardless of chosen monitoring methods. Regular observation of hydrological indicators, such as mapping and monitoring of plant communities may provide similarly useful information regarding the groundwater system for less cost. A shallow groundwater monitoring program may be worthwhile for a site-specific project, such as pole planting of woody riparian trees. Specific goals and objectives need to be determined prior to implementing any groundwater monitoring program which will help determine the monitoring strategy and approach.

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Use of Explosives for Channel Clearing and Wetland Creation

Introduction

This section examines the concept forwarded by Inyo County Water Department staff to use explosives for channel clearing and the creation of ponds/wetlands. The technique of blasting has been used in restoration efforts, usually in situations where there are challenges to using heavy excavation equipment (e.g. boggy conditions, access, etc.). The use of explosives as a restoration tool is new and impacts from blasting have yet to be fully understood.

Discussion

To test the utility of blasting at the Klamath Marsh National Wildlife Refuge in Oregon, a series of pilot projects were completed between 2010 and 2012 using explosives to excavate channels and wetlands in areas with boggy conditions or where the groundwater lies at or near the surface (USFWS 2014). The technique was found to be efficient at creating open water while matching specified design dimensions for both channels and wetlands (USFWS 2014). Explosives were also used to create a meandering tidal creek in soft marsh surfaces in the South Slough National Estuarine Research Reserve, Oregon (Cornu 2005). In areas with a high water table, explosives have been used to establish small emergent wetlands, such as in the Superior National Forest in Minnesota and the Daniel Boone National Forest in Kentucky (Biebighauser 2007). In all of these cases, explosives were not used in open water with aquatic wildlife.

In-channel use of explosives generally includes the removal of levees and other structures affecting natural hydrology. For example, in the South Fork Skagit River in Washington, explosives were used in the summer of 2007 to remove levees; demolition occurred during daytime low-low tides in order to limit the impact on local fish populations (SRSC 2008). In 2006, the U.S. Forest Service used explosives to clear a large log jam that had completely blocked the Middle Fork Salmon River, though this was primarily conducted for safety and recreational purposes (USFS 2011). The use of explosives as a tool to remove overgrown wetland vegetation, such as cattail and hardstem bulrush, has been proposed for study by the Oregon Department of Transportation (ODOT 2014). However, the status of this study is unknown and results, if any, have not yet been published.

Benefits to using explosives as a restoration tool have been cited as lower cost and time savings when compared to traditional earth moving activities as well as cost savings associated with on-site disposal of excavated material (as it is dispersed in the blast radius). Researchers postulate that the use of explosives may have fewer environmental impacts than mechanical excavation due to the shorter time-frame and less ground disturbance (McDevitt and Carleton N.D.).

However, comprehensive environmental impacts from blasting have not been fully studied. It is known that the use of explosives in open water causes a shock-wave which can injure or kill fish and aquatic life; impacts vary depending on the timing, location and energy of the explosion (Keeven and Hempen 1997, Govani 2008, Dunlap 2009). Use of explosives can also result in mortality, habitat destruction, disturbance and displacement for birds and other terrestrial species (Holthuijzen et al. 1990, Larkin 1994, BLM 2005). Both water and terrestrial pollution is also an issue of concern when using explosives (Lusk and MacRae 2010). For this reason, a permit under the Clean Water Act through the U.S. Army Corp of Engineers would be required. The California Department of Fish and Wildlife would also require a permit; use of explosives in state waters inhabited by fish is prohibited without a permit (FGC Section 5500). Lastly, the LADWP and Inyo County would need to hire trained and certified individuals to administer the use of explosives.

To date, proper justification for employing such active interventions has not been provided. The issue to be addressed (i.e. to remove occlusions across the channel, to create one primary channel, to create deepwater habitat, etc.), the specific locations these problems exist and reasoning for the use of explosives as the best tool to address the problem at each site needs to be provided. Before undertaking invasive measures such as demolition of existing wetland habitats, substantial investigation and justification must be presented to warrant serious consideration for implementation.

While the use of explosives to manage tule and cattail in the LORP might be effective on a site-specific scale, in the short-term when managers have specific objectives that are not practically achieved through less invasive methods, these active restoration techniques do not address the processes that drive the location and extent of marsh vegetation. This method is not self-sustaining as mandated by the MOU (1997). Modifying the current flow regime to bring more variability to the hydrograph is the best tool for managing marsh vegetation on the LORP project scale (See Tule and Cattail Management section).

Further, LADWP and Inyo County currently do not have site-specific goals to manage tule and cattail with which to develop cost and justification for such an effort. While sources indicate cost savings when using explosives versus conventional earth-moving techniques, this is from the standpoint of a one-time restoration action that would ultimately be self-sustaining. When viewed as an ongoing management tool, the costs associated with using explosives, including environmental assessments, permitting and implementation, are considerably higher than other management techniques. Lastly, the unknown impacts from the use of explosives on fisheries, indicator species, and their habitat would render the use of explosives as an unjustified and unacceptable risk to the LORP.

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Lower Owens River

Recommendations 5

Baseflows - page 40

2013 Baseflow Recommendations

Recommendation 1 - The MOU Consultants recommend that all requirements in the MOU (1997) and respective Stipulation and Orders that dictate how the 40 cfs base flow must be applied be rescinded.

Recommendation 2 - The County, the City, and with the assistance of the MOU Consultants develop a new Lower Owens River base flow management strategy. This flow management strategy would be compatible with the requirement that the City release an annual average 55 cfs flow into the Lower Owens River at the Intake Control Station.

Recommendations 1 and 2, made in 2013, still stand and again have the MOU Consultants full support.

2014 Baseflow Recommendations

Recommendation 1 - The MOU Consultants recommend that their 2013 base flow adaptive management recommendations be implemented in 2015.

Recommendation 2 - The MOU Consultants recommend that the City's proposed base flows, as outlined in Figure 1 and documented in Table 1, be implemented in 2015. The City submitted their proposed base flows for review and comment to all Parties at the "2014 River Summit."

Recommendation 3 - The MOU Consultants recommend that the City's proposed base flows be implemented, monitored and evaluated to determine their effectiveness and needed refinement.

Seasonal Habitat Flows - page 42

2013 Seasonal Habitat Flow Recommendations

To implement more productive seasonal habitat flows the MOU Consultants made the following adaptive management recommendations in 2013 (County-City 2013):

Recommendation 1 - The MOU Consultants recommend that the County, the City, and with the assistance of the MOU Consultants develop during the winter of 2013-2014, a new Lower Owens River flow management strategy. This flow strategy would be compatible with the City releasing an annual average of 55 cfs into the Lower Owens River from the Intake Control Station.

Recommendation 2 - The MOU Consultants recommend a seasonal habitat peak flow of 300 cfs or more be released in 2014. (Note – This flow recommendation was made in case the other flow recommendations were rejected.)

The MOU Consultants 2013 adaptive management seasonal habitat flow recommendations still stand. These recommendations still have the MOU Consultants full support for implementation.

2014 Seasonal Habitat Flow Recommendations

Recommendation 1 - The MOU Consultants recommend that the City's proposed seasonal habitat flow be implemented in 2015 (see Figure 1 and Table 1 for details). This Lower Owens River flow management proposal was submitted by the City for review and comment to all Parties at the "2014 River Summit".

Recommendation 2 - The MOU Consultants recommend that the City's proposed base seasonal habitat flows be implemented, monitored, and evaluated to determine their effectiveness and needed refinement.

Flushing Flows - page 43

2013 Flushing Flow Recommendations

The MOU Consultants recommended in their 2013 adaptive management recommendations that a late winter-spring flushing flow, similar to the flushing flow released in February 2008, be released during 2014. The MOU Consultants recommended flushing flows be evaluated to determine if benefits are received. Flow releases of this type could provide experience and information allowing future winter-spring flushing flows to be more effective.

These flushing flow recommendations made in 2013, still stand and again have the MOU Consultants full support.

2014 Flushing Flow Recommendations

Recommendation 1 - The MOU Consultants recommend that the proposed flushing flow submitted by the City be implemented in 2015 (see Figure 1 and Table 1 for details). This flushing flow proposal was presented for review and comment to all Parties at the "2014 River Summit".

Recommendation 2 - If the MOU Parties refuse to accept and implement Recommendation 1, then the MOU Consultants recommend that a flushing flow exceeding a peak of 300 cfs be released in late spring of 2015. This flushing flow would be monitored and evaluated for effectiveness and refinement.

Recommendation 3 - The MOU Consultants recommend that all implemented flushing flows be monitored and evaluated to determine their effectiveness and needed refinement.

Combined Flow Management - page 43

Recommendation 1 - That MOU Consultants recommend that their final recommended combined flow pattern, displayed in Figure 2 in this report, be reviewed and evaluated by the Scientific Team and submitted for action in time to be implemented in 2015.

Pumpback Station and Flow Limitations - page 45

Recommendation 1 - The MOU Consultants again recommend that all Pumpback Station restrictions appearing in Stipulation and Orders or in any other related legal or policy form be rescinded. No limitation should be placed on the amount of water that can be pumped-out by the Pumpback Station as long as it does not interfere with required flows that must go to the Delta Habitat Area.

