Appendix B_Oregon

This report was provided to Pacific States Marine Fisheries Commission (PSMFC) on the Middle Fork John Day Intensively Monitored Watershed (IMW) by the Middle Fork Working Group. The Middle Fork IMW is characterized, in part, by many agency partners and complex studies. This report summarizing a decade of work and provides detailed information on the background, experimental design, monitoring methods, initial results and lessons learned. . This report is the basis for the NOAA final report submitted by PSMFC entitled "Synthesis of Five Intensively Monitored Watersheds in Idaho, Oregon, and Washington". The report can be referenced as the "Middle Fork IMW Working Group. 2017. Middle Fork John Day River Intensively Monitored Watershed Final Summary Report.

We provide the Executive Summary of the full report provided by the Middle Fork IMW working group in this Appendix as a convenience to the reader. The full report can be found here.

Middle Fork John Day River Intensively Monitored Watershed

Executive Summary

Introduction

In the Middle Fork John Day River (MFJDR) basin in Oregon, nearly two centuries of land management practices have contributed to the decline of federally threatened Mid-Columbia summer steelhead *Oncorhynchus mykiss* and non-listed spring Chinook Salmon *O. tshawytscha*. Beaver trapping, road building, clear-cut logging, fire suppression, channel rerouting, floodplain/wetland drainage, grazing, and mining have all impacted the MFJDR through time. While the most damaging of these practices have been curtailed, their harmful legacies remain, including degraded floodplain function and connectivity, reduced habitat quantity and diversity, increased water temperature, and altered hydrology and sediment routing. These key limiting factors have been identified as negatively impacting steelhead and salmon recovery in the MFJDR (CBMRCD 2005; Carmichael and Taylor 2010). Habitat restoration is a primary strategy to address the limiting factors in Columbia Basin tributaries that hinder salmonid recovery in the Pacific Northwest (PNW), including the MFJDR.

Investments in salmonid habitat restoration oftentimes do not include effectiveness monitoring (Roni et al. 2002; Roni P. ed. 2005, Bernhardt et al. 2005), leaving project planners to rely upon anecdotal evidence to infer benefits to fish populations. To address this problem, the Intensively Monitored Watershed (IMW) program was created to monitor fish population responses to restoration actions, provide evidence of restoration effectiveness, and better understand the relationships between fish and habitat. In 2008, the MFJDR joined the IMW program, seeking to study how ongoing stream restoration actions were affecting salmonid populations, and to guide future restoration efforts.

The Middle Fork IMW (MFIMW) is coordinated by a subset of organizations that originally participated in the Upper Middle Fork John Day Working Group (UMFWG). These participants convened in April of 2007 to develop a monitoring approach. In 2008, the National Marine Fisheries Service (NMFS), in coordination with the Pacific States Marine Fisheries Commission (PSMFC), and the Oregon Watershed Enhancement Board (OWEB) began funding the MFIMW.

The goals of the MFIMW are to 1) evaluate the overall benefit of restoration actions to summer steelhead and spring Chinook Salmon in the Upper MFJDR, and 2) understand how specific restoration actions impact instream habitat, temperature, and salmonid metrics at the watershed, sub-watershed, and reach scales.

Over 100 active and passive restoration projects of varying size and scope were implemented over the 10-year period of the MFIMW by organizations that originally participated in the UMFWG. A restoration inventory shows 30 restoration projects implemented along the mainstem MFJDR and 70 projects in the tributaries. This habitat restoration work targets the key limiting factors described above. Many of the restoration projects were multi-faceted, designed simultaneously to address multiple limiting factors, with the intent of maximizing ecosystem 'returns' from these restoration investments.

