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.

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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

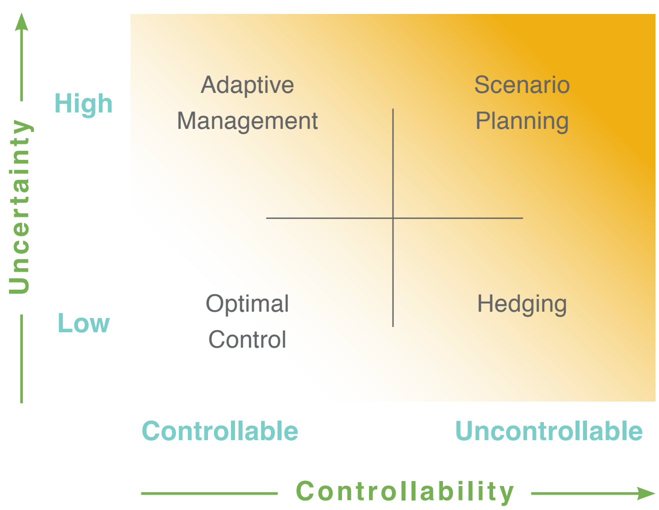
- **the failure of decision makers to understand why adaptive management is needed**
- **the hijacking of management goals for research interests**
- **using bureaucratic and political inaction as a policy choice**
- **inadequate funding for monitoring needs**

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.

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.

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

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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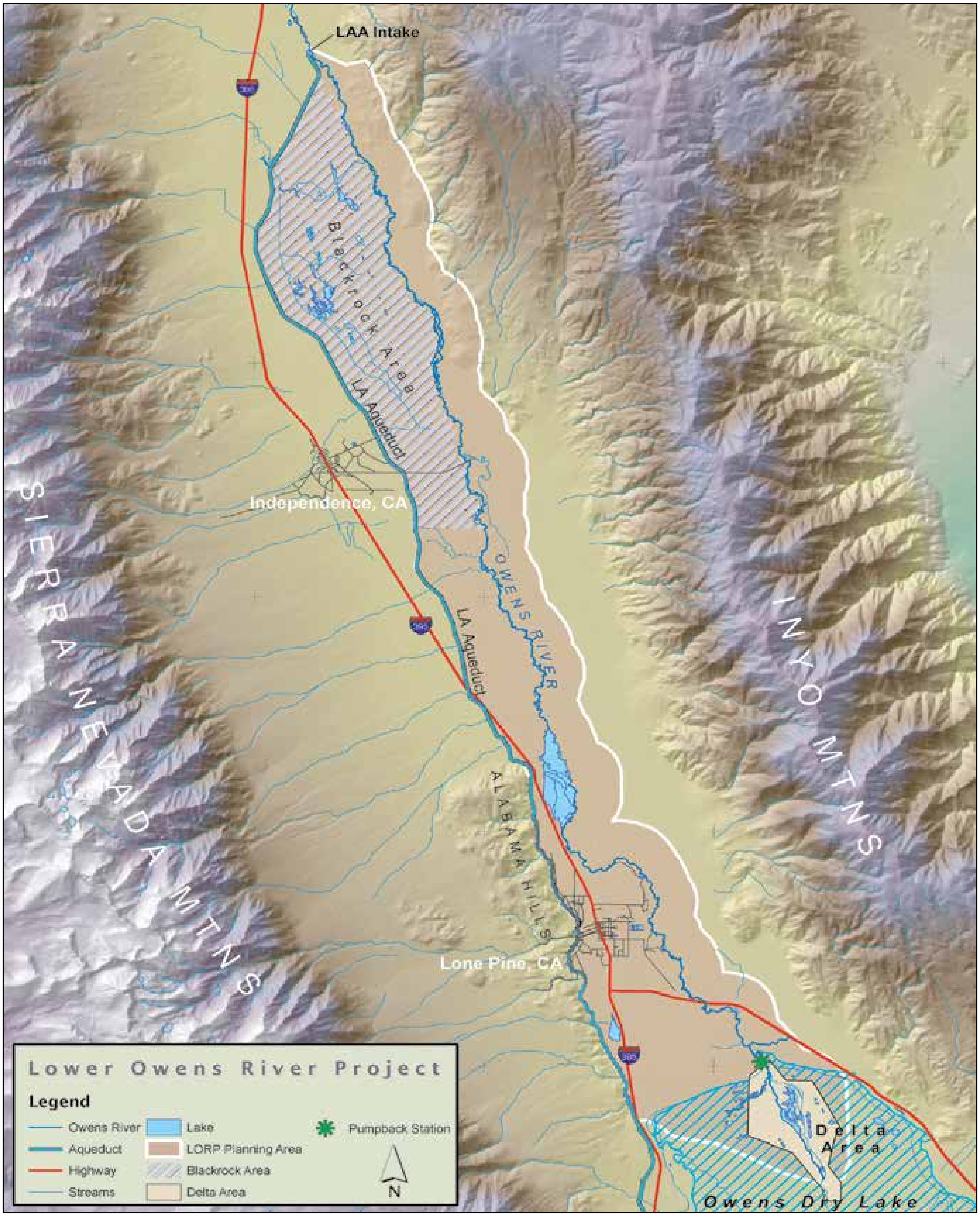


Lower Owens River Project Planning Area

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.

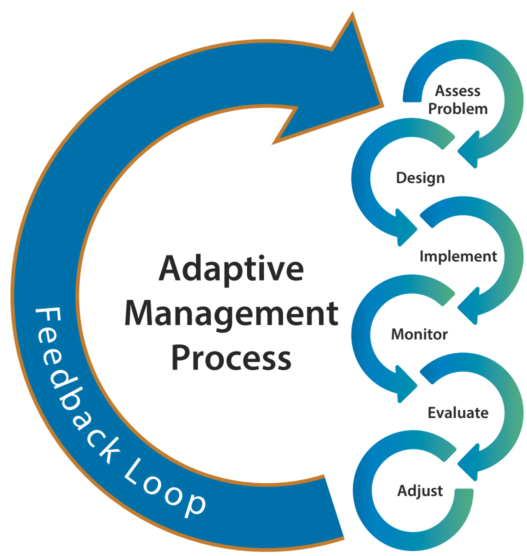
The MOU describes goals for the LORP once the mandated changes in land and water management have been applied over a sufficient period of time. The five goals were recognized as broad and lacking in specifics. Therefore, in consultation with all MOU parties, 13 objectives were identified to attain the 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

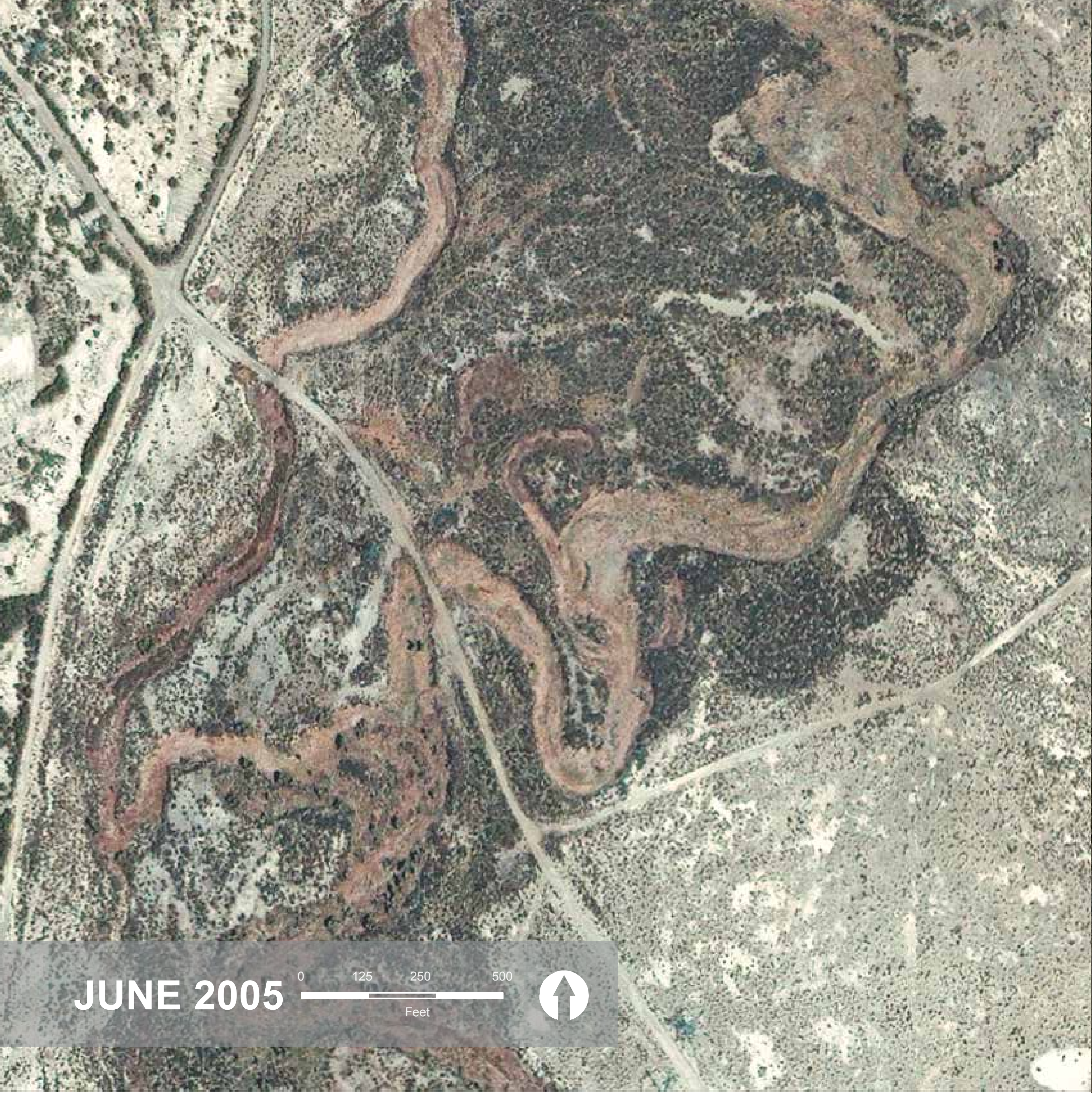
An essential idea of adaptive management is to recognize that management policies can be changed. Thus, managers cannot be rigid in their adherence to certain policies and must be willing to alter their approach for the benefit of the resource. An approach that is not working, although it has worked 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.