Recommendation 2 - The County responded to the MOU Consultants 2013 Adaptive Management Recommendation to eliminate the 50 cfs pump-out limitation. The County called for this matter to be discussed for solution by the MOU Parties. The MOU Consultants recommend that the County follow their stated direction and make every effort possible to come up with a workable solution favorable to the Parties.

Recommendation 3 - If the MOU Parties cannot come to a consensus on deleting the 50 cfs pump-out limitation, then the MOU Consultants recommend that the Parties agree to a three year moratorium lifting the 50 cfs limitation and increase this limitation during this three year period to a 72 and hopefully 92 cfs pump-out. After the third year the pump-out authorization limitation of 50 cfs would go into effect. This three year moratorium would help considerably in the design and implementation process to test, evaluate, and fine tune experimental habitat and flushing flows for the Lower Owens River.

River Flow Augmentation - page 46

Recommendation 1 - The MOU Consultants are not recommending any additional flow augmentation for the Lower Owens River in 2015. The MOU Parties and LORP managers must first develop the capability of releasing more favorable flows and testing these flows for effectiveness and improvement. Once this capability is gained then flow augmentation can fine tune the process.

Recommendation 2 - The MOU Consultants recommend that the Scientific Team develop a flow augmentation management plan for the Lower Owens River. This plan should be able to adjust to whatever flow patterns the MOU Parties finally decide and implement for the Lower Owens River.

DHA Flow Management
- page 49

Recommendation 1 - The MOU Consultants recommend that the City conduct a preliminary analysis that determines the feasibility and the cost to construct and operate a water control structure in the DHA stream channel. This structure would be located just below the west overflow channel. Excess water flow could then be diverted into the west over-flow channel. The structure would need to be designed to release the required flow into the DHA.

Recommendation 2 - The MOU Consultants recommend that the City evaluate the pros and cons of gaining additional wetlands and resulting wildlife in the west over-flow channel basin. This evaluation would also determine if this flow diversion would influence, if any, the operation of the Owens Lake Dust Control Project.

DHA Flow Release Changes
- page 52

Recommendation 1 - The MOU Consultants recommend implementing and evaluating three DHA habitat flows (Periods 1, 3, and 4) released from the Intake Control Station over a two year period (2015-2016). Results should help determine if Lower Owens River water quality and other environmental conditions can be improved via flow management. Results will also allow better predictions of how these flows pass downriver and when and how much of the flushing flows arrive in downriver reaches. The three DHA habitat flow periods recommended for release at the Intake Control Station are Period 1 (March-April), Period 3 (September and add October), and Period 4 (November-December).

Recommendation 2 - The MOU Consultants recommend that during the winter of 2015, the Scientific Team review the MOU Consultants DHA three flushing flow examples presented in this report. The Scientific Team's would then improve the MOU Consultants flow release examples and present their final flushing flow recommendation to the Technical Group for early spring action.

Recommendation 3 - The MOU Consultants recommend that the Scientific Team develop a monitoring program to evaluate the effectiveness of the flow releases and their ability to buffer river limiting factors. The Scientific Team would then send the monitoring and evaluation package to the Technical Group for action.

Recommendation 4 - The MOU Consultants recommend that the County and the City eliminate the present programmed habitat flow release schedule into the DHA. The County and City would then instruct the Scientific Team to develop a new flow release program for the DHA. A flow pattern that that is compatible with flow needs of the Lower Owens River while still maintaining healthy DHA habitats meeting all MOU (1997) goals.

Water Quality - page 62

Recommendation 1 - The recommendations remain the same as in previous years to modify or remove the Stipulation and Order that codifies a 40 cfs base flow and the MOU language that limits the pumpback station to 50 cfs. The section on flow management describes in detail the experiment needed to test a dual flow release (late winter and early spring), lift the restrictions on pumpback capacity, and modify base flows.

Recommendation 2 - Water quality monitoring during a two-year flow experiment was discussed at the River Summit. LADWP suggested multi-site sampling of dissolved oxygen, changes in organic material storage following flushing flows, transport rates of organic material during flushing flows, and identifying organic versus non-organic composition of transported material. The details of water quality monitoring will be elucidated in the event a two-year experimental flow program is approved by MOU Parties.

Fisheries - page 67

Recommendation 1 - One question to be answered with the next creel census scheduled for 2015 is whether fish have repopulated Area 2 by emigration from Area 1 and/or Area 3. As suggested by Morgan (2014), this next census should be conducted in the same manner as with past surveys to obtain a uniform data set.

Recommendation 2 - It is also recommended that the same anglers fish in Areas 1, 2, and 3 because the reliability of observational data is improved when the individuals making the observations are the same.

Recommendation 3 - The fish corridor at Goose Lake is neither useful as a fish conveyance nor as a water conveyance. The corridor should be discontinued and water shutoff.

BWMA - page 70

Recommendation 1 - Monitor and report on wetted acres and open water within the BWMA.

Recommendation 2 - Managers should develop a plan to prepare the next unit for flooding. A plan that includes multiple treatments, including excavation, burning and experimental use of herbicides at localized areas within the unit is recommended. The plan should consider the merits of keeping the Drew unit flooded for an extended period of time. The MOU Consultants should provide input on this plan prior to submission to the Scientific Team.

Recommendation 3 - The Drew Unit should remain flooded until a plan is approved to flood additional cells.

Recommendation 4 - When the run-off year is known, make an informed decision about flooding the newly prepared unit (Winterton or Waggoner) and the utility of retaining water inflows into the Drew unit based on the characterization of Drew habitat quality, the number of target acres, and the preparation made to the new unit.

Indicator Species - page 72

Recommendation 1 - The MOU Consultants recommend that the species listed in Table 20, under the four physical features of the LORP, form the new LORP updated HIS list. This HIS list should become the habitat indicator species list for input into guiding future LORP management.

Recommendation 2 - Perform avian surveys in the riverine-riparian area in 2015. Perform CWHR in conjunction with mapping and avian survey results.

Recommendation 3 - Identify appropriate metrics to be used in evaluating indicator species population dynamics and change.

Recommendation 4 - Evaluate the efficacy of revised indicator species lists after two cycles of monitoring and census data is completed.

Tule and Cattails - page 83

Recommendation 1 - LADWP and Inyo County should prepare a specific set of goals pertaining to each reach and the entire LORP area. Within each reach, site specific locations should be identified where fine scale control is needed (e.g., recreational access points). This report is to be presented to the Scientific Team. In conjunction with the Scientific Team, the appropriate list of recommended actions to address each goal should be determined.

RAS / Woody Riparian - page 86

Recommendation 1 - Perform a RAS database clean up and organization. There are many inconsistencies through the years. The focus should be to locate the woody recruitment sites in space and time and normalize that data values to accommodate for changes in RAS methodology (e.g. clonal vs. seedling, etc.). The revisit data for those points should be merged into the recruitment site to create a point for each recruitment site that contains all the RAS data for that site. A memo to the MOU parties with all recruitment sites recorded by year, number of seedlings, species and revisit results should be completed.

Recommendation 2 - All past recruitment sites documented during the life of the project should be revisited and evaluated. The sites that are being monitored under the SMWS protocol may be omitted.

If resources are not available for a specific effort, this should be performed during the 2015 RAS.

Recommendation 3 - Based on a review of the recruitment sites, the SMWS protocol should be expanded to include additional recruitment sites identified by the RAS as resources allow. The largest sites and those that are geographically isolated from other sites should be prioritized.

Recommendation 4 - Woody recruitment is occurring on the LORP, but management decisions could increase recruitment rates. Flow management is the most powerful tool that managers can use to increase recruitment. Further, the flow regime has affected establishment as well by flooding past recruitment sites due to the increasing base flow levels. The flow regime changes should be undertaken with the goal of increasing high flows and decreasing base flows. Recruitment flows should be designed to target specific reaches and elevations in high water years. See figures 16 and 17 near the end of this report.

Recommendation 5 - Treat and re-treat perennial pepperweed sites as resources permit.

Recommendation 6 - Browse, from either cattle or elk impairs woody species growth rates. In an effort to maximize the woody species growth and development, temporarily fencing should be installed at recruitment sites with the highest value until the mean height exceeds 6 ft in height, when they likely will be able to sustain browse without impairing growth significantly. Sites such as ISL_4B in the Islands lease should be considered for fencing due to the site location near some of the only shade in the area. This site has experienced heavy browse for several seasons. Temporary exclusion fences would be a much better use of resources than planting a grove of trees (as has been proposed and is discussed in section X), which would then require cattle exclusion and possibly irrigation – when naturally reproducing woody species already exist. A management goal of maximizing establishment and rapid development of naturally reproducing woody species should be a high management priority.

Rare Plants - page 96

Recommendation 1 - Evaluate the water regime within grazed and ungrazed sites. OV checkerbloom cannot withstand extended dry soil moisture conditions.

Smotherweed Biomass - page 97

Recommendation 1 - The MOU Consultants recommend that the City complete and report on its study on the Fivehorn smotherweed livestock heavy hoof trampling experiment. All study results and follow-up recommendations need to be documented in the County-City 2015 LORP Annual Report.