Photo 2. Setting up weather station. *Courtesy of NFJDWC.*

Key Findings

The MFIMW evaluated the effects of restoration actions on native steelhead and Chinook populations and habitat throughout the Upper MFJDR watershed. A range of parameters were monitored, including but not limited to fish populations, physical instream habitat, and water temperature. Key findings include:

- Evidence strongly indicates that elevated stream temperature remains the most significant limiting factor for steelhead and Chinook populations, overriding the benefits to salmonids from observed instream habitat improvements from restoration actions in the MFJDR.
- Without the simultaneous and effective mitigation of high stream temperatures, restoration actions that targeted quantity and quality of instream habitat were insufficient to generate positive fisheries metric responses at all scales monitored.
- High stream temperatures, and their negative effects on fisheries responses, are the direct result of a warming climate, reduced snow pack, and severely modified riparian habitats. While riparian restoration efforts have been and are being implemented, habitat improvements resulting from these are slow to progress, due to insufficient extent of plantings throughout the watershed and the unexpected magnitude of ungulate browsing.

- Riparian vegetation restoration has great potential to address stream temperature concerns, but riparian maturation takes a great deal of time and careful stewardship to ensure success.
- River restoration is a long-term investment. Restoration actions aimed at improving watershed function, such as riparian restoration and instream habitat improvement, take decades to fully develop and produce detectable improvements in salmonid productivity.
- Various habitat and population changes expected from restoration actions have different response times, from short (a few years) to long (decades), and monitoring should be scaled accordingly.
- During the planning process, it is important to delineate expected response timing and magnitudes from restoration actions to ensure that monitoring goals are realistic and can be achieved within a reasonable time frame.
- Life cycle modeling can aid in predicting the expected magnitudes and timing of fisheries response variables from restoration, and help to prioritize the restoration actions that maximize restoration effect on population metrics.

Response of Salmonid Populations to Restoration Actions

We monitored the response of summer steelhead and Chinook Salmon to restoration actions in the MFJDR. Our hypothesis, based on previous MFJDR observations, was that freshwater salmonid productivity will respond positively to increased quality and quantity of habitat. However, results at the watershed scale indicate that to date, freshwater productivity of salmonid populations has not increased. Evidence indicates that temperature and discharge, rather than restoration actions, were the dominant influences on juvenile salmonid responses in the MFJDR watershed. Salmonid growth was influenced by both temperature and discharge, while low discharge was the dominant factor limiting salmonid survival. Furthermore, we found through distribution surveys that juvenile Chinook habitat quantity was significantly limited by high summer water temperatures. Although our habitat surveys indicate that factors limiting freshwater production were improved through restoration actions in the MFIMW, the most significant limiting factor, stream temperature, has not yet been adequately addressed. Therefore, despite gains made in habitat quality, suitable stream temperatures and habitat quantity remained limited, suppressing significant increases in watershed-scale salmonid productivity.

While improvements to habitat quality were also observed in our Camp Creek surveys, they were not sufficient to create concurrent observable increases in freshwater productivity. Instead, as in the watershed-scale finding, stream discharge and temperature were the most significant influences on juvenile steelhead survival and productivity. In Camp Creek, we observed increased steelhead density during the early post-restoration period, but higher discharges during that period were most likely responsible, not habitat improvement. Additionally, evidence indicates that elevated stream temperatures in Camp Creek continued to suppress growth and productivity in the post-restoration period, and very likely negated positive fisheries responses to observed habitat quality improvements.

Despite significant habitat quality improvements in MFJDR and Camp Creek, elevated stream temperatures continue to limit the production of salmonid juveniles by limiting habitat quantity and decreasing juvenile salmonid growth and survival. MFIMW life cycle modeling efforts support this finding, concluding that water temperature remains the primary limiting factor in the MFJDR system. The slow progress and limited extent of riparian restoration and lack of reductions in temperature limited freshwater responses throughout the MFJDR watershed. Finally, given the limited time for habitat recovery from active restoration, and the lag time associated with population-scale fish responses, limited fish responses to the recent restoration actions of the MFJDR are reasonable.

Response of Instream Habitat to Restoration Actions

The majority of MFIMW restoration actions were designed to improve instream habitat quality and quantity. These include pool creation and pool modification, floodplain reconnection, fish cover enhancements, increased sinuosity, channel narrowing, and habitat diversification. Therefore, geomorphic and in-stream habitat monitoring was a primary component of the MFIMW, focusing on three spatial scales: project, reach, and watershed level.

