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Review of Hungry Horse Mitigation Retrospective Report

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Background

In response to the Northwest Power and Conservation Council's May 17, 2016 request, the ISRP reviewed a report for the Flathead River system titled *Retrospective Report Hungry Horse Mitigation*. The report was by developed by the Salish and Kootenai Confederated Tribes (CSKT) through Project #1991-019-01, *Hungry Horse Mitigation/Flathead Lake Restoration and RM&E* and Montana Fish, Wildlife and Parks (MFWP) through Project #1991-019-03, *Hungry Horse Mitigation Habitat Restoration RM&E.* The intent of the report is to address a condition that the Council placed on these projects (based on the ISRP review, ISRP 2012-6) as part of the Resident Fish, Data Management and Program Coordination Category Review in July 2012. The specific Council recommendation for the project directed the "sponsors to co-lead in the development and submission of a retrospective report for the interconnected Flathead River system, as described by the ISRP for Project # 199101903 and to include a joint M&E plan as described for project # 199101904 and that addresses ISRP comments."

The ISRP's 2012-6 review asked that:

> MFWP develop a retrospective that summarizes past work under five general themes and prioritizes general objectives for work in the next 5 to 7 years, showing links among themes as necessary. This retrospective would be reviewed by the ISRP. These themes might be arranged as below:
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> 1. Effects of dam operations on fish and invertebrate habitat and populations.
> 2. Restoring native westslope cutthroat trout (WCT) to the refuge in the South Fork Flathead River (SFFR) above Hungry Horse Dam (HHD).
> 3. Understanding and managing non-native species invasions, primarily from rainbow trout, lake trout, and northern pike.
> 4. Population structure, demography, and viability of three salmonids and several sculpins.
> 5. Processes that create and maintain habitat for these species, and habitat enhancement to aid these processes.
>
> Therefore, the ISRP recommends to the Council that the sponsors prepare a 10- to 20-year retrospective evaluation as a qualification for further support. The evaluation should address previous and long-term efforts within the context of how well actions have met or not met mitigation goals/objectives associated with the loss statement and mitigation plan. From this retrospective, the sponsors should construct within the next 18 to 24 months a prioritization framework for ongoing and future mitigation actions and RME. These backward and forward looking document(s) would be reviewed and reported on by the ISRP in a retrospective report. Ultimately, the latter will assist the Council by informing how an individual Objective fulfills a priority and then ultimately how it will accomplish this fulfillment.

> An additional qualification is the absence of M&E for resident trout produced by Creston NFH (USFWS; see project 1991-019-04 and associated ISRP review) and stocked by and for MFWP in fishing lakes. The Creston proposal indicates the recipients of the hatchery trout are responsible for stocking decisions and monitoring. The program requires a coordinated M&E effort. This current proposal appears to be the likely venue for evaluating the vital fishery and harvest components of the fish stocked into fishing lakes. The ISRP recommends to the Council that the cooperators (USFWS, MFWP, and CSKT) submit a joint monitoring and evaluation plan for the associated production and stocking activities.

The Hungry Horse Mitigation Retrospective Report chapters and the ISRP's comments below are organized by the five themes the ISRP identified in 2012.

In 2015, the ISRP and the Independent Scientific Advisory Board (ISAB) examined the 2014 annual reports from the Hungry Horse Mitigation (HHM) projects to evaluate the projects' contributions to addressing critical uncertainties in the Fish and Wildlife Program's 2006 Research Plan (see ISAB/ISRP 2016-1, Appendix D, pages 351-357). The ISRP/ISAB Critical Uncertainties Report provided additional context for this review.

ISRP Recommendation

The qualification for a retrospective report is satisfied.

The Retrospective Report is a useful summary of past activities and will help to guide future directions for HHM activities. It is well written and concise. The authors briefly summarized research and monitoring results and pointed to the numerous reports and publications that HHM collaborators have produced. The genetics research and applications approach is innovative, management relevant, and should have important implications for fisheries recovery both in the study basin and beyond.

The proponents were asked to *"address previous long term efforts within the context of how well actions have met or not met mitigation goals/objectives associated with the loss statement and mitigation plan."* Although the report summarizes completed tasks, the report could be strengthened by evaluating how past actions and evaluations could be used to guide future directions for HHM activities. More discussion is needed on what has been learned at both project and program scales. Clear statements are needed on lessons learned, ideas or hypotheses about what is currently limiting progress, and what should be implemented to overcome these limitations. Also, long-term strategic guidance and project prioritization are not included in the Retrospective Report but would seem to be logical and important products that should be developed from this effort. Future annual reporting, statements of work, and proposals for this program will benefit from more emphasis on these important aspects. The ISRP's specific recommendations for future reporting are highlighted in boxes below.