Range Condition - page 98

Recommendation 1 - The MOU Consultants support LADWP 's Recommendation 1. This livestock grazing timing and removal policy should be implemented in 2015.

Recommendation 2 - As documented in our past adaptive management recommendations, the MOU Consultants fully support LADWP's Recommendation 2. Controlling non-willow dense shrub community invasions along the river should be a primary management goal as long as control does not interfere with or cause mortality on present or future willow-cottonwood recruitment or survivability.

Recommendation 3 - The MOU Consultants fully support LADWP's Recommendations 3 and 4. The MOU Consultants river flow recommendations in their 2014 Adaptive Management Section in the Annual Report provides flow management direction that, if implemented, will help solve the concerns expressed by LADWP.

Recommendation 4 - The MOU Consultants support LADWP's Recommendation 5 calling for continuing the streamside woody recruitment and survivability evaluation study. The study is providing information that will help guide future livestock grazing management. The MOU Consultants do, however, also recommend that the City's Staff, during the winter of 2015, develop a proposed study plan that addresses and solves the problem of data being collected and findings being determined that cannot be transferred across the entire Lower Owens Riverine-Riparian system. RAS and the streamside woody vegetation evaluations are not providing all the necessary information and understanding needed to determine what is going on ecologically over the entire riverine-riparian system as related to willow-cottonwood recruitment and survival. The City should be prepared to submit this proposed contingency monitoring document to the scientific team by the spring of 2015 for their evaluation and action, if any.

Lower Owens River

Conclusion 6

Future of the Lower Owens River

Introduction

The Lower Owens River is a heavily managed river system, like many rivers and streams in California that allocate their water for uses beyond instream flow. The Tuolumne, Feather, Truckee, Walker and American are all "working rivers" in California that support multiple uses (drinking water, irrigation and power needs) and provide water to densely populated areas. These rivers, along with the Lower Owens, all function under altered flow regimes; water is diverted out of the channel for multiple uses and the volume of water that remains in the stream is significantly reduced when compared to historical levels.

With this water demand in mind, we should view the Lower Owens under this "working river" context and within the landscape (low gradient alluvial valley) that it resides. LADWP has an obligation to provide water to Los Angeles and a desire to remain water neutral. These obligations are likely fixed for the foreseeable future. Add in the effects of climate change, and the future of the Lower Owens River Project is cloudy under present management prescriptions.

LADWP has an obligation to provide water to Los Angeles and a directive for the LORP to remain water neutral. These obligations are likely fixed for the foreseeable future.

This section examines the future of the Lower Owens River Project in this context and describes how certain actions (e.g., removing/altering the Stipulation and Orders or changing the capacity of the pumpback station) or no action will affect the system. It must be noted that the LORP has many successes such as the vast increase in wetland acreage, the proliferation of avian species in the area and the overall improvement in ecosystem function, but to meet the goals of the project and the continued improvement in the ecological functionality of the river, management changes are important.

What will the LORP look like if no actions are taken?

Presentations from the river summit (July 2014) highlighted many of the issues the LORP is facing such as fish kills, tule blockages, insufficient woody riparian recruitment, and the assertion that the river is aggrading and moving towards a wetland landscape rather than a riverine landscape. All these issues are valid and are rooted in the present management of the LORP.

Rivers are dynamic in nature and subject to varying degrees of disturbance (Naiman and Descamps 1997). Prior to the construction of the LA Aqueduct the Owens River was subject to significant annual and decadal flow fluctuations (Table 25) (Danskin 1998, Smeltzer and Kondolf 1999). Data from City of Los Angeles hydrographers (Historic Hydrograph in the What We Know Section) prior to the construction of the LA Aqueduct tell a similar story, with the exception of the higher flows (100yr and 10,000yr events) occurring on a greater interval. Regardless, these flow fluctuations created a scour and deposition pattern, coupled with significant depth, that stressed tules and promoted riparian vegetation on floodplain surfaces.

It is well understood, and has been articulated many times, that these dynamic flows are not possible today under existing project constraints and infrastructure. With that said, it is important to acknowledge that present management of the river does not sufficiently represent the hydrologic dynamics that could be possible with currently available water. For example, the seasonal habitat flow from the past three years (2012 - 2014) has been lower than the peak base flow released to the system (Figure 10, and flow figures and annual hydrographs in Project Status section). In snowmelt driven river systems, even ones that function

Flow Period	CFS - Range	% of Base
Annual Base Flow	247 to 318	NA
Annual High Flow	636 to 742	250%
100 Yr. Flow	1660 to 1730	670%
10,000 Yr. Flow	3531 to 4061	1430%

Table 25. Pre Aqueduct Estimates of Lower Owens River Flows (Smeltzer and Kondolf 1999, Danskin 1998)

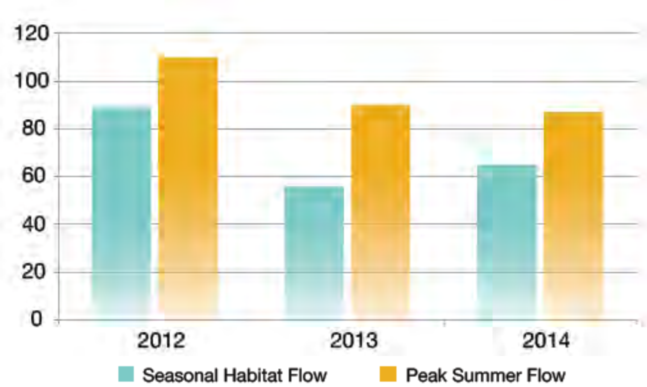

Figure 10. 2012 - 2014 Comparison of SHF and Peak Summer Flow.

under a reduced flow regime, summer instream flows should not be higher than spring snowmelt period flows. Under the constraints placed on the Lower Owens, through the Stipulation and Order, the river functions like a canal. Maintaining a minimum flow in the Lower Owens is akin to ensuring a downstream water demand is met, and that downstream demand is the specified flow at the pumpback station (40 - 55cfs). Unfortunately, as presently mandated, the flow regime of the LORP resembles that of many regulated river reaches downstream of reservoirs operated to provide irrigation water; the spring peak is reduced and the summer flows are increased (the "flattening" of the spring pulse). This situation, especially in summer when evapotranspiration rates are highest, forces LADWP to increase flow in the river to meet the obligation placed under it via the Stipulation and Order. This is not how rivers function and treating the Lower Owens like a canal disregards a vital tenant of rivers that make them so dynamic; river systems are subject to seasonal flow fluctuations that create diverse landscapes especially within gaining and losing reaches (Hill and Platts 1998).

The Lower Owens is an interesting system because of its interaction with groundwater and its losing and gaining reaches. The Owens River, prior to the creation of the LA Aqueduct, was the primary drain of both the surface-water and ground-water systems (Danskin 1998) in the valley. Today, tributary streams that once confluenced with the river are diverted by the aqueduct; however, groundwater continues to flow upward under pressure and drains to the Owens River (Danskin 1998). As of 1998, the groundwater level in the Lower Owens and the valley floor was not significantly affected by the years of water extraction. It was the alluvial fans and their springs that experienced the greatest decline. As Danskin (1998) explains, the widespread presence of hydrologic buffers (evapotranspiration, springs, and permanent surface-water features) is the primary reason the water-table altitude beneath the valley floor has remained relatively constant since 1970 despite major changes in the type and location of groundwater discharge (Danskin 1998). What this means is that even during periods where no water flowed in the river, the groundwater level of the Owens Valley remained shallow and in close proximity to the Lower Owens riverbed. Once water was returned throughout the system, beginning in December of 2006, the dynamic exchange of groundwater and surface water was renewed in the system.

The groundwater and surface water interaction is not consistent along the course of the Lower Owens, but rather exchange rates (loss or gain) are variable and are dependent on the physical characteristics of the stream channel, and on the local hydraulic gradient between the stream and the groundwater system (Danskin 1998). This variable rate of exchange is described in LADWP's 2014 Hydrologic Monitoring Report. In the report, LADWP not only documents the groundwater/surface exchange rate of the reaches (Table 26) but also the monthly gains and losses the river experiences (Figure 11).