We estimated instream habitat trends at the watershed scale by measuring changes in individual stream habitat metrics at established PacFish/InFish Biological Opinion (PIBO) sampling sites in Camp Creek and the mainstem MFJDR. This study demonstrated that stream restoration and land management efforts had a measurable effect on habitat quality at the watershed scale. Overall habitat index improved, large woody debris increased in frequency, and the percentage of undercut banks increased in Camp Creek and the MFJDR. However, percent fines in pools increased in Camp Creek and the MFJDR. These results indicate that most individual aspects of habitat condition in the MFIMW are stable or improving. While habitat conditions in Camp Creek are improving, it remains of poorer quality than reference conditions in the Blue Mountains and Upper Columbia Basin. This comparison highlights the need for additional restoration actions and time for riparian restoration to deliver expected results.

In addition to monitoring broad habitat changes at the watershed scale, finer-scale habitat changes at the reach and individual restoration project scales were also studied. Channel geomorphology, sinuosity, pool depth, bed material, and fish cover were monitored for seven years at restoration and control reaches. Changes to channel morphology at individual log structure treatments were also monitored. The results show that while restoration reaches did not narrow and deepen or become more sinuous, active restoration measures did produce a significant increase in pool depth, mainly due to deep pools created during the restoration projects. Both treatment and control reaches also experienced a significant decrease in the percentage of embedded gravels, indicating that gravels are becoming more porous and that accumulation of fine sediment in the gravel bed is not a problem. These results indicate that the MFJDR channel is relatively stable and in dynamic equilibrium, and not susceptible to significant net erosion or deposition, even during the 2011 flood, the largest flood ever recorded on the MFJDR.

Interestingly, stream reaches that had experienced passive restoration (i.e., removal of livestock grazing) showed large increases in torrent sedge, a native species, within the active channel. These plants had important influences on channel morphology and habitat by increasing fish cover, creating lateral movement of the channel, and increasing channel complexity. These results suggest that long-term passive restoration is making important contributions to improving geomorphic and fish habitat conditions.

In conclusion, significant overall habitat improvements attributed to watershed-scale land management decisions and stream restoration actions were observed throughout the MFIMW as evidenced by our PIBO surveys. In the MFJDR, log structures did not significantly alter channel morphology. However, cattle exclusion in the MFJDR did successfully improve habitat and channel complexity, as well as fish cover, via increases in sedge vegetation.

Response of Riparian Habitat to Restoration Actions

Riparian planting has become a popular restoration strategy given its ability to provide shade to reduce stream temperatures and contribute large wood to improve instream habitat. Monitoring is important to inform the adaptive management process of riparian restoration, but effectiveness evaluation of riparian planting is often lacking. In the MFIMW, field monitoring was employed to gage the success of various riparian restoration scenarios and theoretical models were utilized to examine the impacts of these scenarios on future habitat quality.

We studied the effects of wild ungulate browsing on native woody riparian plantings along the MFJDR. To restore shade to highly modified riparian habitats, thousands of seedlings were planted on the Oxbow and Forrest Conservation Areas in 2006. These areas were already fenced to exclude cattle, but not wild ungulates. Results showed that browsing by deer and elk suppressed the growth of most planted hardwoods and concluded that browsing pressure from ungulates severely limits the restoration of native riparian forests. This limitation must be considered by restoration practitioners during project planning and design phases.

Ecological modeling can complement riparian field studies by using field measurements to predict where restoration plantings are most effective and, thus, inform the prioritization of riparian restoration actions across large landscapes. We modeled historical, current, and future scenarios of riparian plant communities and their effects on salmonid habitat in the upper MFJDR using state and transition models. Alternative management strategies for passive versus active riparian restoration were examined. Simulation results indicate that recovery toward historic conditions occurs under both passive and active strategies, though recovery was slower under passive restoration alone. Simulations also suggested that streams would not fully recover to the historical condition within 50 years (the duration of the modeled simulations), even in the most aggressive active restoration scenario we examined. These results indicate that river restoration investments, particularly those with a long lag time such as riparian restoration, need to be planned and evaluated over several decades. It also suggests that the slow recovery time of riparian restoration may undermine the ability to detect positive fisheries responses from restoration actions within a reasonable time frame, especially in areas where high temperatures are a primary limiting factor, such as in the MFJDR watershed.