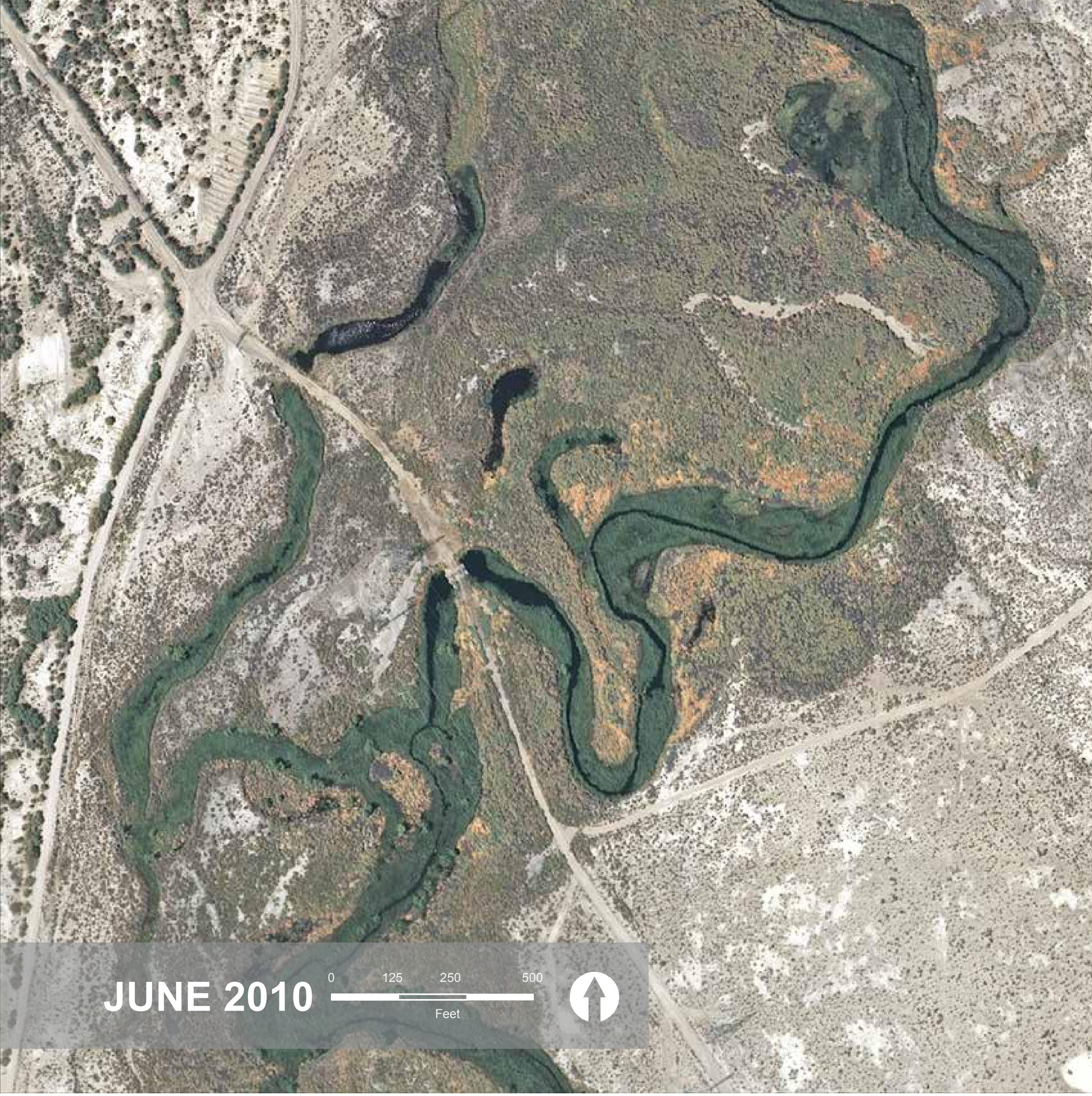
By 2012, with the implementation of the LORP, conditions changed to that shown in the lower right photo. The aerial imagery shows a segment of the river reach between the Intake and Mazourka Canyon Road. This area of the river clearly shows how the groundwater has risen and filled relic oxbows and ponds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



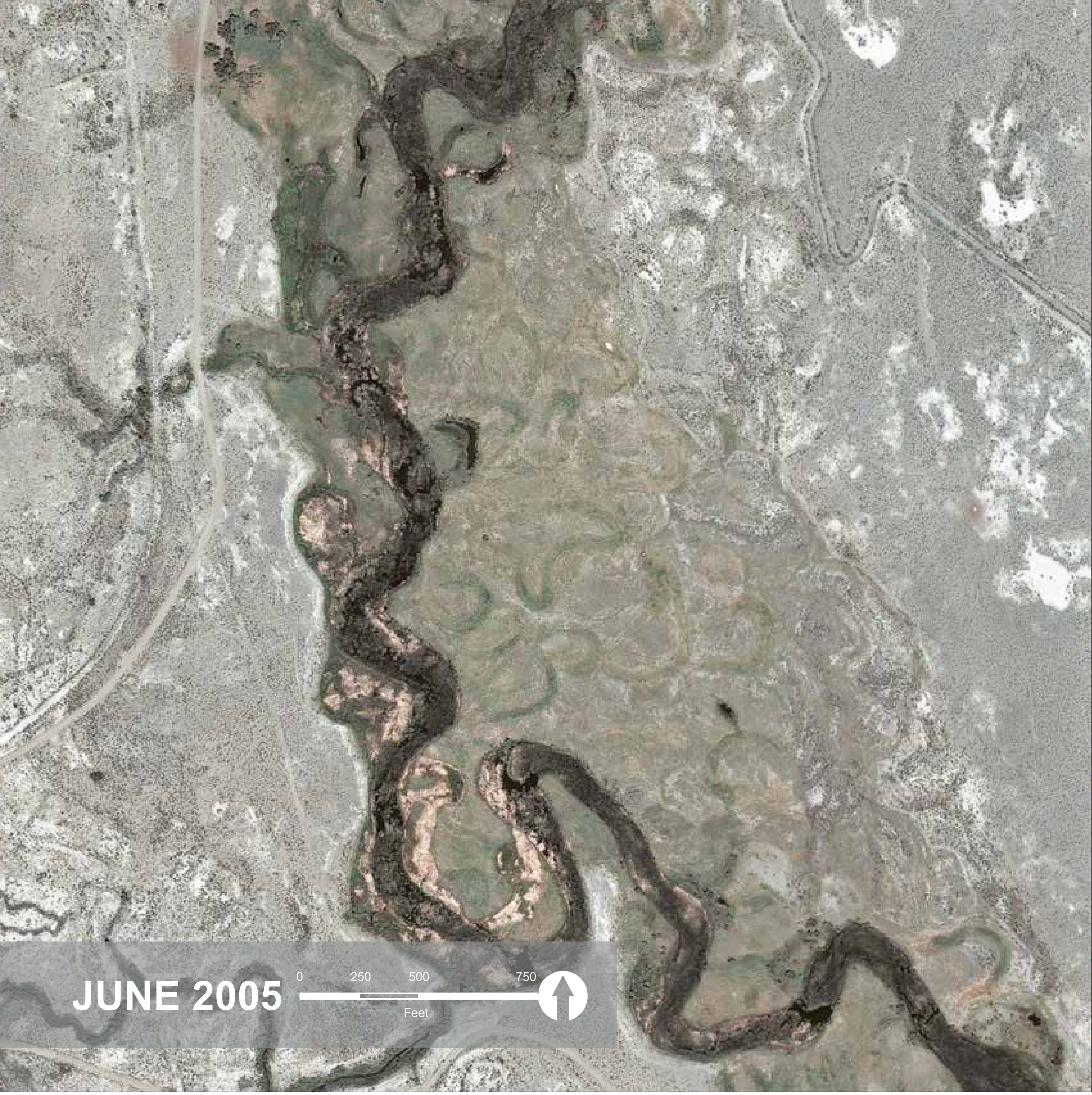
The River - Then and Now

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.