Station	Winter Gain/ Loss (CFS)	Summer Gain/ Loss (CFS)
Intake	N/A	N/A
Mazourka	-6	-14
Reinhackle	+2	-4
Pumpback	+12	-8

Table 26. Hydrologic Monitoring - Winter and Summer Flow Gains and Losses by Reach

Gaining and losing reaches create diverse riverine landscapes. Areas of the Lower Owens that are further from the hydrologic buffers mentioned above or have certain topographic features (e.g., incised reaches) are likely to lose instream flow to groundwater. The opposite effect occurs in reaches closer to the hydrologic buffers or that have topographic features closer to groundwater level (e.g., graded floodplains) (Danskin 1998). Forcing a flow into the Lower Owens, as the Stipulation and Order does, ignores this dynamic aspect of rivers and is a major reason the LORP suffers from many of the problems described throughout this document. For example, allowing losing reaches to function as they should stresses instream plants (e.g., tules) during low flow periods. This is one reason the MOU consultants have recommended rescinding the Stipulation and Order so that flows of less than 40cfs

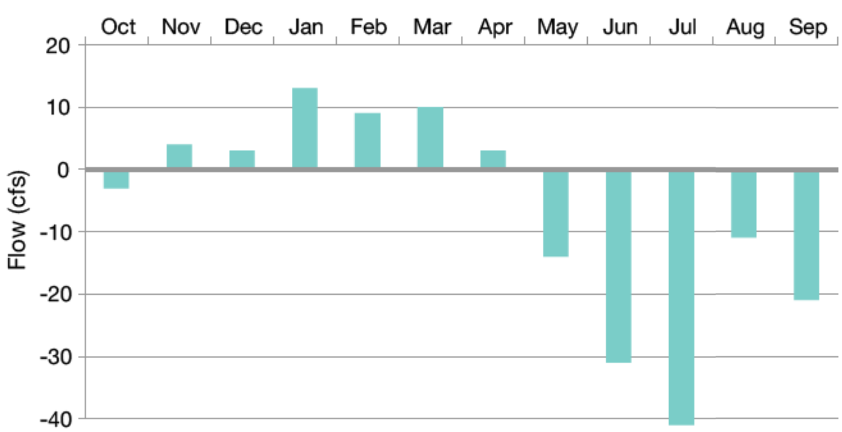

Figure 11. Cumulative Monthly Flow Gains and Losses for the Lower Owens River

can occur in the Lower Owens River. It is important to the future of the LORP that losing and gaining reaches be embraced, without forcing compensation for losses, which will allow the ecology of the river to respond to these fluctuations.

If no action is taken to remove the Stipulation and Order or increase the pumpback station capacity, the LORP will continue to suffer from the problems it is facing. Tules and cattails will continue to proliferate within the channel, water quality issues will continue and may be magnified, the river will continue to aggrade and move to a wetland rather than the desired riverine landscape, woody riparian recruitment and establishment will be hindered and the river may never reach the goals or meet the expectations that were set forth under the MOU.

What will the LORP look like if the Stipulation and Order is rescinded?

Rivers that drain the Eastern Sierra have a typical snowmelt driven system hydrograph, characterized by low winter flows, increasing flows from late spring through a peak in early summer and a decline to very low in late summer. These river systems usually experience a small increase in discharge in mid-fall as precipitation increases but is not yet snow, especially in lower elevations.

To highlight the importance of Eastern Sierra hydrographs, we examine the West Walker River as a corollary to the Lower Owens River. Figure 12 depicts the West Walker River average flow from 2008 - 2014 (USGS gage @ Coleville); Lower Owens flows over the same period and the proposed LORP flow regime. The high flow period that extends from late March to mid-July is the result of multiple high flow events over the seven-year period. Looking at only one year of data (2009, an average year in that time span) gives a similar picture (Figure 13), but with a shorter duration high flow period from late spring to early summer. These two hydrographs demonstrate how Eastern Sierra Rivers function throughout the year. Eastern Sierra Rivers have dynamic hydrographs which introduce hydraulic complexity to their systems. Hydraulic complexity has been shown to be very important to riverine dynamics effecting fluvial geomorphology, habitat heterogeneity and aquatic biodiversity (Bice et al. 2013). In this section and the next (increasing the pumpback capacity) we'll examine how to introduce hydraulic complexity to the Lower Owens and the benefits that this complexity brings to the system. But without modifying the Stipulation and Order and the pumpback station capacity, it will be very hard to introduce hydraulic complexity to the Lower Owens.

In this section we examine the low flow periods (i.e., late summer/early fall) of the hydrograph and the benefits that the Lower Owens could experience if flows below 40cfs are allowed in the system. If the Stipulation and Order is rescinded the Lower Owens flow could experience flows below 40cfs during critical times of the year.

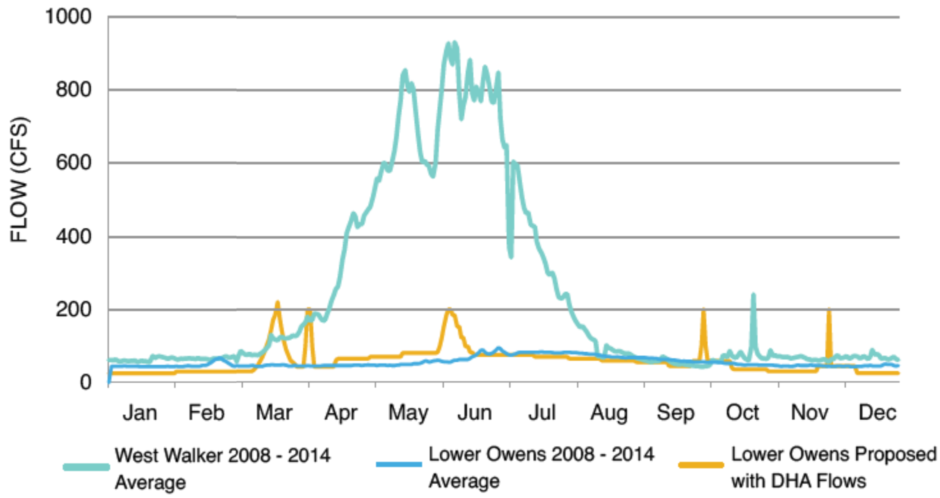

Figure 12. Average flow in the Walker River from 2008 - 2014 (USGS @ Coleville). Average flow during the same period for the Lower Owens is added for comparison as well as the proposed flow regime for the LORP.

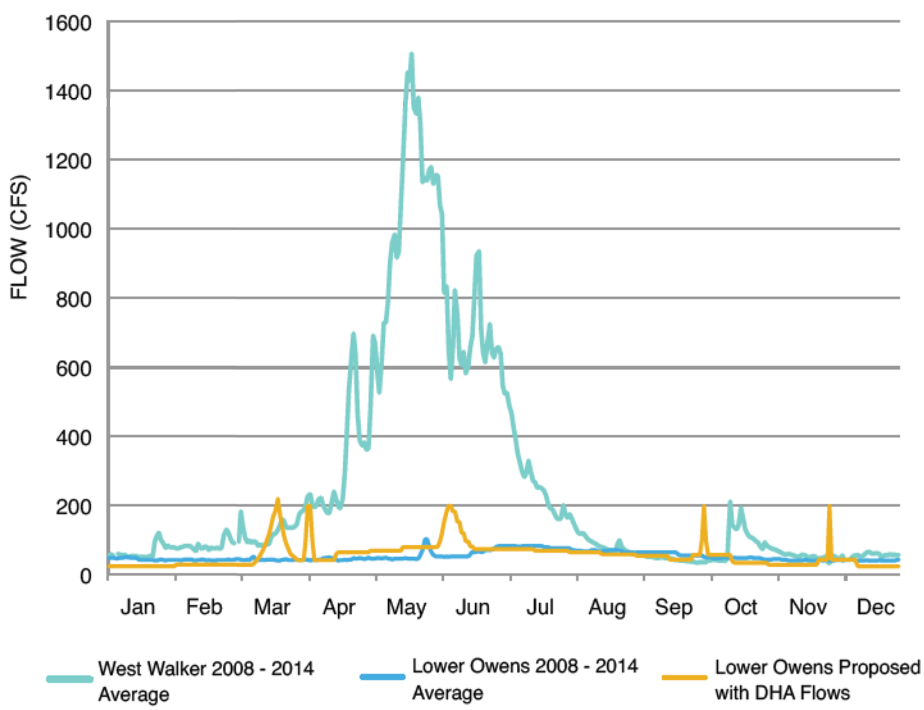

Figure 13. Flow in the Walker River for 2009 (USGS @Coleville). 2009 Lower Owens flow is added for comparison as well as the proposed flow regime for the LORP.

Under present management the Lower Owens experiences abnormally high flows in late summer and early fall (compared to Eastern Sierra Rivers). The reason for the abnormal flows is that LADWP must increase flow in the summer and late fall while evapotranspiration (ET) rates are high to ensure that the requirements of the Stipulation and Order are met (i.e., 15 day average of all in-river stations must be 40cfs or higher). To understand ET we've included a chart depicting the ET rates at the Ash Meadows Area in Nevada (Figure 14) (USGS 1999). Figure 14 demonstrates that ET is highest in summer and early fall, meaning that plants are consuming large quantities of water for transpiration and the adjacent ground is consuming water from the river channel through capillary action to replace water lost to evaporation. The Owens Valley experiences similar annual ET variations.

Forcing LADWP to raise flow in the Lower Owens River during high ET periods is detrimental to creating a functioning riverine-riparian environment in the LORP. Figure 15 demonstrates how uncharacteristic of Eastern Sierra Rivers (i.e. abnormal) flows in the Lower Owens are during the summer and early fall. Figure 15 shows the percent of median flow per month for the Walker River and Lower Owens. We used the median flow as a surrogate for base flow and then determined the percent of median flow per month (i.e., high flows are well over 100% and low flows are under 100%). The resultant graph scales the Lower Owens and Walker River, who have two very different flow volumes (high flows primarily), so that they can be compared. For August, September and October, Lower Owens flows are over 100% of the median flow. If we compare that to the West Walker, only August's median discharge is over 100% while September and October are well below 100%. Under normal conditions, riparian plants within and adjacent to Eastern Sierra streams are stressed by high temperatures, long daylight periods and low water.