ISRP Comments

1. Effects of dam operations on fish and invertebrate habitat and populations

Since the construction of Hungry Horse Dam more than 60 years ago changes to flow strategies and operations have reduced reservoir fluctuations and improved downstream thermal conditions in the river. These demonstrable improvements have been accomplished within the context of maintaining flood control capabilities and seasonal water retention requirements. Quantitative models have been created to develop integrated rule curves (IRCs). These models have valuable applications and were used by the U.S. Army Corps of Engineers (USACE) to develop a more dynamic flood regulation strategy (VarQ) and by NOAA Fisheries and the U.S. Fish and Wildlife Service in establishing the 2000 Biological Opinions. Reservoir operations, with respect to restoring normative flow conditions on the river downstream of the dam, have been greatly improved. VarQ has been successful in returning the below-dam hydrograph to a semi-normal historical pattern for this river. The HHM activities have also focused on normalizing the thermal regimen downstream of Hungry Horse Dam. Based on HHM modeling, selective water withdrawal control structures were constructed at the dam to enable mixing reservoir water of various temperatures to regulate temperatures downstream in the mainstem Flathead River.

The thermograph in the mainstem Flathead River appears to have returned to a more typical annual pattern (i.e., warmer in summer, colder in winter) and is most likely improving habitat conditions for native species. However, the sudden drop in water temperature in the fall experienced in most years (2008-2013) has the potential to cause problems for aquatic life (Figure 7 of the Retrospective Report). This potential problem should be addressed moving forward. Before and after charts to illustrate the flow pattern adjustment would also be helpful in future reporting.

Changes in physical habitat conditions reported in the Retrospective Report are restricted to water flow and temperature. Flows of sediment (suspended and bedload), embeddedness of the substrate caused by prior flow conditions, and land-water (riparian) interactions are not addressed. These latter environmental processes and characteristics, as well as flow and temperature conditions, have strong influences on aquatic habitat. Some factors, such as historical sediment conditions, may be more intractable to restore than others, such as land-water (riparian) interactions. Looking forward, however, it would be beneficial to implement to the extent practicable, restoration of normative sediment flows, remediation of severe embeddedness of river substrate, and management of flows for better land-water (riparian) interactions. Such considerations would involve major operational changes to Hungry Horse Dam. For example, substantial changes would be needed to pass sediments through the dam. However, sediment passage would be expected to: 1) loosen the severely armored substrate (i.e., the embedded or cemented cobble) downstream of the dam, 2) improve subsurface-surface water flows (i.e., hyporheic) through the substrate, and 3) restore semi-annual flooding to mobilize additional sediments. Riverine carrying capacity and productivity would likely increase, underpinned by off-channel habitat and robust riparian zones and greatly improved riverine conditions for invertebrates and fish below the dam.

It is stated in this section that "Results indicate more favorable biological responses compared to earlier dam operations, and assessments of those responses are ongoing, including additional work now in

Mainstem Amendments Research Project 2006-008-00." However, little specific evidence is presented in the Retrospective Report in support of the biological responses to operational changes identified in this statement. The operational changes appear to have had some positive environmental effects downstream, especially the thermal effects on bull trout and lake trout interactions, apparently due to the mixing of thermal layers being discharged. Although other beneficial effects on fishes and fisheries in terms of community composition, carrying capacity, and productivity would logically seem to follow the operational changes, it is not clear how reductions in reservoir fluctuations have affected these three responses in the reservoir, downriver habitat, and upstream tributaries. Some additional data and discussion of the benefits caused by project level flow and temperature changes on community composition, carrying capacity, and productivity should be included in future reporting. More information on how the effects of flow and temperature modifications are being assessed and monitored are also needed as this information will clarify how potential benefits are being determined. Additionally, brief descriptions of the management actions directed at reservoir-tributary habitat and fish populations should be included, along with a discussion of what further research on these topics is needed.