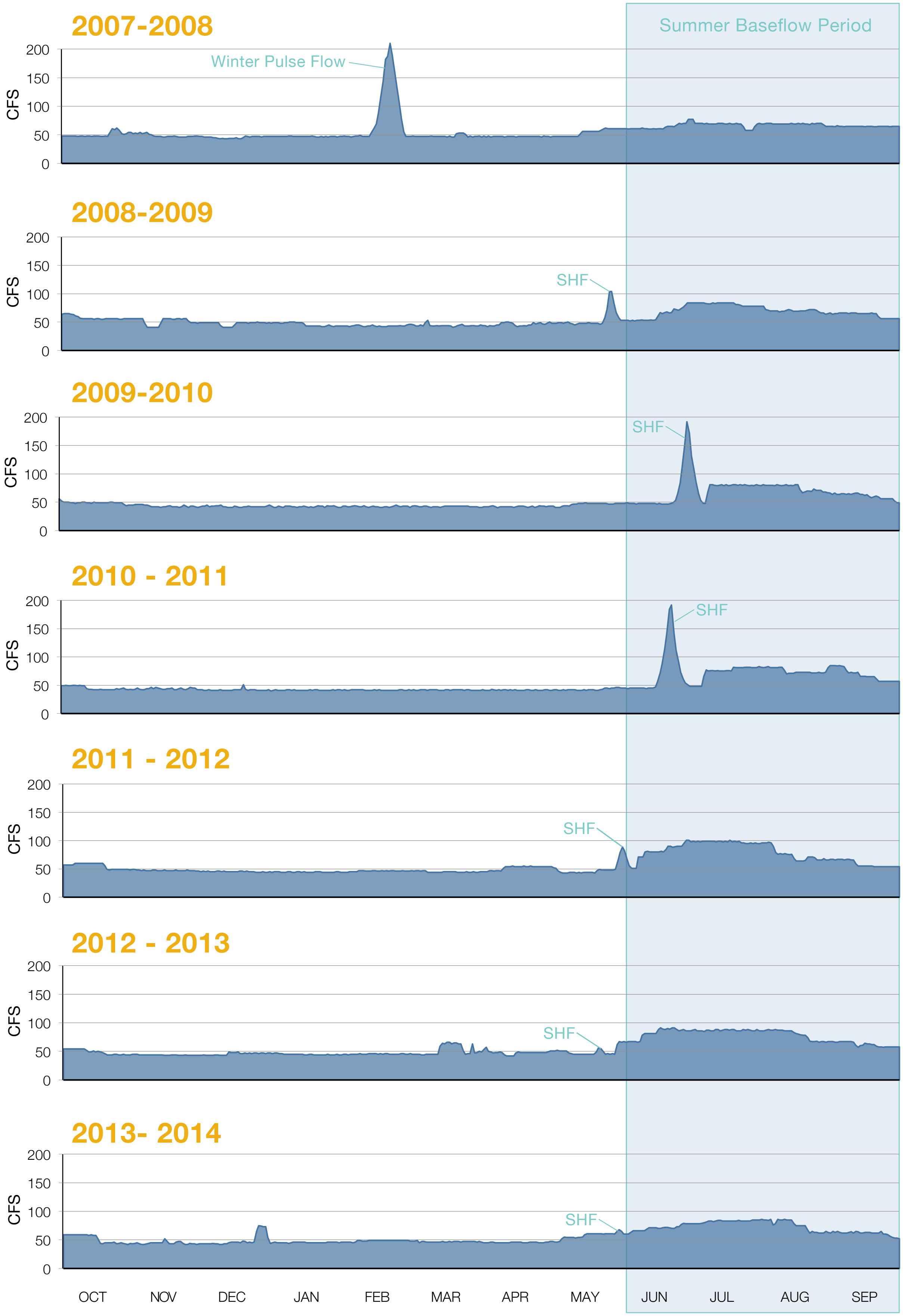
The flow regime for the Lower Owens River, as currently configured, is problematic yet it is the key to whether the LORP will succeed or fail. The current flow regime is managed to attain policy and compliance obligations first and foremost. If these prescribed river flows happen to benefit the riverine 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

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

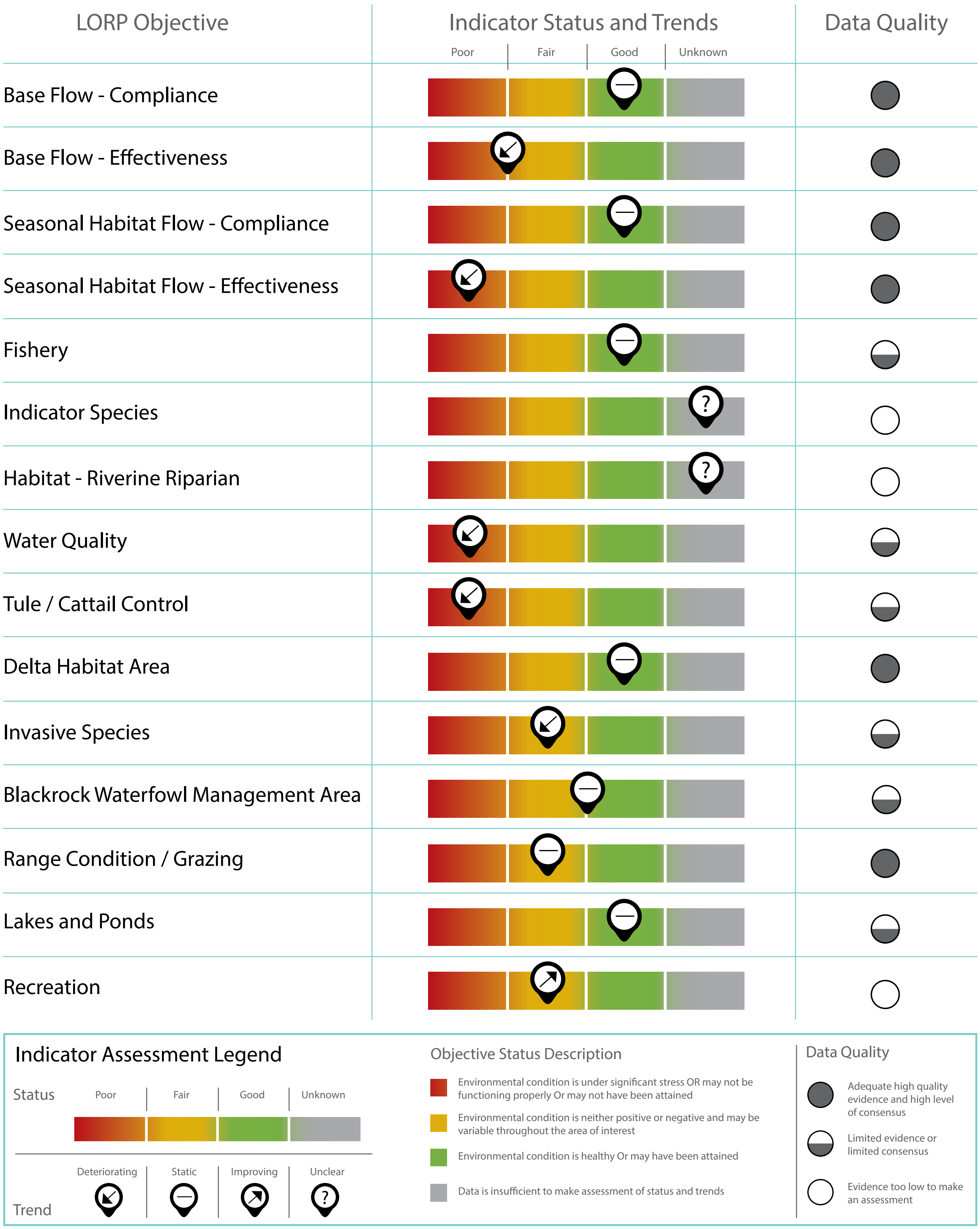
The objective for off-channel lakes and ponds such as Goose and Billy lakes is to maintain existing water surface elevation. In addition, Thibaut Pond will be maintained for 28-acres.

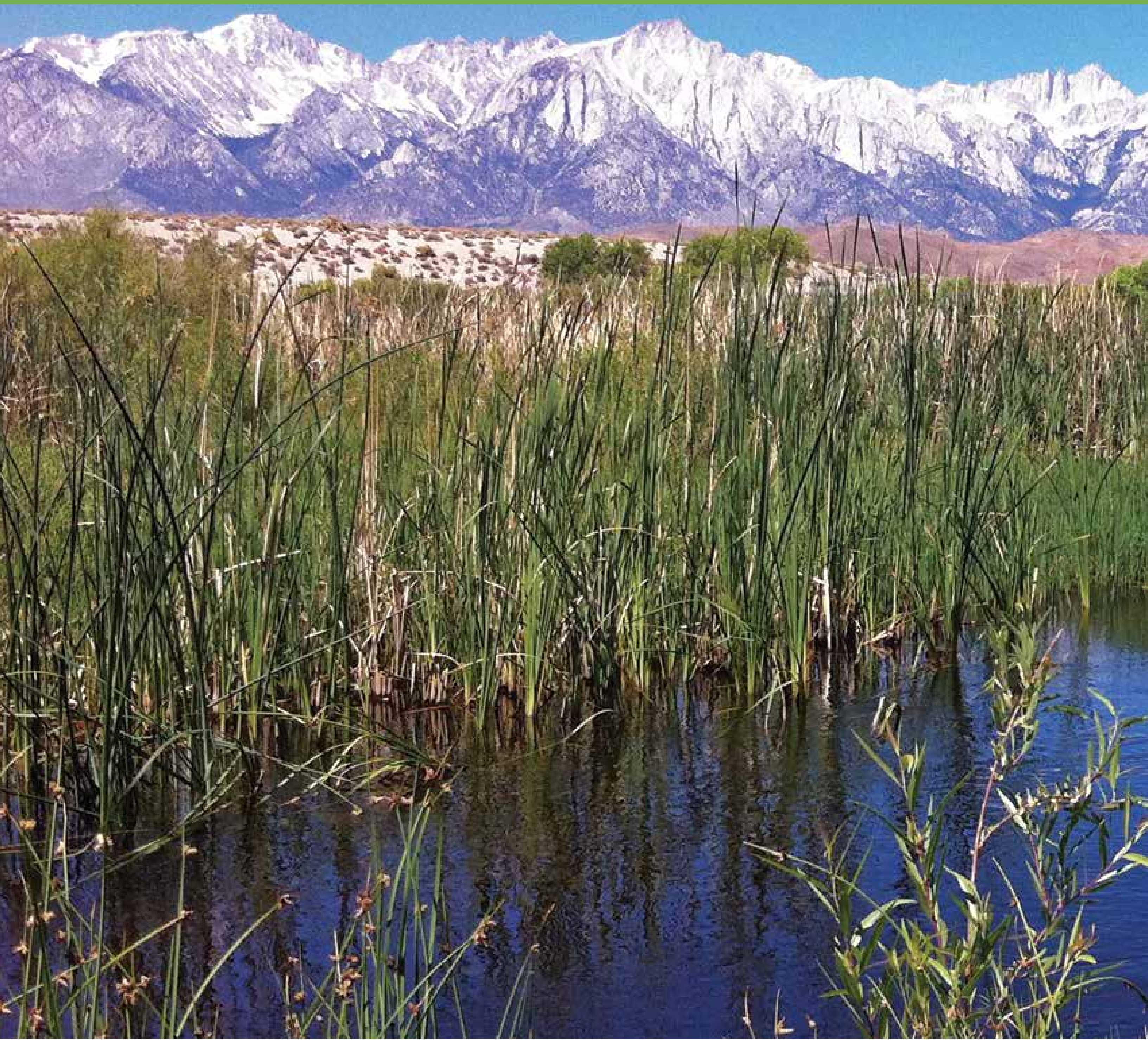
The adaptive management tools will focus on altering inflows from adjacent canals to maintain water levels. Another action specific for Thibaut Pond is a wet/dry cycle somewhat like BWMA. In the past LADWP has affectively maintained 28 acres of suitable habitat for waterfowl by drying Thibaut in the 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.**