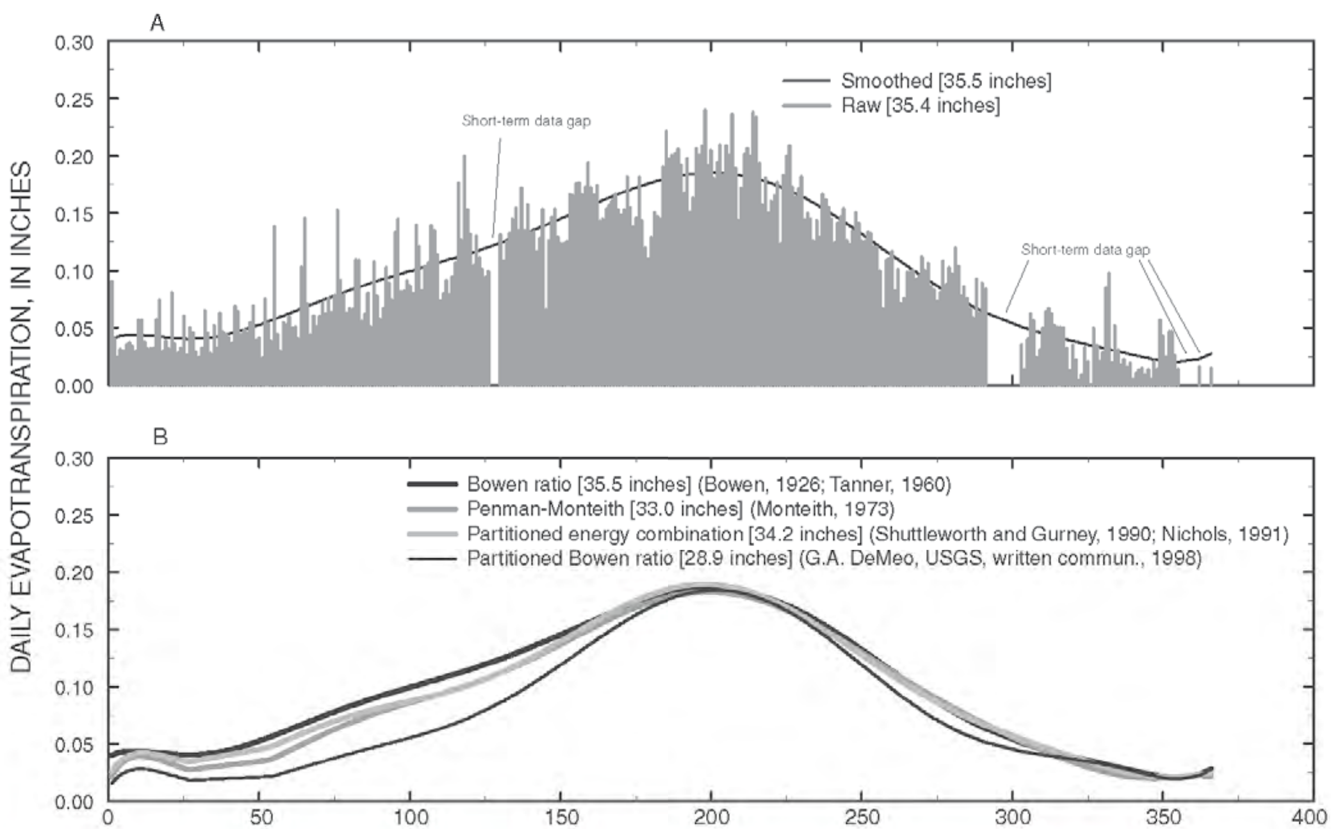

Figure 14. Calculated daily ET at Carson Meadow (Ash Meadows Area) for 1996 (A. Raw data, B. ET curves calculated using different methods (USGS 1999). The X-axis is the Julian day calendar, where day 200 is July 19th.

This is not the case in the Lower Owens, where water is continually added to the system to account for ET and to ensure that the Stipulation and Order is met. Over the long term, flow regulation (as is currently seen in the LORP) will lead to a proliferation of species less dependent on disturbance for establishment (Busch and Smith 1995). This phenomenon is currently being experienced in the LORP with the increase in marsh vegetation and limited woody recruitment. This action is one of the main reasons that tules proliferate in the channel. Under existing conditions the flow regime in the Lower Owens selects for tules by continually increasing flow enabling them to thrive during times when they should be stressed. Removing the Stipulation and Order would allow DWP to return the Lower Owens to a more natural flow regime with hydraulic complexity, primarily lower flows in the summer and early fall and higher flows in the spring that would stress instream aquatic vegetation and lead to more habitat heterogeneity (and potentially more open water) (Bice et al. 2013).

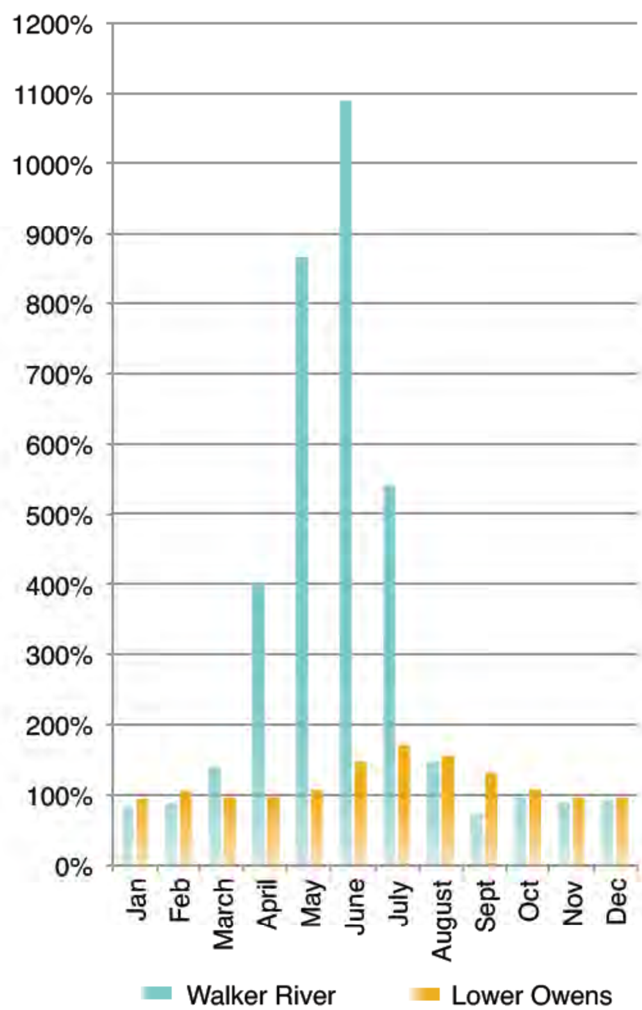

Figure 15. Percent of Median Flow in the Walker River (USGS @Coleville) and Lower Owens from 2008 to 2014.

It was surmised in comments on the River Summit that the tules were in an early successional state:

> *Allow the tules to "live out their time" on the LORP, because they may be successional to the next wave of dominant vegetation. OVC concurs with an observation presented by LADWP staff member Sherm Jensen that the more choked parts of the project are likely to aggrade over time. In fact, this prediction was correct: on the field trip, we saw water had backed up and spilled into an old channel at the east side of the "Island" reach.*

If the present management prescriptions remain in the Lower Owens, tules will continue to thrive in the channel because the existing flow regime is optimized for their survival. Lower flows in the summer and early fall would stress the tules leading to some die off and the potential for succession. But this can only occur if the Stipulation and Order is rescinded.

What will the LORP look like if the Stipulation and Order was rescinded and the pumpback capacity increased?

Noted throughout this document are the deficiencies of the present LORP flow regime; that it is uncharacteristic of Eastern Sierra rivers, or is "upside down" (flows are higher in the summer than in the spring – "flattening of the spring pulse"). The reason for the uncharacteristic or "upside down" hydrograph is the Stipulation and Order and the limited capacity of the pumpback station. We've addressed the Stipulation and Order in the previous section, and the fact that it creates a flow regime similar to those in regulated river systems operated for irrigation, when restoration is the goal. In this section we examine the high flow periods of a typical Eastern Sierra hydrograph and the benefits that riverine habitats could experience if a similar hydrograph was implemented in the Lower Owens River. The only way that higher flows with a longer duration can be implemented in the LORP is through increased pumpback capacity. Increased pumpback capacity allows higher magnitude flows into the system while ensuring LADWP remains water neutral by having the ability to recoup these flows.