In addition, the ISRP identified other details that should be addressed in future reporting to strengthen the analysis of the ecological impacts of changing reservoir fluctuations:

- Since PHABSIM has some non-trivial limitations, more information is needed regarding the data sources for the suitability curves and what operational changes resulted from the PHABSIM modeling.
- Figure 7 would be more useful if there was a reference (i.e., upstream of the reservoir) temperature profile plotted.

Recommendations for future reporting - dam operations

a. Figures are needed that illustrate how flow patterns have changed before and after VarQ was initiated.

b. Quantitative evaluations should be conducted of past and present sediment regimes (suspended and bedload), embeddedness of the substrate caused by prior flow conditions, and land-water (riparian) interactions. This information could form the basis for developing plans to promote sediment movement, reduce substrate embeddedness, and improve land-water interactions through the adaptive management process

c. Analyses are needed that quantitatively evaluate how changes in flows, temperatures, and other habitat conditions have influenced community composition, carrying capacity, and productivity of invertebrates and fish.

2. Restoring native westslope cutthroat trout to the refuge in the South Fork Flathead River drainage above Hungry Horse Dam

Westslope Cutthroat Trout Restoration

The South Fork Westslope Cutthroat Trout (SFWCT) program began in 2007 to remove non-native trout and restore westslope cutthroat trout populations. The two methods of non-native trout removal, whole lake poisoning with rotenone and "genetic swamping" by planting westslope cutthroat trout into lakes containing non-native trout, seem to have had the desired effects. Rotenone applications removed non-native trout from treated lakes, facilitating the successful reintroduction of westslope cutthroat trout into these waters. The occurrence of non-native genes in populations subjected to genetic swamping is expected to decrease over time due to hybridization between westslope cutthroat trout and hybrids possessing non-native trout genes. These two methods are both realistic and consistent with the objectives for native trout restoration. However, more information on the effectiveness of the rotenone treatments and some clarification on the success of genetic swamping, including quantitative information, should be provided in future reports.

The high-elevation, isolated lakes undergoing treatment were originally fishless. Introductions of rainbow and Yellowstone cutthroat trout occurred in the 1920's through the 1940's. After eradication by rotenone, westslope cutthroat trout were reintroduced into the lakes for two purposes: to provide conservation refuges for westslope cutthroat trout and to offer recreational fishing opportunities. Superficially, there would seem to be few if any serious consequences of the fish toxicant projects. However, no data are provided about the potential effects on other fish species (e.g., sculpins) and aquatic organisms such as amphibians, crustaceans, and invertebrates in the report. The introduction of trout into high mountain lakes may have substantial adverse biological effects on existing non-fish biota, including native amphibians and invertebrates (Drake and Naiman 2000, Knapp and Matthews 2000). As westslope cutthroat trout restorations continue in the Flathead River system, it would be good to know what consideration will be given to restoring some high mountain lakes to their historical fishless condition.

Future reports should include a brief description of the criteria used to determine which trout removal procedure (eradication or swamping) is selected and applied to treated lakes. The procedure chosen did not appear to be driven by lake area, maximum depth, or volume (see Table 3, p 19). It was mentioned that "temporal genetic data" were used to identify lakes receiving the genetic swamping treatment, though details on those data were not present in the report. Future discussion about how those data were collected and used would help explain how removal treatments were determined and assigned, and how they may be applied elsewhere.

There was also no mention of the persistence and effects of hybrids in drainage areas below the lakes where non-native fish have been eradicated. Although not stated, it would seem that genetic swamping is being used in downstream locations to reduce the occurrence of non-native trout genes in westslope cutthroat trout. If this is the case, the methods used to evaluate the effectiveness of swamping should be described. For example, how often are genetic samples being collected and how will trends in the prevalence of non-native trout genes be determined and tracked?

Similarly, few details were presented in the Retrospective Report about the outcomes of the genetic swamping procedure being employed in six highland lakes. This program has been ongoing since at least 2009, if not earlier. Genetic samples are being collected, but data that reflect the efficacy of this approach were not presented. If genetic analyses are not yet complete, future reporting should include a brief explanation of how these data will be used to assess the utility of the genetic swamping approach.