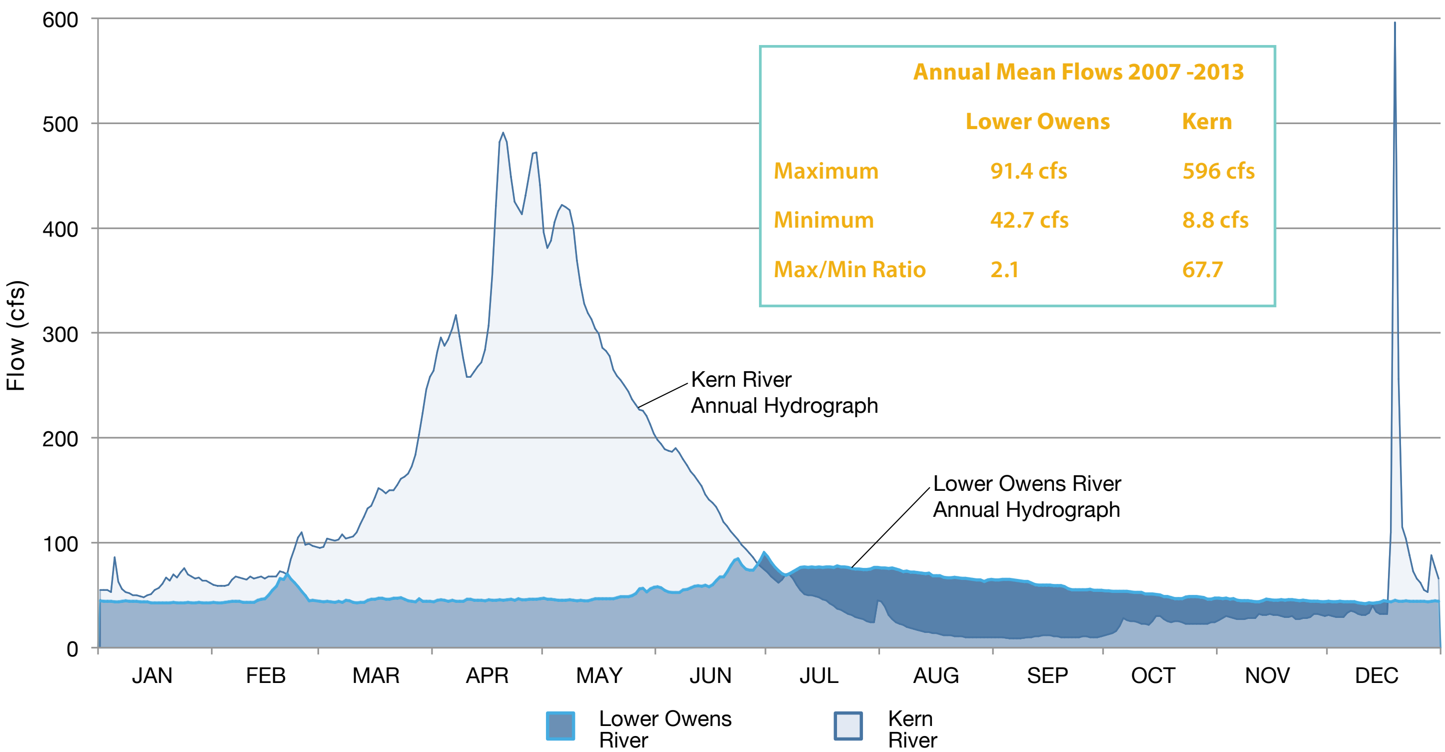
Although the intent has always been to initiate the project with 40 cfs base flow and 200 cfs pulse flow, this should not be viewed as the beginning and end. To achieve the biological/ecological goals of the MOU, it will be necessary to create a river, not a canal, in the long-term.

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

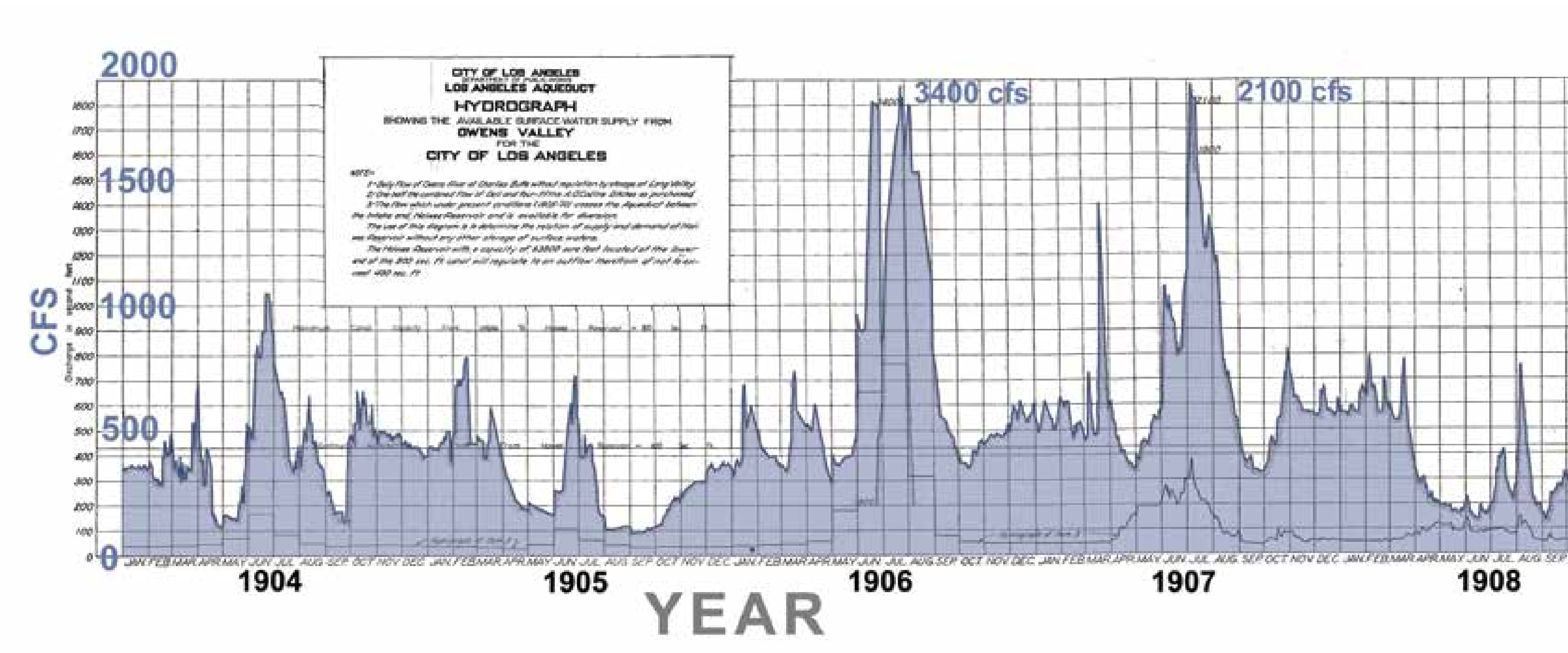
Historic Flow Regime

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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California Drought. Accessed 12/10/2014 http//ca.gov/drought.

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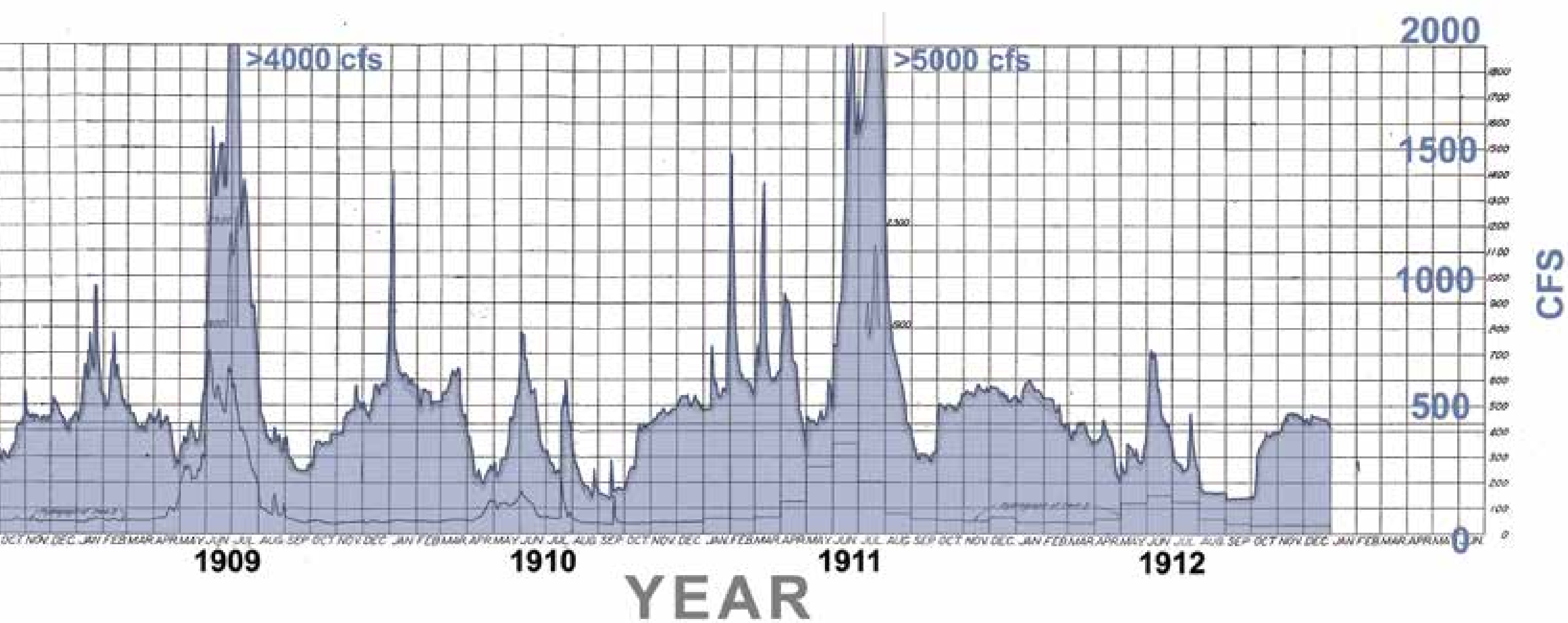

What We Don't Know

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.