The most important aspect of increasing the pumpback capacity is that doing so provides managers with flexibility. Flexibility that will allow LADWP to return the Lower Owens River hydrograph to a more natural state, while ensuring LADWP remains water neutral. The magnitude and duration of high flows in the LORP are presently not sufficient to support the goals of the project (i.e., woody recruitment). For example, Figure 15 demonstrates that the average magnitude of high flows (spring snow melt) in the West Walker River are greater than 400% (and often over 1,000%). These greater than 400% magnitude flows occur from April to July, thus often last for a long duration. Compare that to the Lower Owens where high flows achieve an average magnitude of 150% of base flow and last for only two months - July to August (Figure 15). Often high flow events in the Lower Owens (seasonal habitat flows) last less than 2 weeks. The peak of the seasonal habitat flow also diminishes in a downstream direction, resulting in the southern portions of the Lower Owens not experiencing the beneficial effects of out-of-channel flows.

A major assertion regarding the LORP is the lack of woody riparian recruitment. Although cattle and elk contribute to the situation through grazing, the present flow regime does not provide the requisite magnitude, duration and variability of flooding to promote establishment and colonization of woody species. Studies have shown that in regulated river systems, such as the LORP, seedlings typically establish lower on the banks (Rood et al. 1999, Johnson 2000, Stillwater Sciences 2006). This is most likely the case in the LORP where seedlings established on lower bank surfaces, especially in recent years where seasonal habitat flows have been insufficient to achieve out of bank flow (LADWP Land Management Chapter 2014). The problem with this situation is that increased summer baseflows inundate seedlings leading to mortality (see figures 16 and 17). Out-of-channel flows (higher magnitude) are needed to promote establishment and colonization of willow and cottonwood outside of the river channel, as riparian tree populations normally establish in years with large floods (Bradley and Smith 1986, Everitt 1995, Scott et al. 1997, Merigliano 1998). Under present prescriptions, and especially if the recent drought in Eastern California continues, woody riparian recruitment will continue to suffer in the LORP. Increasing pumpback capacity will enable greater magnitude flows (>300cfs) over a longer duration (>2 weeks) in the LORP. Such events will not only promote woody tree recruitment but would also provide the water quality improvements that have been discussed throughout this document.

In short increasing the pumpback capacity will provide the flexibility managers need to change the magnitude and duration of flow events, offering the best chance of increasing woody recruitment and establishment in the LORP. The ability to create a more natural hydrograph, exceeding the 200cfs limit and allowing lower flows (< 40cfs) in the summer and early fall, will bring beneficial system-wide responses. To accomplish this, the pumpback station capacity must be increased and the Stipulation and Order rescinded. If these two things occur, managers will have the flexibility to institute a flow regime that returns missing ecological processes (i.e., a complex hydrograph with hydraulic complexity) to the Lower Owens resulting in a more functional landscape.

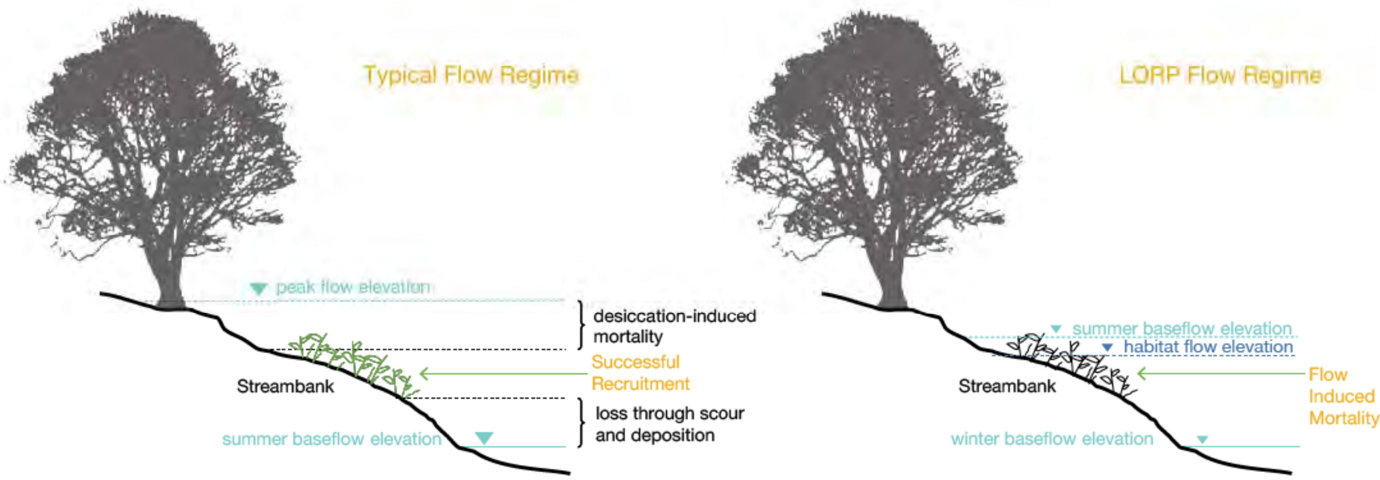

Figure 16. Seedling recruitment patterns and flow regime (adapted from Stillwater Sciences, 2006)

The figure on the left illustrates seedling recruitment patterns typical of semi-arid alluvial river systems. Seedling recruitment is constrained in the first year by desiccation-inducted mortality at high bank elevations, and overwinter mortality from scour and deposition at lower elevations.

The figure on the right illustrates seedling recruitment patterns of the LORP. Seedling recruitment is constrained by an inverted flow regime in the LORP. The summer baseflow is higher than the seasonal habitat flow inducing mortality of sedlings.

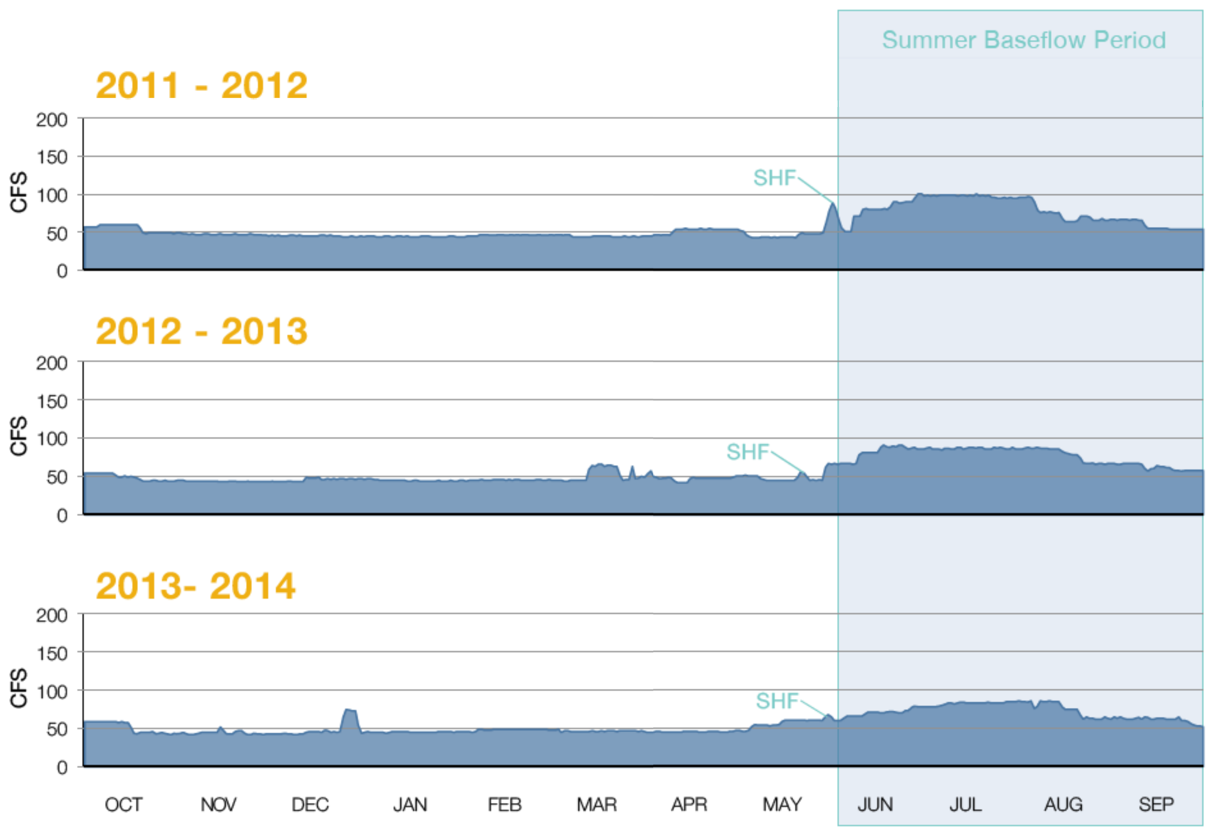

Figure 17. Annual hydrograph of the Lower Owens River from 2011-2014.

These graphs illustrate the diminishing Seasonal Habitat Flows (SHF) through the years since the project was initiated with rewartering flows. It also illustrates the static flow regime and the abnormally high summer baseflows needed to meet the LORP Stipulation and Order of 40 cfs throughout the river system.