The decision to use multiple indigenous populations of South Fork westslope cutthroat trout to maintain genetic diversity and adapted gene complexes is justified. Substantial genetic differences exist among westslope cutthroat trout populations in the South Fork drainage. When westslope cutthroat trout reintroductions took place in the poisoned lakes, it would have been expedient for MFWP to simply introduce the diverse M012 stock (which originates largely from westslope cutthroat trout populations within the Flathead River Basin and is maintained at their Washoe Park State Fish Hatchery) into the treated lakes. It was recognized, however, that the genetic variability of the M012 stock was substantially less than that exhibited by the westslope cutthroat trout populations in the South Fork. It was also acknowledged that the use of a single donor stock could homogenize genetic variation and potentially disrupt local adaptations.

It remains unclear, however, how effectively this preferred multi-stock approach was implemented in the field. Naturally produced non-hybridized westslope cutthroat trout were collected from two creeks, Danaher and Youngs, and used as broodstock. Yet no mention is made of an overall plan for how the progeny of these fish were distributed or used in the reintroductions that have taken place. Does a genetic plan exist? What procedures are being used to determine the stock origins of the westslope cutthroat trout that are being used in the program’s reintroduction efforts? Like non-native trout, reintroduced westslope cutthroat trout are likely to disperse from their lakes and become incorporated into the native cutthroat populations that are present in downstream areas. What efforts were made to match the genetic heritage of the reintroduced fish to the genomic profiles of the populations they will inevitably encounter? Answers to these questions would be valuable in future reporting.

Sekokini Springs

The Sekokini Springs Facility is used by the program to rear to maturity wild westslope cutthroat trout juveniles collected from South Fork streams. Upon maturity, the fish are spawned and their progeny are reared for varying periods before being transplanted into lakes in the South Fork subbasin. This effort started in 2009 when the first wild westslope cutthroat trout juveniles from Danaher Creek were brought to the facility for rearing. The proponents have developed this program in a thoughtful manner and used some innovative approaches to resolve fish culture issues when they have arisen. Conversion of the hatchery from rainbow trout to westslope cutthroat trout is consistent with MFWP’s Wild Fish Policy and program goals.

Some additional details about the program are needed to provide a more complete picture of how this facility and the fish it is producing are being used. For instance, some lakes are being stocked with M012 westslope cutthroat trout. It seems that only lakes undergoing genetic swamping are receiving M012 fish. If so, why was this decision made; or perhaps more importantly, why are fish from the M012 being used at all?

The factors used to determine how many fish should be stocked into each of 17 South Fork lakes (Table 5) were not disclosed in the Retrospective Report. Eradicated lakes were re-stocked with native westslope cutthroat trout over multiple years. Have evaluations been performed to determine the survival and growth of fish released during different years? Cannibalism of newly released fry is possible and does not appear to have been examined. Since these lakes are subject to recreational fishing, a number of marking methods (e.g., thermal otolith marking, parentage-based tagging) could be used along with creel sampling to make such evaluations. Results would help determine the fate of fry released into lakes. For example, in lakes already containing larger trout, do stocked fish survive and contribute to overall abundance? Such an analysis would support management decisions regarding the numbers of fry to release into the lakes. Has this been considered?

The ISRP supports the proponents' efforts at incorporating genetic considerations into the Sekokini Springs program. All wild juvenile westslope cutthroat trout brought into the facility are PIT tagged and genetically sampled making it possible to determine relatedness and whether any are rainbow x cutthroat hybrids. The relatedness information is being used in a spawning protocol to avoid mating close relatives. Presumably, fish detected as hybrids are not used as broodstock, although the fate of these fish is not disclosed. At spawning, 3x3 factorial matings are made and variance in family sizes is also controlled by capping juvenile contributions from each fish used as broodstock. It was also reported that a given fish was spawned only once. All of these practices help maintain genetic diversity and should be continued.

The methods being employed to monitor fry health during the rearing period appear to be appropriate. However, it is somewhat surprising that monthly assessments of health are made on just three fish collected at a specific location in each rearing vessel. Future reporting should include an explanation for why this method is being employed along with the results of some of these assessments.

Numerous research projects and investigations are planned using a range of methodologies at the Sekokini Springs facility. In studies, which are past the idea stage, brief descriptions of the proposed work—including rearing treatments, controls, and within-hatchery and post-release comparisons—would be useful. Such documentation would provide the proponents with a reference to what was done and why and also allow others to make constructive comments on the experimental designs and treatments being investigated.