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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

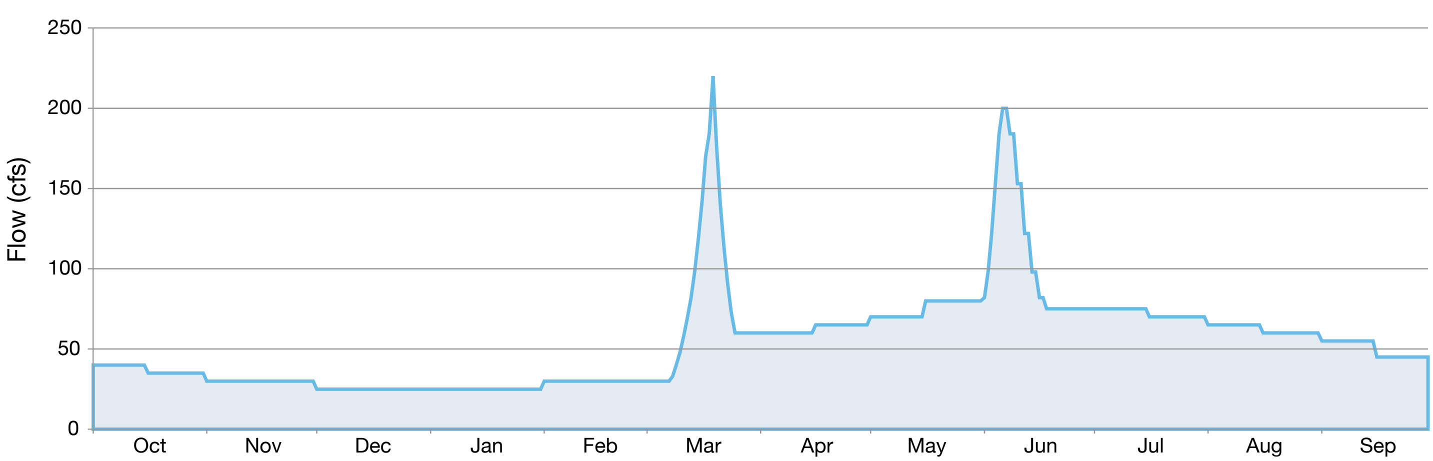


Figure 1. Proposed LORP Base and Seasonal Habitat Flow Regime

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

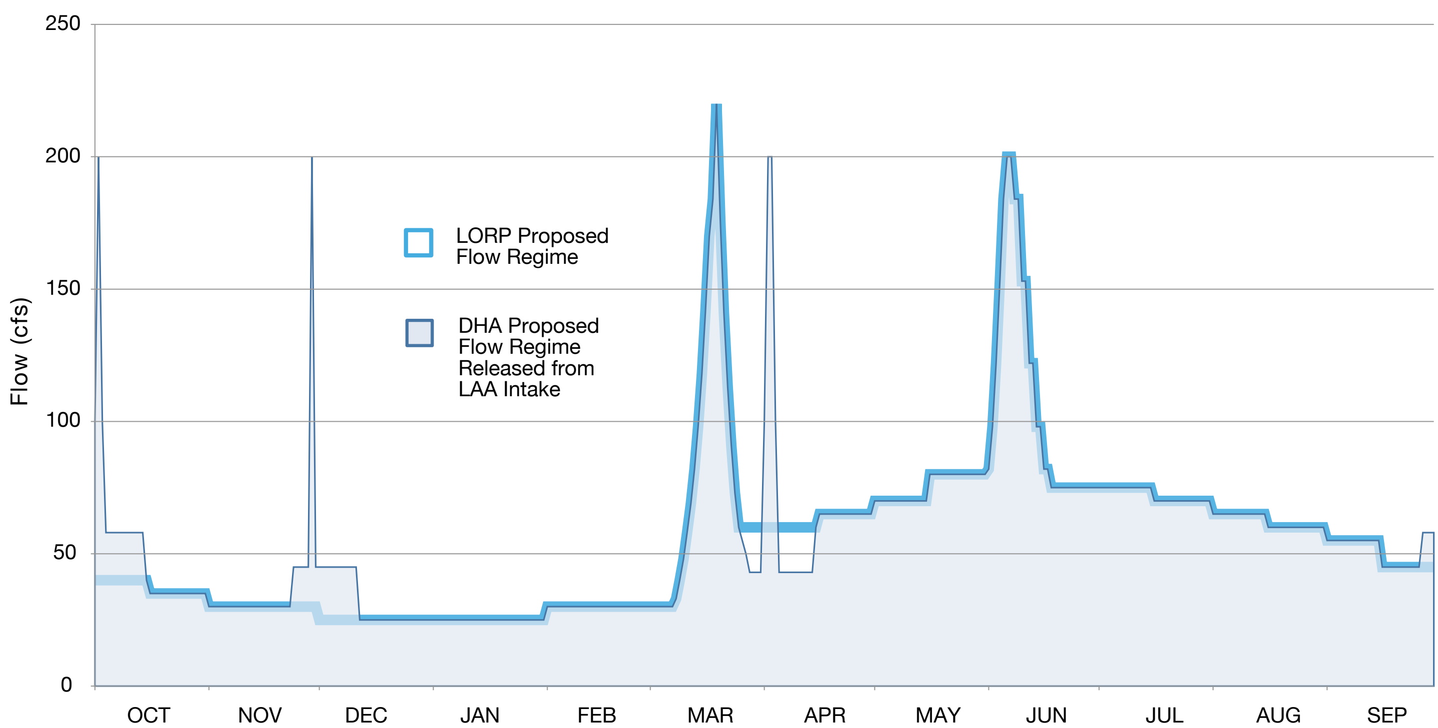
Ecosystem Sciences 2013. Lower Owens River Project Adaptive Management Recommendations. Ecosystem Sciences, Boise, ID.

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
Mazuorka	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.

EIR. 2004. Final Environmental Impact Report (EIR) and Environmental Impact Statement (EIS), Lower Owens River Project. Los Angeles Department of Water and Power.

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).

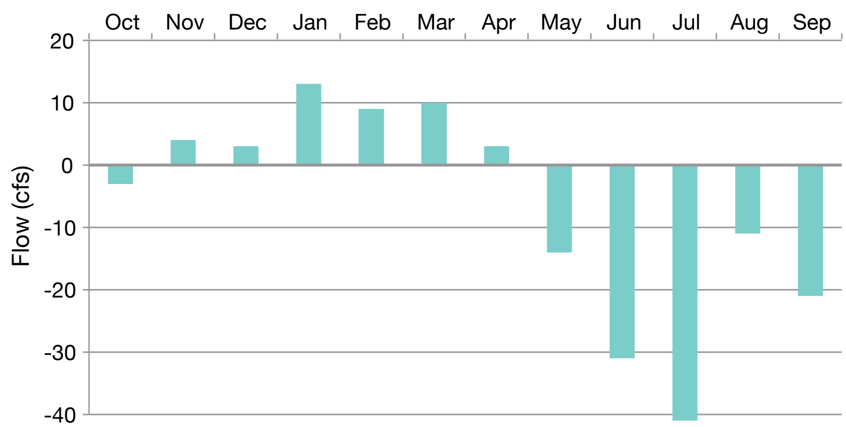


Figure 4. Lower Owens River flow gains and losses by month for water year 2013-2014.

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.

References

EIR. 2004. Final Environmental Impact Report (EIR) and Environmental Impact Statement (EIS), Lower Owens River Project. Los Angeles Department of Water and Power.

MOU. 1997. Memorandum of Understanding. County of Inyo and City of Los Angeles, CA. Bishop, CA.

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

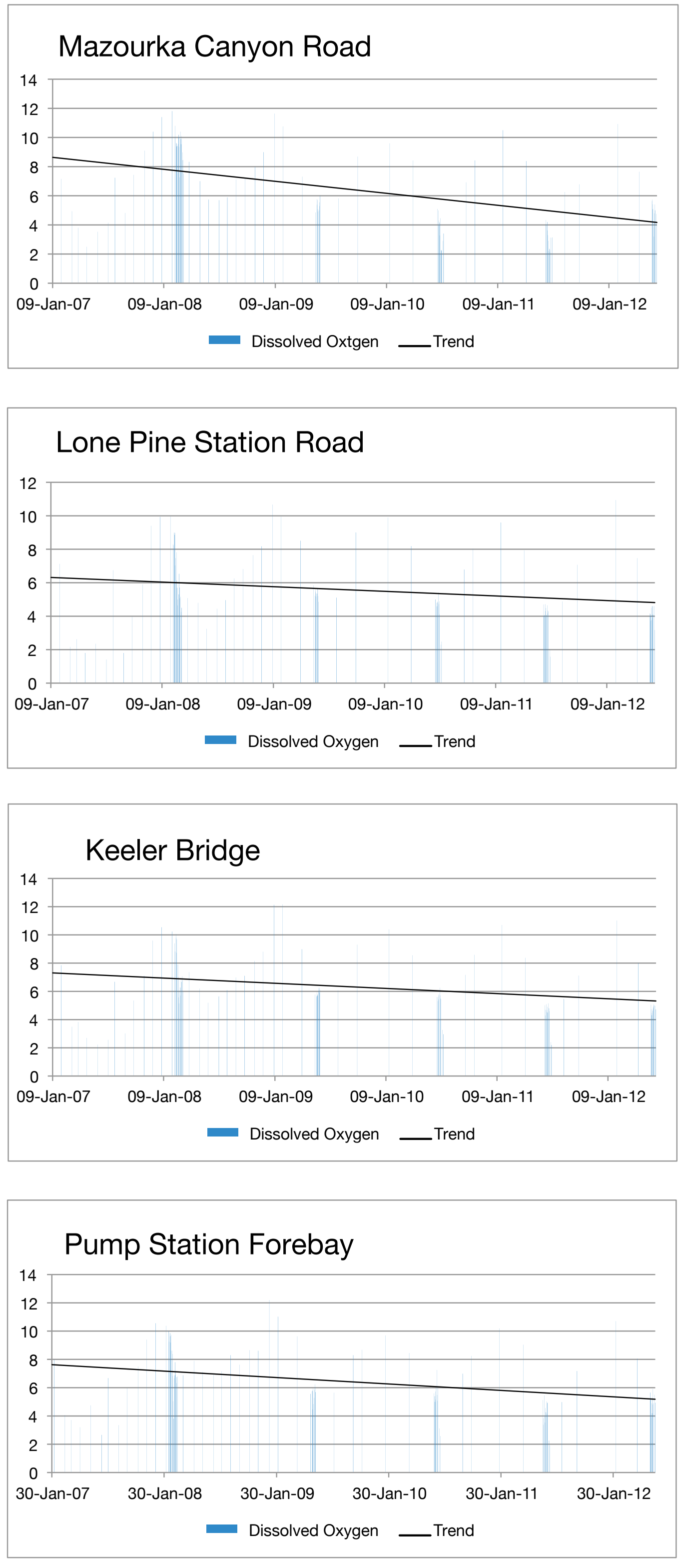


Figure 5. DIssolved Oxygen in the LORP.
Data collection taken by LADWP for long-term water quality monitoring from January 2007 to April 2013 indicating diminishing DO levels over time

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.