LORP River Summit

Introduction

When interested parties and management entities don't have a clear understanding of each other's desired outcome, or share a common vision, conflicts inevitably arise. In an effort to increase understanding and reset the goals and objectives for the LORP, a river summit was convened. The purpose of the River Summit was to bring together all of the MOU Parties (LADWP, ICWD, Owens Valley Committee, California Department of Wildlife, the Sierra Club, and California State Lands) to discuss critical junctures in achieving LORP goals and long-term recommendations of the MOU Consultants.

When interested parties and management entities don't have a clear understanding of each other's desired outcome, or share a common vision, conflicts inevitably arise.

Flows into the Lower Owens River were initiated in 2006 with the first seasonal habitat flow released in 2008. Since then the LORP has changed dramatically from an almost completely dry channel to a continuous flow river. Some of the initial goals and objectives set out for the LORP have been attained while others have not, and some may be trending in directions that are counter to LORP goals. Nevertheless, after seven years of monitoring and some adaptive management actions, it was clearly time to revisit initial goals and expectations for the LORP.

At the beginning of this report adaptive management was described, with attributions from recent scientific literature and the MAMP. It is important to understand that adaptive management applies equally to goals and objectives as well as to water quality or tules. To effectively manage the dynamics of ecosystem restoration, goals and objectives must be adapted over time that cannot be predicted or even adequately anticipated at inception. Adaptive management is the specified and agreed upon approach for managing the LORP ecosystem in order to reach the desired goals of a healthy functioning 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. For example, lessons learned from other adaptive management programs show that institutional and stakeholder support is critical (Gregory, et al., 2006). Peterson et al., 2002, argued that the participation of a diverse group of people in a systemic process of collecting, discussing, and analyzing scenarios builds shared understanding. Consequently, it is clear that LORP stakeholders, MOU Parties and the public at large, would benefit the project with greater participation and understanding. To that end, ICWD and LADWP agreed to a River Summit with MOU Parties to discuss the LORP's status, goals and objectives, and fundamental adaptive management needed.

Purpose

The purpose of the River Summit was to bring together all of the MOU Parties to discuss critical junctures in achieving LORP goals and long-term recommendations of the MOU Consultants. As far back as 2007, at the inception of the project, the MOU Consultants expressed strong reservations about the 40 cfs base flows and the limit of 50 cfs on pumpback capacity. We argued that without the ability to modify flows through time, the river would take-on canal characteristics of vegetation choked channels, degrading water quality and potential for fish kills. Since all of these predictions have come to pass neither management nor MOU Parties could ignore the real condition of the Lower Owens River and the threat of non-achievement of some original goals.

The summit was held from July 29 to 31, 2014. The first day was devoted to presentations by LORP scientists to appraise all of the participants on the status of the river as well as discussion and questions and answers. The second day was a field trip to the river so that participants could match on the ground conditions with what was learned in the presentations, and the last day focused on what adaptive management actions are needed to reset the LORP toward goals.

Most participants recognized that while many goals set out in the MOU have been met, there remain serious issues with water quality, actual and potential fish kills, tule encroachment, lack of woody riparian development, and the Stipulation and Order that places such tight limits on flow management that achievement of some goals is unlikely.

The 2013 fish kill below Alabama Gates focused the discussion on dissolved oxygen and water quality. Previous sections in the chapter discuss dissolved oxygen in great detail and why it remains a threat to the fisheries. LORP goals to develop a healthy warmwater fishery and sustainable aquatic ecosystem will be seriously challenged unless adaptive management actions are implemented to remove accumulating organic material. The summit discussion focused on ways to “flush” the river using a dual-flow approach. How to implement an experimental program within the constraints of the MOU and Stipulation and Order, remain water neutral, and a monitoring program to measure improvements in dissolved oxygen and organic material are all linked to flows.

Although the summit attendees also discussed the appropriateness of indicator species designated in the MOU, geomorphic-fluvial state of the river channel, feasible channel clearing techniques, Delta inflows, and recruitment of woody riparian habitat as well as pole planting, most attendees agreed that the number one priority at this time was flow management. The OVC dissented arguing that there may be insufficient water quality data to justify modification of the MOU and Stipulation and Order.

Outcomes

From the point of view of the MOU Consultants, the summit was extremely valuable. Our adaptive management recommendations were the basis for the summit and were well documented in the 2013 LORP Annual Report. The summit gave us the opportunity to listen to the concerns, suggestions, ideas of all MOU Parties - something which had not been done since the first meetings to develop the MOU. As learned in other adaptive management projects similar stakeholder input and buy-in of critical decisions builds essential shared understanding. We believe the river summit can now be a template for other such meetings in order to sustain the tenure and participation of all MOU Parties. This will be particularly important if a two-year experimental flow and monitoring program is implemented. If this occurs then MOU Party review and input will be required.

The discussion at the summit was lively and informative and, for the most part, stayed on track and deliberated one issue before moving to another. Needless to say, in the absence of an electronic recording or video, the MOU Consultants made the best of note taking by hand in order to have at least a reasonably accurate record of each MOU Party’s primary concerns, comments and positions to help us with future adaptive management recommendations. Below is a summarized listing of the summit outcomes from the position of each Party.

This list is paraphrased, which means there may be oversights or slight misrepresentations of each MOU Party. Hopefully, any misrepresentations are minor and the comments do properly represent what was discussed as well as the positions taken. Since the MOU Consultants believe the outcomes from the summit are extremely important and will provide us and the ICWD and LADWP direction for this next phase of the LORP, correct representation of each parties views are important and can be ammended.

Paraphrased comments made by MOU Party participants at the River Summit

Sierra Club

- Modification of MOU is needed to change water conditions in the Blackrock Waterfowl Management Area but not the Delta so long as the average annual inflow of 6 to 9 cfs is maintained.
- Could use the west side channel in the Delta to better manage seasonal inflows.
- Willing to accept a 2 year temporary agreement to test alternative flows using a set volume of water for flushing and woody riparian recruitment.
- Water quality is the primary issue but flow augmentation at Alabama Gates and feasible methods to remove tule blockages should also be analyzed.

Inyo County Water Department

- Agrees to pursue an alternative hydrograph for two years with effectiveness monitoring to address the water quality issues as well as increasing pumpback capacity.
- Modify existing legal documents as necessary.
- Develop feasible ideas on BWMA waterfowl management and to alter Delta inflows.
- Be aware of the standing injunction against putting water into Owens Lake to prevent impacts to mine operations.

California Department of Fish and Wildlife

- Supports a two-flow test to improve water quality and promote woody riparian habitat
- Supports altering legal documents as necessary for a temporary time and test period.
- Need to clarify baseline water quality conditions with quantifiable measurements to guide flow changes with shorterm goals using adaptive management.
- Separate habitat and T&E species from indicator species and assess with different census method before deciding on changing indicator species.

Los Angeles Department of Water and Power

- Supports a two-year experiment to test water quality improvements with dual-flows and increasing pumpback capacity.
- Flows during the experiment can use the volume of water considered water neutral (approximately 44,000 ac-ft).
- Cautioned that a peak flow of 600 cfs in the channel would cause damage to roads and bridges.
- Supports modification of legal documents as necessary to allow the test to go forward.
- Committed to flexibility to increase pumpback capacity over time as pumps are replaced.
- Supports analyzing feasible options to clear the channel of some tules.

Owens Valley Committee

- Based on the data and information presented, OVC did not agree that water quality was of sufficient threat to warrant altering the flows or to lift the pumpback restriction of 50 cfs.
- Would not agree to MOU or Stipulation and Order modifications as this time.
- In a set of written comments, OVC expanded on their position and suggested a dozen adaptive management and monitoring actions.

Limitations and Benefits of the MOU and Stipulation and Order

For many years the MOU Consultants have made adaptive management recommendations to modify the MOU and the Stipulation and Order to allow changes in base flows and pumpback capacity. These recommendations can be traced back to 2007 with the Stipulation and Order. While it is an old refrain it is still a fundamental recommendation. It was not until the River Summit that all MOU Parties finally convened to focus on river flows as the core issue impacting LORP goals. Although the MOU and Stipulation and Order may have hindered achievement of some LORP goals it is also important to acknowledge that there would not be a LORP without the MOU and Stipulation and Order.

The purpose of the legal sideboards was and is to plan, implement, monitor, and adaptively manage the LORP and facilitate work with contentious and frequently distrusting parties. The legal documents provide the framework that creates a level playing field. As a consequence, some of the initial LORP goals set out in the legal documents have been attained or are trending toward attainment.

Returning to the Glen Canyon Dam project referred to previously, Feller (2008) described the adaptive management program as facilitating non-compliance with the ESA and given hydroelectric power and fisheries higher priorities than they are legally entitled to, and collaborative decision-making has actually stifled adaptive management. While intentions were good, implementation of an adaptive management program was not well designed with guidelines and legal understandings (Camacho, 2008). Other adaptive management projects have failed or not met expectations without the guiding hand of strong legal frameworks (Layzer, 2008; Wiersema, 2008; Ruhl and Fischman, 2010).

A growing body of case law is beginning to outline the legal parameters of adaptive management and show how such plans meet substantive standards and comply with CEQA and NEPA (Nie and Schultz, 2011).