Recommendations for future reporting – westslope cutthroat trout restoration

a. Include a description of the criteria used to determine which trout removal procedure (eradication or swamping) should be applied to treated lakes and on what basis lakes should be treated (i.e., historically fishless or not).

b. Describe progress on implementing the genetic swamping approach to native fish restoration and how that progress is being monitored and evaluated. Describe studies proposed at Sekokini Springs Hatchery, including rearing treatments, controls, and within-hatchery and post-release comparisons, in quantitative terms, so that ISRP feedback might be provided.

3. Understanding and managing non-native species invasions, primarily from rainbow trout, lake trout, and northern pike.

Rainbow Trout

The approach described to reduce introgression of rainbow trout into westslope cutthroat trout populations seems appropriate. HHM collaborators use fish barriers, traps, and electrofishing to remove rainbow trout from Abbot Creek, the main source for rainbow trout invading other waterways. The proponents have expanded the understanding of the distribution and movement of rainbow trout and the consequences of their hybridization with westslope cutthroat trout.

It is of some concern, however, that captured rainbow trout continue to be released into "closed" waters for fisheries. Rainbow trout are useful for providing fisheries in many lower river locations with hybridized populations but also pose a major threat to westslope cutthroat trout, as indicated by the proponents. It seems unlikely that waters where rainbow trout continue to be released are completely closed. Stocking them also could send a mixed message to the public about the value of non-native fishes at a time when part of the HHM effort is to educate the public about the threats from non-natives and the need to restrict the distribution of non-natives. It appears that ongoing genetic and ecological monitoring will be needed to inform decisions about whether the stocking of rainbow trout in a given area is acceptable or not. Fortunately, HHM collaborators have also developed an array of genetic and morphologic tools that can be used to determine the level of hybridization in captured trout and to measure changes in population structure. These methods need to be consistently applied to ensure the success of the existing approach in reducing introgression while maintaining fishing opportunity.

Lake Trout

The proponents have expended considerable effort in understanding and attempting to control the ecological threats from lake trout, which can be a major predator and a competitor of native fishes. The intentional introduction of *Mysis* as a putative food source for the kokanee led to a rapid increase (by 10x-14x) in the population of lake trout, resulting in the demise of the kokanee and threats to native trout. Accordingly, HHM partners and others (e.g., Flathead Biological Station) have conducted research to understand the trophic dynamics of fishes in Flathead Lake and adjacent waters. These studies were not reviewed in any detail in the Retrospective Report. Including and discussing results from them is needed to improve future reporting.

Some progress has been made in lake trout suppression, through encouraging sport fishing, electrofishing to kill embryos, and gill netting to remove spawners. MFWP has liberalized fishing regulations on lake trout, resulting in an annual harvest equal to about half of what is needed to reduce the population by the target of 75%. HHM collaborators have also used acoustic telemetry to track adults to spawning beds and genetic and statistical tools to determine the number of adult lake trout that successfully produce offspring. These research efforts have quantified the recreational fishery and predation losses of bull trout and westslope cutthroat trout and estimated the population abundance of Lake trout in Flathead Lake. ISAB/ISRP reviewers for the Critical Uncertainties assessment (ISAB/ISRP 2016-1) noted that the 2014 report for project *199101901 - Hungry Horse Mitigation/Flathead Lake Restoration and Research, Monitoring and Evaluation (RM&E)* 2014 indicated no changes in lake trout abundance (2009-2013) associated with removal of lake trout through angling. This lack of success is not mentioned in the current report. Future suppression efforts must be monitored to assess their effectiveness and the results reported.

Northern Pike

Based on the Retrospective Report, it appears that northern pike have received the least amount of research attention of all non-native fish in the system. Nonetheless, the proponents have used bioenergetics modeling, mark-and-recapture methods, and stomach contents analysis to determine northern pike distribution and abundance, consumption rates of prey, and pike growth and diet. Although it appears that bull trout and westslope cutthroat trout are not numerically important prey for northern pike in comparison with other species, existing predation still could have an impact on these native fish. The only suppression effort mentioned is a liberal harvest limit.

Northern pike seem to be a major problem farther downstream in the basin, but not much is said about them in the Retrospective Report in terms of their priority for management actions. Reasons for this (presumed) low priority should be clarified in future reporting. In view of the other ongoing and proposed northern pike suppression efforts downriver by states and tribes (e.g., ISRP 2016-6, ISRP 2016-7), it has become vital to communicate and coordinate with other managers and co-managers region-wide on pike suppression techniques and their effectiveness.