Response of MFIMW Stream Temperatures to Restoration Actions

Elevated stream temperature is clearly implicated in salmonid population declines in the MFJDR, and is considered to be the primary limiting factor for salmonids in this system. Some of the restoration projects implemented throughout the MFIMW study area were designed specifically to cool the river, but most were primarily directed to other objectives (e.g., increased habitat, access to low-velocity water during floods). We monitored temperature at both coarse (watershed, subwatershed) and fine (individual project, reach-level) spatial and temporal scales. Field-validated implementations of the physically-based model HeatSource were applied to predict stream temperature changes under various climate and restoration scenarios. Results showed that although some projects did succeed at lowering temperatures in localized areas, others were predicted to increase temperatures, and overall, the elevated summer temperatures due to a lack of riparian shade was not significantly impacted during the study period, with the exception of the Oxbow consolidation of two channels into one.

We used standard temperature loggers to assess temperature trends at the MFJDR watershed scale for over a decade. Between 2005 and 2016, 122 water temperature loggers were deployed in the mainstem MFJDR and 26 of its tributaries. Summer water temperatures, reported as maximum 7-day average daily maximums (7DADMs) were above the EPA recommended 18°C thermal threshold for cold-water salmonids for all locations and all years. Riparian restoration activities in the MFJDR designed to cool water temperatures are relatively recent, including many within the last 5-7 years. Additionally, these plantings were implemented in a relatively small proportion of the watershed. It was found that these temporal and spatial recovery scales were insufficient to affect a watershed-level change in temperature values.

In addition to the watershed-scale temperature monitoring, we implemented distributed temperature sensing (DTS) to measure stream temperatures at high temporal (minutes) and spatial (0.5 m) resolutions. These data were utilized to calibrate predictive models and investigate the effects of reach-scale restoration projects on stream temperatures.

Floodplain reconnection is an important restoration objective. We investigated whether a MFJDR floodplain reconnection project could mitigate late-summer low flows and elevated stream temperatures through increased mainstem flow by delivery of water stored in the floodplain, from high winter flows, in the summer. This restoration action was shown to be ineffective in the mitigation of summer water temperatures. It should be emphasized, however, that the floodplain reconnection has benefits to salmonid communities during high flow periods.

Tributary inputs of cool water were shown to be critical components of creating thermal conditions suitable to salmonids. We found that the major cooling sources for the mainstem were from tributary contributions, and not from direct entry of groundwater. However, consistent with summer flows being generated from stored groundwater, it was also found that groundwater did provide significant cooling to the MFJD tributaries, which deliver this cool water to the mainstem. At tributary confluences colder contributions to the mainstem provided large areas of thermal refugia.

The mainstem MFJDR experiences very high summer stream temperatures and we investigated the drivers that caused these elevated temperature levels. While tributaries are the primary cooling mechanism to the mainstem MFJDR, our modeling efforts employing HeatSource found that solar radiation is the primary driver of temperature gain along the mainstem MFJDR. The relationship is linear, making it easy to predict the impact of restoration efforts on temperature by simply comparing the pre- and post-restoration surface area of the stream at low-flow. Therefore, wider channels with larger surface (wetted) areas are more susceptible to temperature increases than narrower, deeper channels.

Monitoring of the Phase 2 Oxbow Tailings Project, which decreased channel surface area, confirmed the HeatSource modeling projections. Monitoring of Phase 2 Oxbow Tailings Project showed a decrease in mainstem mean temperature of over 0.6°C (1°F). On the other hand, the Oxbow Tailings Project Phases 3-5 introduced meander bends to an artificially straightened channel and resulted in reduced channel velocities and an increase in stream channel surface area. HeatSource model projections indicated that these meander bend additions most likely caused increased solar heat inputs into this channel section and increased temperatures (Hall, 2015). Model results considering the impact of shade from stream-bank vegetation found modest and very slow temperature responses, with riparian restoration unlikely to provide significant thermal cooling within a decade on rivers the size of the MFJDR. These results suggest that re-meandering channels, without severe limitation of the wetted area during summer low-flow, may cause temperature increases in the absence of tall riparian vegetation. The results suggest all restoration efforts be assessed for their impact of low-flow stream surface area as a primary predictor of the expected impact on critical stream temperature.