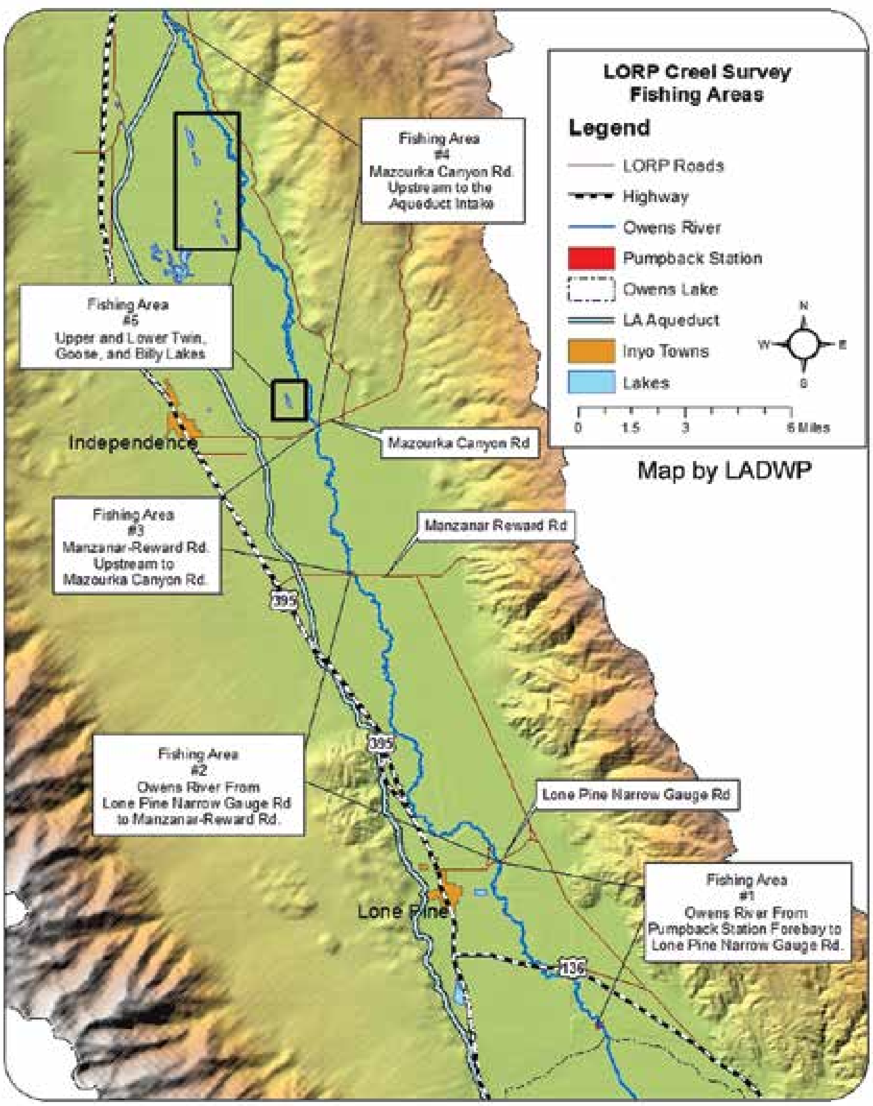

Figure 6. Creel Census, Fishing Areas Map.
Map by LADWP.

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.

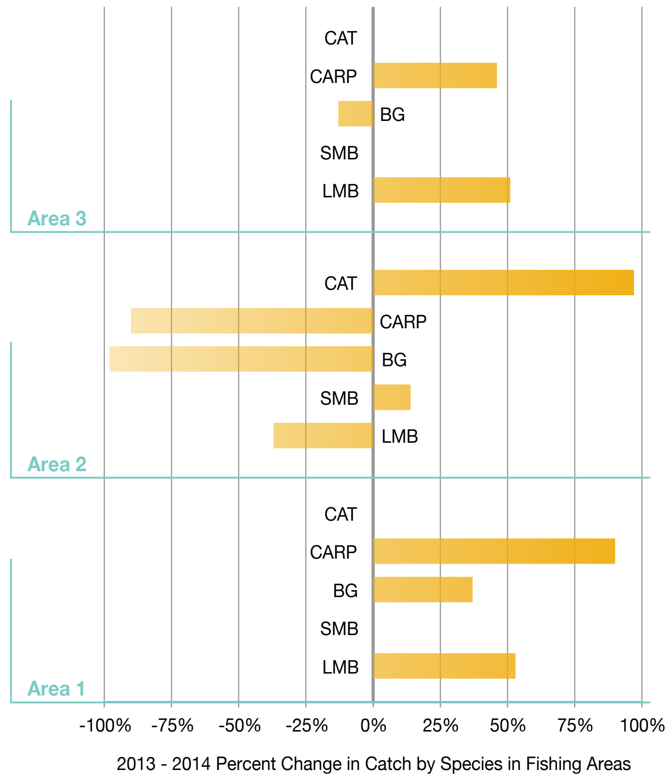

Figure 7. Percent Change in Catch from 2013 to 2014 by Species within Fishing Areas 1, 2, 3. Data from ICWD and LADWP based on Creel Census conducted in 2013 and 2014.

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*		

Table 21. Commonly Occurring Species in the Region

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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.