Looking ahead, efforts to control the spread of non-native species through the HHM project include a blend of research, management action, and communication engaging and educating the public regarding impacts. It appears that the proponents will continue to expend considerable effort to control non-native species and to stop the introduction of additional species. However, there remains a considerable difference in the proposed approach of CSKT and MFWP on how to manage lake trout in Flathead Lake. A lesser problem appears to exist in Swan Lake, where there is no established fishery. It will be increasingly important, moving forward, for the goals and approaches to lake trout suppression to be discussed more directly. Genetic tools will also be helpful in assessing the spawning behavior and reproductive success of lake trout. A coordinated management approach combined with these efforts should yield positive results.

Recommendations for future reporting – non-natives

a. The potential conflicting demands of rainbow trout stocking and native trout restoration require that genetic and morphological methods be applied and evaluated regularly to ensure that the goal of reducing introgression is met while maintaining fishing opportunity. Quantitative results of these evaluations should be provided in future reports.

b. Future lake trout suppression efforts must be effectively coordinated among HHM collaborators and consistently monitored to assess their effectiveness. A brief description of how this work is being coordinated is a continuing need.

c. In view of the other northern pike suppression efforts downriver by states and tribes, it has become vital to communicate and coordinate with other managers and co-managers region-wide on pike suppression. Future reports should indicate how the project is interacting with other entities involved with northern pike suppression in the Columbia River Basin.

4. Population structure, demography, and viability of three salmonids and several sculpins

This topic is reasonably well covered in the Retrospective Report. A variety of actions are being used in an effort to restore and maintain genetic diversity in Flathead River westslope cutthroat trout and bull trout. One of these actions is the removal of non-native fishes in lakes via piscicide application. This removal is expected to reduce hybridization, predation, and competitive effects. Treated lakes are being restocked with westslope cutthroat trout juveniles produced from wild progenitors. These re-introductions are being evaluated to determine the benefits of using local, wild cutthroat in restoration actions. The wild broodstock being used have come from two South Fork tributaries. Currently, work is also underway to ascertain if scales or fin rays, instead of otoliths, can be analyzed with LA-ICPMS (laser ablation-inductively coupled plasma mass spectrometry) to determine where fish have resided in the past. Unlike otoliths, these structures can be collected without sacrificing the sampled fish. Project personnel are also working with Glacier National Park staff to establish secure genetic reserves for westslope cutthroat trout and bull trout. All of these actions seem appropriate to achieving goals of the program.

Bull Trout

The Retrospective Report provides a good summary on the biology, genetics, viability, and current status of bull trout in the Flathead River subbasin. Major threats to the species include habitat loss, predation and competition by non-native fishes (lake trout and northern pike), hydropower impacts, and angler harvest. Most of the subbasin's bull trout exhibit an adfluvial life history: spawning in streams, then rearing for one or more years in stream habitats prior to migrating to lakes to mature. Power generating dams at Flathead, Hungry Horse, and Swan lakes subdivide the subbasin's aboriginal bull trout population into four "metapopulations" (South Fork, Swan Lake, Flathead Lake, and Jocko River). Redd counts and juvenile electrofishing estimates are used to monitor the abundance of bull trout in each of the metapopulations. These surveys show that bull trout abundance has increased in the four metapopulations over the past 20 years. The proponents also identified 16 disjunct or isolated populations of bull trout. The viability status of the disjunct populations is mixed. Some populations are maintaining their abundance while others are declining. Habitat restoration actions, changes in angler regulations, and non-native fish removal efforts are being implemented to protect and enhance bull trout. The overall approach for moving forward seems well reasoned.

Westslope Cutthroat Trout

As with bull trout, an overview of Flathead River westslope cutthroat trout was provided in the Retrospective Report. Habitat fragmentation due to hydropower dams, hybridization with non-native rainbow trout, predation and competition with non-native fishes, and angler exploitation have all served to reduce the abundance of this species. Genetic surveys indicate that substantial differences exist among the subbasin's westslope cutthroat trout populations. Methods to estimate population size vary by habitat type and include electrofishing counts in smaller streams, Petersen mark-recapture estimates in larger rivers, gillnetting in lakes, and redd counts. Results from these surveys show that the abundance of westslope cutthroat trout has increased over the past 20 years.