Bridge Creek and the influence of Bates Pond provided an illustrative example of the interplay of temperature, cool water tributary influence to the MFJDR, surface area exposure to solar radiation, and fish habitat use. Bridge Creek flows into Bates Pond, a man-made millpond; Bates Pond then outflows into lower Bridge Creek, which empties into the MFJDR soon after. The increased surface water area of Bates Pond elevates water temperature outflow to the extent that lower Bridge Creek is warmer than the MFJDR during much of the summer. This restricts the potential of Bridge Creek to act as thermal refugia both downstream and above Bates Pond since fish will not ascend the fish ladder at the elevated temperatures. If the thermal condition of Bridge Creek within the State Park boundary, including Bates Pond, were improved to replicate temperatures upstream of the park, more steelhead and salmon would be able to utilize Bridge Creek as cool water refugia during periods of heat stress.

Photo 3. Bates Pond fish ladder.

Courtesy of ODFW.

Changing environmental and climatic conditions underscore the need to understand the mechanistic linkages between climate, habitat, and fish. For example, increases in air temperature and decreases in stream discharge due to climate change have the potential to increase future stream temperatures. We combined HeatSource and riparian state-and-transition models to predict the interactive effects of climate changes and riparian vegetation to stream temperatures in the upper MFJDR. Simulations suggest a wide range of possible future thermal regimes for the MFJDR. Future 7DADM stream temperatures ranged from 4^{o}C warmer to 8^{o}C colder than current conditions, depending on the extent of riparian vegetation simulated in the model.

Stream surface area exposed to air and shading from tall riparian vegetation had the largest influence on stream temperatures compared to air temperature and streamflow. These model results suggest that constraining channel width and development of tall riparian vegetation has the potential to mitigate the deleterious effects of future climate scenarios. While riparian restoration requires time to achieve anticipated results, investment in this restoration strategy will have critically important, positive effects to salmonid species and their habitats over the long term.

Response of Macroinvertebrates to Restoration Actions

Because macroinvertebrates are the dominant food source for juvenile salmonids in the MFJDR, it is important to understand the causal mechanisms linking stream restoration, macroinvertebrates, and salmonid production. We predicted that restoration actions in the MFJDR would increase overall macroinvertebrate abundance, increase the number of taxa, and produce community compositions more closely resembling those at undisturbed reference sites. To test these predictions, benthic and drift macroinvertebrate communities were compared between control and restored reaches in the MFJDR.

We found that, contrary to our prediction, restoration actions have not significantly affected the macroinvertebrate community composition when compared to reference sites. However, restoration actions did appear to affect the amount of drift macroinvertebrate biomass within the MFJDR from year to year. This was likely due to disturbance of the substrate and drift mobilizations from restoration activities. We also found, again contrary to our hypothesis, that restored reaches had a significantly lower number of drift taxa, probably because the disturbance caused by active restoration may alter the type and number of taxa at that site over the short term. Overall, however, we often observed more variability between years than sites, indicating that annual environmental conditions were more influential than management actions over the short-term period we monitored macroinvertebrate response.

Socio-Economic Benefits of Restoration

We monitored the contribution of restoration projects to the socio-economic health of the local community (often referred to as ‘the restoration economy’). This work aims to better understand if and how watershed restoration benefits the local economy. Community indicators assessed the overall socio-economic well-being of Grant County over time. Outcome measures estimated the contribution of MFIMW restoration work to the Grant County economy. The indicators show that Grant County was in socio-economic decline over the past 40-50 years, but that conditions are improving. In particular, jobs and earnings are on upward trajectories, with other indicators supporting that trend. At the same time, restoration work is bringing work and money into the Grant County economy, contributing to its recovery. The 100 restoration projects documented in the restoration inventory from July 1, 2007 to June 30, 2017 brought a minimum of $15.6 million dollars into the local economy, along with creating almost 170 jobs and generating additional economic activity in the range of $20-25 million.