Trigger mechanisms are being used in this political and legal context. The term trigger, as used in this context, is a type of pre-negotiated commitment specifying what actions will be taken if monitoring information shows x or y. They are predetermined decision points that are built into the decision-making framework at the outset (i.e. if this, then what). These pre-identified commitments are one way of possibly bridging the theory and science of adaptive management with the need for political and legal certainty that particular actions will be taken in the future.

The MAMP (2008) uses triggers and thresholds to make adaptive management recommendations. Chapter 3 of the MAMP provides for the dichotomous approach used for all resource areas (Figure 18). These triggers specify actions to be taken if x or y happens and were developed for all of the LORP goals and objectives. Using monitoring feedback in this way removes much of the uncertainty inherent in adaptive management programs like the LORP.

While the Stipulation and Order hinders attainment of some LORP goals, the MOU has benefited the LORP in many ways. The MOU requires the LORP to be monitored and adaptively managed which resulted in the MAMP and measurable thresholds and triggers.

In many ways the LORP with its MOU is a model for other adaptive management programs because it incorporates several key conditions:

- A well-defined monitoring and adaptive management program
- Adaptive management decision points built on triggers and thresholds
- Stakeholder access to the project and decision making
- Flexibility to adaptively manage (modify) legal documents

The real message from the LORP after more than seven years is not that the legal documents do not work, but rather adaptive management recommendations that are ignored or not implemented undermine the utility

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)

Figure 18. Monitoring Triggers and Thresholds - LORP MAMP example for Fishery

The MAMP (2008) uses triggers and thresholds to make adaptive management recommendations. Chapter 3 of the MAMP provides for the dichotomous approach used for all resource areas. These triggers specify actions to be taken if x or y happens and were developed for all of the LORP goals and objectives. This example illustrates the processes developed for fishery.

of legal documents. If, in the end, recommendations are ignored after all the monies spent, monitoring effort expended, and scientific analysis performed, adaptive management programs are of no value.

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Resetting Expectations

During the River Summit a field trip to the LORP area was conducted. The group visited the east-side of the Islands to discuss ways to by-pass flows and control tule expansion. A point made by Harry Williams of the Bishop Paiute Tribe needs consideration when it comes to the expectations for the LORP. Mr. Williams was not dismayed by current conditions, in particular the dense tule growth. He said "What is wrong with this? Its life… abundant plants, birds, and other animals, so why is this wrong?" Unfortunately, we have come to view tules as an overwhelming problem when in fact there is reason, as Mr. Williams expressed, to see value in the tules and current density of vegetation.

The density of tules from the Intake to the Delta appears to contradict the original expectation of an open river channel throughout the system with tree willow canopy and open stream banks with more convenient recreational opportunities.

The MOU Consultants have consistently argued that tules are necessary to support the high quality warmwater fishery that has developed. Without tules bass and bluegill would not have escapement habitat for young-of-the-year and juveniles and recruitment into the adult population would be much lower. Tules also provide essential components of the food chain supporting fish as well as macroinvertebrates, amphibians and reptiles. Tules adjacent to open water provide nesting habitat for water birds of all species.

Conversely, we tend to focus efforts on the other side of the equation; that tules dominate the riverine-riparian vegetation community, impede the river channel in many locations, inhibit angler access and limit boating activities, and diminish the availability of open water habitat. The density of tules from the Intake to the Delta appears to contradict the original expectation, or view, of an open river channel throughout the system with tree willow canopy and open stream banks with more convenient recreational opportunities.

The acres of open water and marsh (tules, etc.) associated with each reach is from the 2010 LADWP landscape mapping (Jensen 2014). Undoubtedly, the acres of marsh and open water have changed since 2010, which is why the MOU Consultants have consistently cited the need for up-to-date data and recommended performing the landscaping mapping more frequently. Nevertheless, one can see from Table 27 the impression that the river is obstructed with tules and is lacking in open water areas and habitat is not correct. However, after eight years under the current flow management it is evident that river conditions and initial expectations are not in sync.

A point to collectively address is should expectations for the LORP be refined, appreciating the values of the wetlands and tule habitat to all biotic and abiotic components, as suggested by Mr. Williams? Or do we continue to try to move the river toward other states with more active interventions such as tule and channel excavations? Initiating flow recommendations made by the MOU Consultants are intended to improve river conditions, water quality and manage organic inputs into the future. The LORP does not have sufficient flow energy to eliminate tules. Tules can be stressed with variable low summer flows and higher peak winter flows, but tules will always be a major component of the aquatic ecosystem in the Lower Owens.

Continuing with the current flow regime and management will increase aggradation leading to more tules, reduced water conveyance, an increase in evapotranspiration, poorer water quality, stagnant woody riparian development, and impacts to existing woody riparian vegetation (Ecosystem Sciences 2013, Jensen 2014). Instituting multiple flows seasonally (dual peak winter and spring freshets, lower summer and fall base flows with ramps as recommended by the MOU Consultants) will not reverse current aggraded conditions, but will improve water quality, arrest or potentially reduce the rate of aggradation in certain

Reach	State	% of LORP	Miles	Marsh (acres)	Open Water (acres)
1	Incised, wet floodplain	40	23.1	40	13.5
2	Incised, dry floodplain	27	15.7	104	37
3	Incised, wet floodplain	-	-	291	76
4	Aggraded, wet floodplain	7	4.1	450	56
5	Incised, wet floodplain	-	-	49	24
6	Graded, wet floodplain	18	10.7	145	44

Table 27. LORP states by reach, distance and area (from Jensen 2014, and 2010 LADWP mapping)

reaches, provide some limits on tule expansion, reduce tule abundance and provide increased open water habitat.

Unless the legal framework restricting base flows and pumpback capacity are removed and replaced with a multiple flow regime approach, we cannot expect the LORP to approach initial expectations without a dramatic shift from passive restoration to active restoration. This would require greater investment in physical and mechanical interventions that were described earlier in this document. It will also mean moving away from the concept of self-organizing and self-sustaining, natural process of restoration and toward greater and more intense management effort and much larger costs.

In addition to lifting the legal sideboards, the MOU Parties should re-evaluate expectations based on existing conditions and projections. Even with improved flow management some trajectories will not change appreciably. Channel aggradation will continue but at a slower rate and potentially reach equilibrium at some point in the future. Tules will remain a major component of the ecosystem. The river will be an alternating riparian-riverine and a marsh-wetland system. Many MOU goals will be met, and unintended consequences will occur, but upon re-examination of expectations these outcomes may have value and provide needed ecosystem services.

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Ecological Restoration and Time

In their written comments on the River Summit, the Owens Valley Committee (OVC) made an interesting statement to "Allow the tules to 'live out their time' on the LORP, because they may be successional to the next wave of dominant vegetation". Dr. Sally Manning, of the OVC, also suggested that we may not be giving the LORP sufficient time for plant succession and are overly concerned about tule growth at this stage of the LORP. These comments are correct in their reference to ecological time factors.

Passive restoration seeks to restore process. The current flow regime has not restored process, but has created a static system that lacks the diversity of flow conditions and disturbance regime required to restore function to the LORP.

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 (Walters 2007). 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 to measure success. 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 (MAMP, 2008). A 20-year monitoring, adaptive management horizon is now taken as the minimum for determining the response and goal-achievement of riverine-riparian systems (SFPUC, 2014).

From one of the earliest river restoration projects on the Colorado River, Anderson and Ohmart (1982) 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 (MAMP, 2008).

Tules were the immediate response to flow initiation in 2006 and seemingly out competed woody riparian plants. In order for the successional stage to move beyond tule dominance, time (as suggested by Dr. Manning) as well as a different flow regime (as recommended by the MOU Consultants) is necessary to move the system from the current canal-like conditions to riverine conditions.

Variable flow magnitudes and duration create disturbance regimes that are critical to maintain biotic and abiotic resources within a river ecosystem (Hill, et al. 1991). Flowing water erodes, transports, and deposits sediment and influences species and growth of vegetation (Morisawa 1968). Streamside vegetation will develop characteristics and features that balance the effects of varied flows and sediment regime (Platts et al, 1985).

The science is clear that 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 – willows and cottonwoods. Without these variable flow conditions streamside vegetation will consist of monocultures such as we have with tules in the LORP.

Passive restoration seeks to restore process. The current flow regime has not restored process, but has created a static system that lacks the diversity of flow conditions and disturbance regime required to restore function to the LORP.

If the LORP flow conditions are changed and a multiple flow regime put in place it will still take time for recruitment and development to occur and for ecological conditions to change. With flow changes the LORP will not change dramatically in a period of one or two years, but rather will evolve over a period of years into a more mature ecological system.

Even after prescribed flow changes the LORP will not change dramatically in period of one or two years, but rather will evolve over a period of many years into a more mature ecological system.

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2014

Lower Owens River Project

Adaptive Management Recommendations

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11.0 LADWP AND ICWD RESPONSE TO ADAPTIVE MANAGEMENT RECOMMENDATIONS

12.0 PUBLIC MEETING AND RESPONSE TO COMMENTS