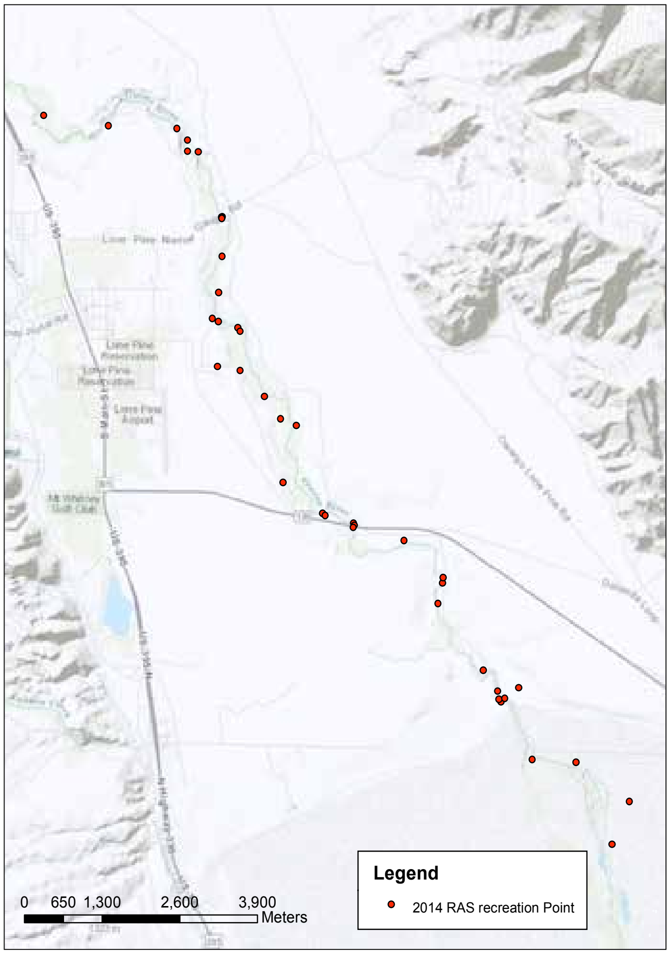

Figure 8. RAS Recreation Locations

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

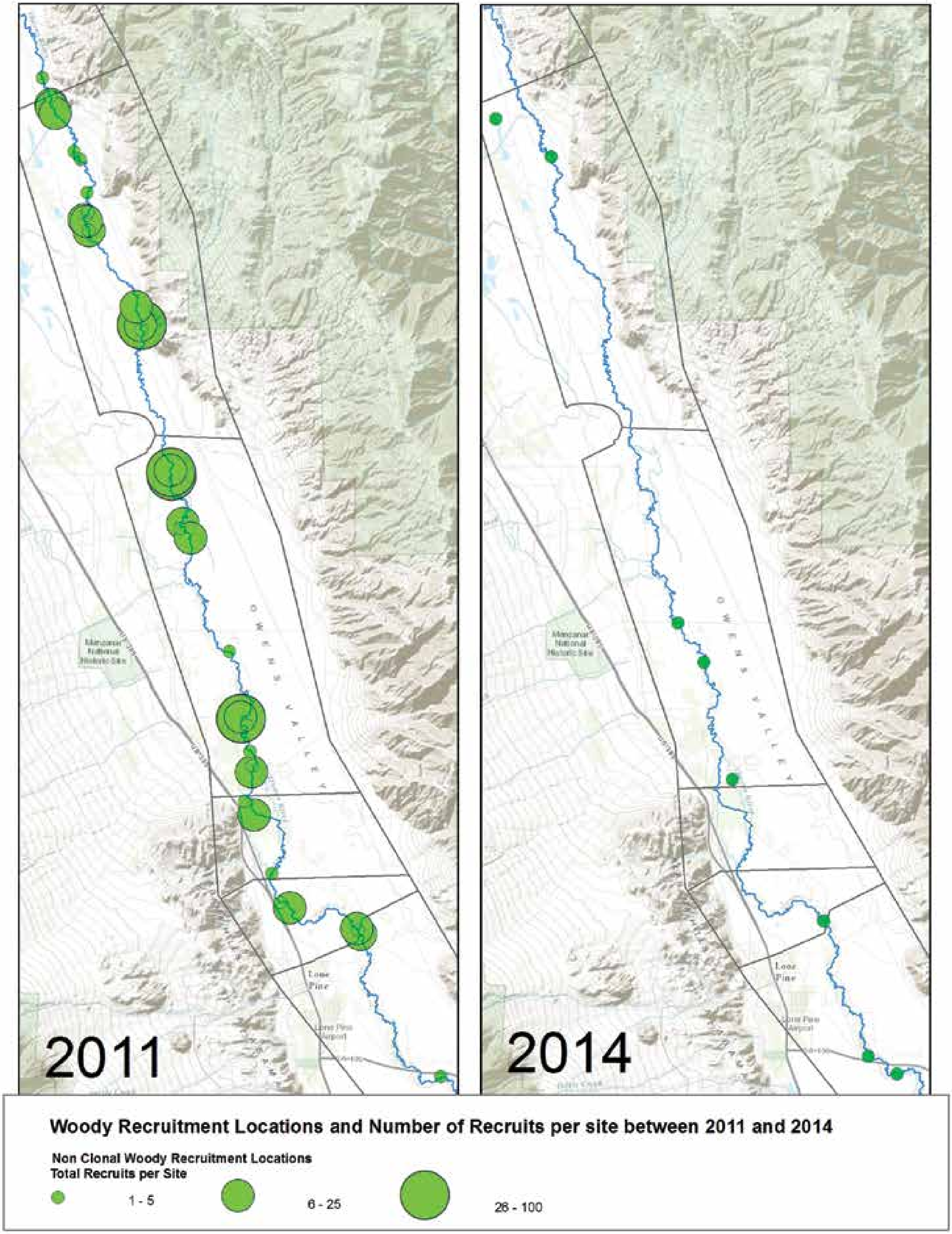

Figure 9. Woody Recruitment Locations and Number of Recruits; 2011 and 2014.

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).

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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.

References

Inyo County and LADWP. 2013. Lower Owens River Project 2013 Annual Report. Bishop, CA.

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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

Summation of all 2014 Adaptive Management Recommendations

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)

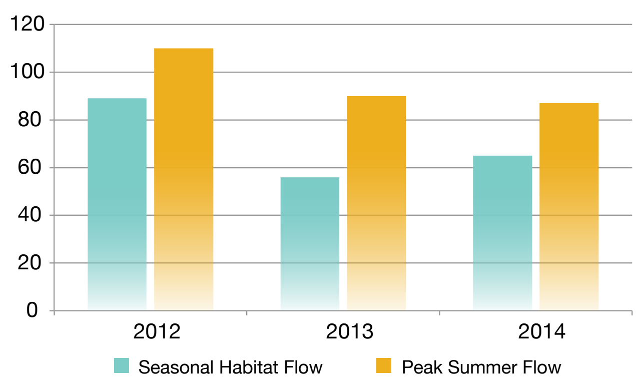

Figure 10. 2012 - 2014 Comparison of SHF and Peak Summer Flow.

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 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.

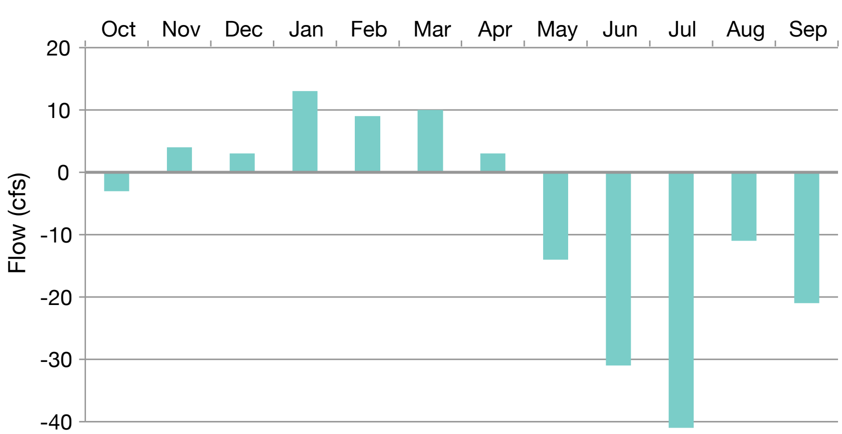

Figure 11. Cumulative Monthly Flow Gains and Losses for the Lower Owens River

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.

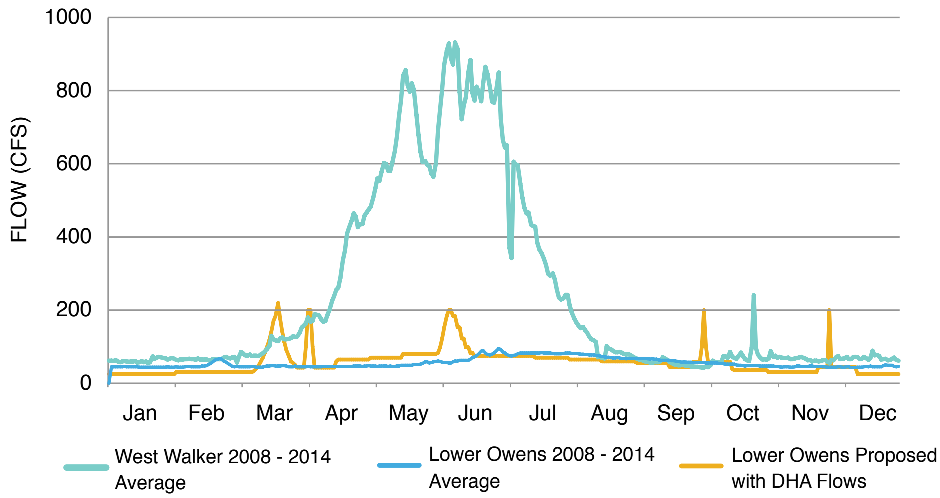

Figure 12. Average flow in the Walker River from 2008 - 2014 (USGS @ Coleville). Average flow during the same period for the Lower Owens is added for comparison as well as the proposed flow regime for the LORP.

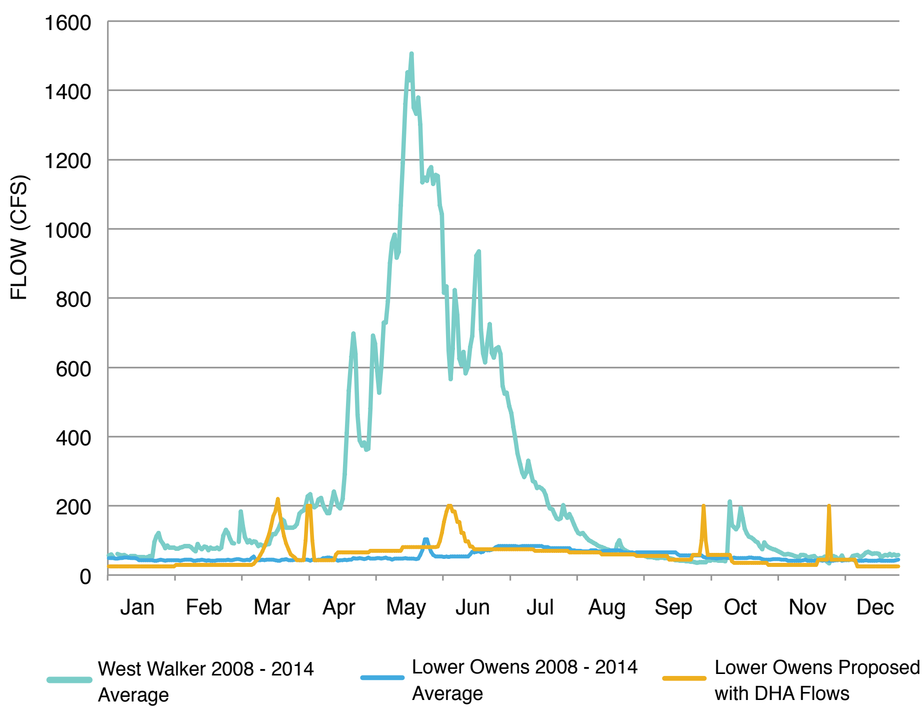

Figure 13. Flow in the Walker River for 2009 (USGS @Coleville). 2009 Lower Owens flow is added for comparison as well as the proposed flow regime for the LORP.

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.