Lessons Learned and Recommendations

Adaptive management is an important tool that should be used to guide restoration actions and be integrated within an IMW framework (Bouwes et al. 2016). As part of the adaptive management process, we asked that researchers and restoration practitioners share lessons learned and future recommendations based on their involvement with the MFIMW. These lessons and recommendations extended beyond what was learned from study findings; they illustrate how the participants would incorporate improved methodologies and strategies into subsequent phases of the IMW process and future IMW programs. During this process, several similar themes emerged from multiple participants. Therefore, lessons learned and recommendations are grouped by the three main topics: Planning, Monitoring, and Restoration. In this context, planning refers to the planning, facilitation, and coordination of the MFIMW process and group itself. We pair lessons learned with accompanying recommendations based on what we gleaned from participant experience. These lessons provide valuable insights for ongoing planning, monitoring, and restoration efforts within the MFIMW and similar IMW efforts.

Planning

Lesson Learned

The monitoring plan designed at the beginning of the study was compromised by unanticipated restoration projects that were implemented during the course of monitoring. There were many organizations implementing restoration actions across the MFIMW study area and a lack of coordination resulted in some restoration projects being implemented in designated control reaches.

Recommendations

Ongoing communication among restoration practitioners and researchers is integral to the long-term success of IMW programs. A communication framework for coordinating these activities is essential to maintaining the integrity of the experimental and monitoring design. A complete review of monitoring activities should be conducted each year prior to the field season and before additional or subsequent restoration occurs.

Lesson Learned

Assessment of the linkages between restoration investments and economic indicators must be designed so that they are relevant to the conditions and situations experienced in local communities.

Recommendation

Identify socio-economic indicators and outcome measures in consultation with local officials and the community.

Monitoring

Lesson Learned

Numerous research studies (e.g., macroinvertebrates and water temperature) were negatively affected by inconsistent temporal and spatial monitoring over their durations. Consistency is the backbone of a successful study design, allowing for long-term quantitative comparisons of restored and control locations.

Recommendation

It is imperative to have a consistent data collection effort across both temporal and spatial scales. Clear and consistent monitoring goals, documentation of site selection, communication among collaborators, data quality assurance/quality control, and ongoing data analyses will help researchers determine which sampling sites are most important to sample consistently over time.

Lesson Learned

The MFIMW was challenged by a lack of control locations with sufficiently similar conditions to be justifiably compared to restoration locations for salmonid productivity monitoring. For instance, the Camp Creek sub-watershed possessed unique geologic, biologic and hydrologic characteristics that were not adequately represented in other tributaries of the MFJDR. Murderer's Creek from the SFJDR was employed as the control watershed for this reason.

Recommendation

It is recommended that restoration and control reaches be allocated within the same watershed, but with careful attention to maintaining independence. Under this scenario, reach-scale monitoring will be most effective if restoration reaches are paired with control reaches that share similar environmental and physical conditions. Alternatively, replicate reaches can be allocated randomly throughout the watershed so that the conditions of the watershed are represented equally across groups.

Lesson Learned

A life cycle model linking fish to habitat variables would have provided a valuable tool at the beginning of the MFIMW effort.

Recommendation

Life cycle modeling can aid in predicting the expected magnitudes and timing of fisheries responses from restoration, and could enhance the probability of success of detecting these responses to restoration actions during IMW monitoring phases. Applying insights gained through these efforts would also help to prioritize restoration actions that maximize restoration effects on population metrics.

Lesson Learned

Natural environmental variability can swamp habitat and fisheries responses to restoration. Increasing baseline or pre-treatment monitoring can reduce noise level by predicting and subtracting among-year variance in the response signal due to environmental fluctuations.

Recommendation

Adequate baseline information is needed to confidently estimate temporal variance of the response variables in pre-treatment conditions. These metrics include salmonid growth, survival, density, and movement, but should also include covariates such as temperature, discharge, and spawner abundance. Ideally, researchers should monitor both treatment and control locations for multiple years prior to restoration. This information would 1) help explain the influence of pre-treatment climate and habitat variables on populations, and 2) provide enough baseline data to be able to factor out environmental variability. Sufficient duration of post-treatment monitoring is also essential to confirm consistency of response variables and covariates in the control location (through the course of study) and to allow time for restorations actions to fully develop and deliver expected responses.