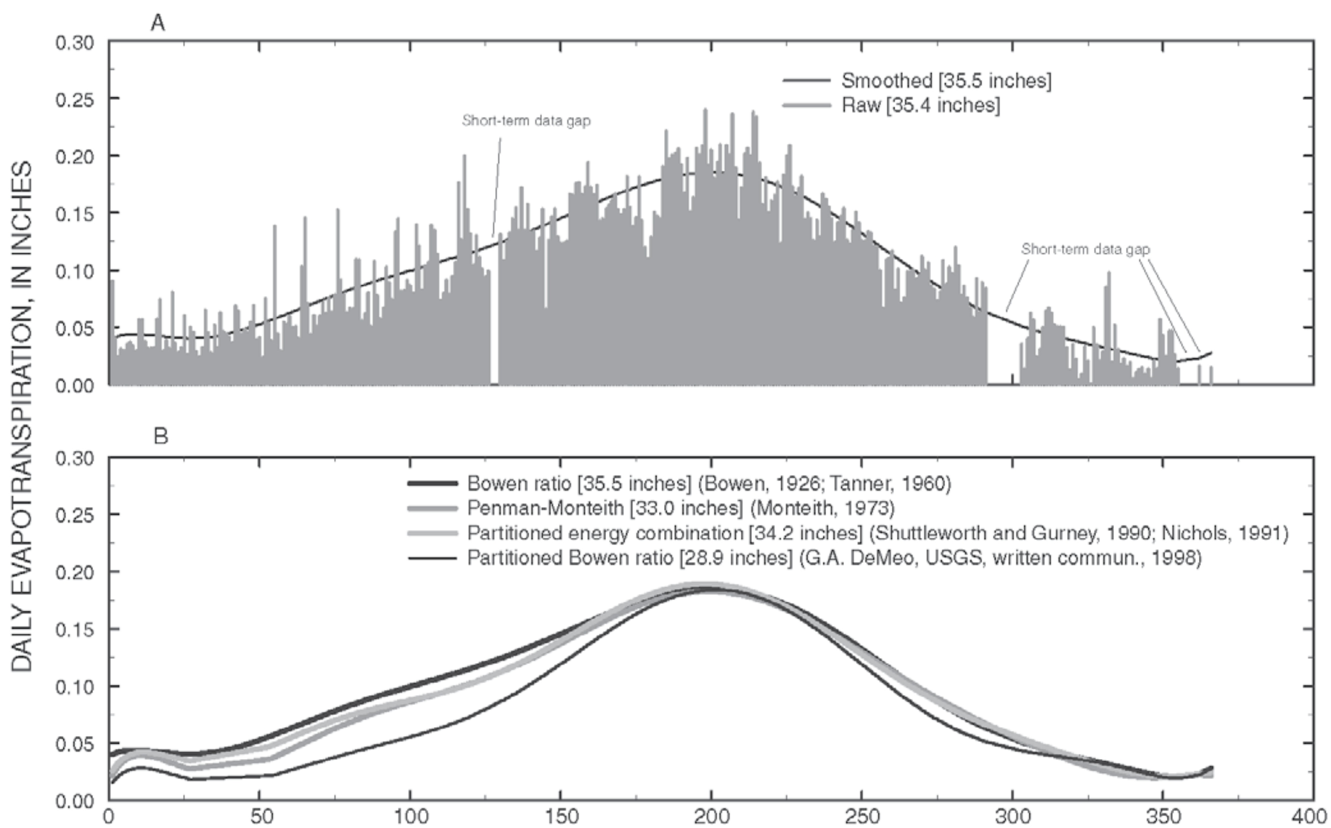

Figure 14. Calculated daily ET at Carson Meadow (Ash Meadows Area) for 1996 (A. Raw data, B. ET curves calculated using different methods (USGS 1999). The X-axis is the Julian day calendar, where day 200 is July 19th.

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).

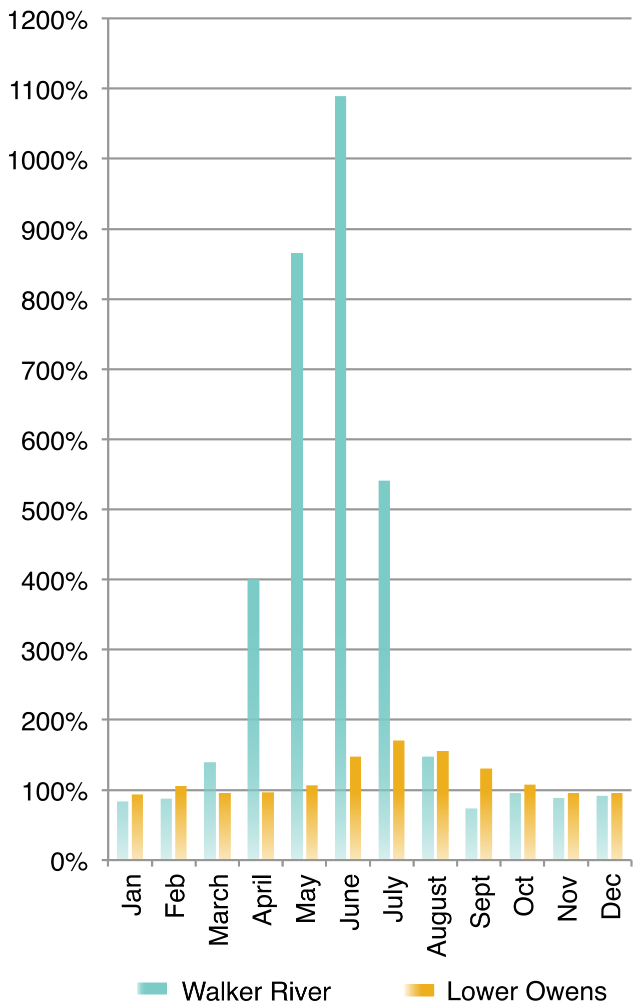

Figure 15. Percent of Median Flow in the Walker River (USGS @Coleville) and Lower Owens from 2008 to 2014.

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.

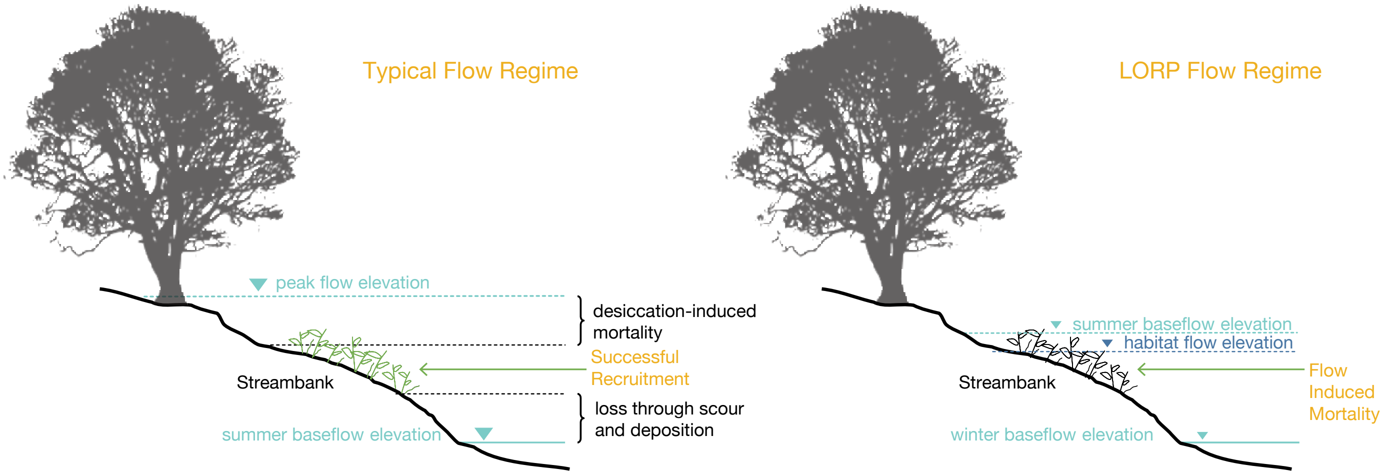

Figure 16. Seedling recruitment patterns and flow regime (adapted from Stillwater Sciences, 2006)
The figure on the left illustrates seedling recruitment patterns typical of semi-arid alluvial river systems. Seedling recruitment is constrained in the first year by desiccation-inducted mortality at high 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.

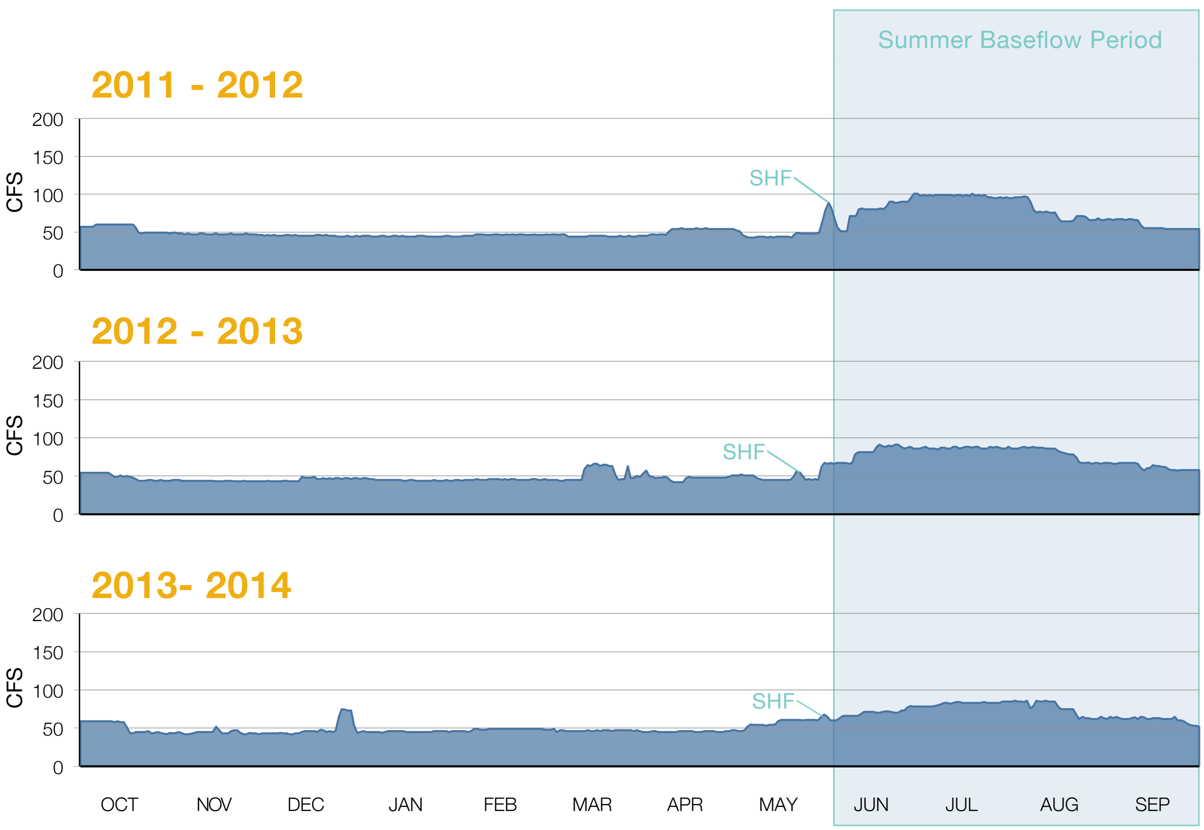

Figure 17. Annual hydrograph of the Lower Owens River from 2011-2014.
These graphs illustrate the diminishing Seasonal Habitat Flows (SHF) through the years since the project was initiated with rewartering flows. It also illustrates the static flow regime and the abnormally high summer baseflows needed 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

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.

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.

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.

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2014

Lower Owens River Project

Adaptive Management Recommendations

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