Lesson Learned

Targeting cold-water input locations for habitat improvements (e.g., large wood additions, channel reconfiguration) may have additive or even multiplicative effects on salmonid productivity. There was a missed opportunity to examine the interacting effects of coinciding and favorable habitat variables in the MFIMW.

Recommendation

These strategies can be better understood by continued monitoring of the Oxbow Phase 3, 4, and 5 projects, which occurred at the end of the current MFIMW study.

Lesson Learned

Restoration actions aimed at improving watershed function may take decades to mature. Some processes and cycles that influence salmonid populations span much longer than 10 years, and will not manifest a fish population response within a 10-year period.

Recommendation

Expectations for restoration outcomes need to be tempered with a realistic understanding of the rate at which natural systems can recover from almost two centuries of Euro-American settlement and land use. Slow restorative processes, such as vegetative change, and those that manifest over generations of the target species require planning and monitoring over decadal scales. However, responses to restoration actions such as fish passage, channel reconfiguration, and cover enhancements require less time to observe a fisheries response and can be targeted successfully for shorter term experiments.

Restoration - From the Researchers

Lesson Learned

Channel reconfigurations, which provide habitat and channel complexity to salmonids, can also increase stream temperatures by increasing stream surface area.

Recommendation

Because channel reconfiguration addresses limiting factors such as habitat quality and quantity, managers will need to consider these goals in relation to other factors, such as short-term elevated stream temperatures versus long-term vegetation recovery, during planning and design phases. Prioritizing limiting factors and clearly specifying restoration goals during this phase will maximize the return on costly restoration investments such as active channel reconfiguration.

Lesson Learned

Targeting cold-water input locations for habitat improvements could have been an effective strategy to maximize benefits from costly restoration actions.

Recommendation

The magnitude and location of cold-water inputs into the MFJDR from tributaries and groundwater upwelling should be leveraged in future restoration designs.

Restoration - From the Restoration Practitioners

Lesson Learned

Intense deer and elk browsing pressure prevented riparian plantings from effectively shading the river in some areas.

Recommendation

Invest in elk-proof fencing on major restoration efforts to protect riparian plantings if browsing pressure presents serious risks to restoration outcomes.

Lesson Learned

Installing willow cuttings, planting nursery stock, and transplanting native vegetation that was salvaged from the restoration site was an extremely challenging task for the heavy equipment contractor.

Recommendation

Salvage and re-plant all native vegetation when possible. Hire a full-time vegetation care specialist to work with the contractor on plant salvage and planting operations.

Lesson Learned

Riffle construction in newly constructed channels can be a difficult prospect. Without a sealed riffle crest, water during low flows tended to move subsurface through glide substrates, especially at sites where the start of the glide was at a higher elevation than the riffle crest. If the riffles wash out, habitat for an entire stream segment may be lost.

Recommendation

Channel design should conform to a profile where the riffle crest or head is the highest feature in the substrate. Riffles need fines washed in to ensure the matrix is hardened and stable.

Photo 4. Young cottonwoods. *Courtesy of ODFW.*

Next Steps

Building from the long list summarized in this document, the MFIMW workgroup will prioritize recommendations for Planning, Monitoring, and Restoration over the next year. The agencies and organizations participating in the MFIMW will prioritize among the recommendations and develop a specific and actionable work plan. The work plan will prioritize what is anticipated to be accomplished within the next year, over 2-5 years and within the next 5-10 years.

Many participants are interested in developing an outreach strategy to report the MFIMW key findings to various audiences. These outreach efforts will likely span over a period of time to receive adequate input and develop the appropriate approach and materials to inform the different audiences that are identified. Important work that also awaits us is to make modifications to core priority monitoring efforts to ensure the study design is sufficient to provide data that will continue to help us answer our questions. In addition, the MFIMW will work proactively with NMFS, the Pacific Northwest Aquatic Monitoring Project (PNAMP) and other IMWs in the PNW to reflect on the lessons learned across the broader IMW network and determine how the MFIMW moves forward to provide needed information for decision-makers and practitioners.