Several detailed studies were performed on westslope cutthroat trout in the subbasin. In one noteworthy effort, the effects of passing trout hybrids (20% and 50% rainbow trout) past two irrigation diversions in the Jocko River were modeled. Based on model results, fluvial westslope cutthroat trout are now being passed over the diversions. It is stated that field crews can visually identify 50% hybrids, and these fish are being removed. If not already taking place, will genetic samples be collected from each fish allowed upstream to verify these field identifications?

Another study identified the core and conservation areas of westslope cutthroat trout in the lower Flathead River. During this study, migratory blockages were identified and a conservation and enhancement plan was developed for lower Flathead River westslope cutthroat trout. It was not disclosed whether there are plans to do similar work in other portions of the Flathead subbasin. The ISRP believes that such evaluations would help guide the conservation and enhancement of this species.

Genetics investigations, combined with otolith microchemistry, should provide important guidance on which westslope cutthroat trout stocks to use as broodstock for restocking and in which locations. Long-term monitoring efforts designed to detect genetic changes in re-established westslope cutthroat trout populations are planned and project personnel hope that this will provide opportunities to link genetic expression with phenotypic traits. If this can be accomplished, it will help future reintroduction efforts.

Fieldwork by the proponents disclosed that westslope cutthroat trout in the Flathead drainage are migratory, moving into different habitats as they move through their life cycle. Microchemistry analyses on otoliths have been used to track movement patterns and are helping define westslope cutthroat trout stocks. As with bull trout, the overall approach seems well reasoned.

Creston National Fish Hatchery (Bull Trout and Redband Conservation)

The ISRP agrees with use of this hatchery for bull trout and redband trout conservation. This mission seems appropriate for the hatchery at this time. In our 2011 review of project 1991-019-04 (Hungry Horse Mitigation-Creston National Fish Hatchery), we recommended that the success of trout releases from the Creston National Fish Hatchery be evaluated. In response, CSKT and MFWP biologists have evaluated survival, growth, angler catch rates, fishing pressure, and reproductive potential of out-planted trout from the hatchery. Future reporting should provide a brief description of the methods used, results of these evaluations, and their potential use for improving the program. Additionally, how the information gained from these investigations may be affecting the fish planting protocols used by the hatchery and its partners were not mentioned in the Retrospective Report. It was stated, however, that angler pressure and harvest are monitored every two years using statewide mail-in angler effort surveys. Is the accuracy of these surveys being assessed by on-the-water creel and effort surveys conducted by the MFWP and CSKT personnel?

Sculpins

The proponents hypothesize that the sedentary habits of sculpins, their close association with substrates, and reliance on insects as a primary food source, may make these fishes useful for tracking changes in environmental quality. This is an interesting idea that will need to be evaluated with laboratory and field experimentation. For sculpin data to be useful, linkages between habitat traits and sculpin demographic information will need to be established. One way to accomplish this would be to collect data on local abundance, recruitment, growth and distribution patterns under a wide range of habitat conditions. From a trout management perspective, the next step would be to ascertain if sculpin demographic information can be used to assess the suitability of habitat areas for trout.

Recommendations for future reporting – salmonids and sculpins

a. Genetic investigations combined with otolith microchemistry should be used to provide important guidance as to which westslope cutthroat trout stocks to use and where. Long-term monitoring efforts designed to detect genetic changes in re-established westslope cutthroat trout populations will provide opportunities to link genetic expression with phenotypic traits. If this can be accomplished, it will help future reintroduction efforts.

b. MFWP biologists have evaluated survival, growth, angler catch rates, fishing pressure, and reproductive potential of out-planted trout from Creston National hatchery. Future reporting should describe the quantitative results of these evaluations and how they are being used in management.

c. The potential utility of sculpins as environmental indicators and their role in native trout restoration need to be clarified. For example, relationships between habitat attributes and population parameters in sculpin populations need to be established and linked to trout abundance.

5. Processes that create and maintain habitat for these species, and habitat enhancement to aid these processes

Successes in matching the seasonal spill regimes and historical discharge temperatures of Hungry Horse Dam, to provide flow and temperature regimes more favorable for biological productivity than under previous dam operation strategies (Topic 1), have already been identified earlier in this review of the Retrospective Report. Emphasis in this section is on other aspects of habitat restoration in the program. Activities range from land acquisition and obtaining conservation easements to instream and riparian habitat restoration and the purchase of stream flows.

Most protection/restoration work discussed in the Retrospective Report is centered on streams and riparian areas. Some impacts of upland effects, however, are also described. It is noted, for example, on page 65 that there has been increased sediment delivery and embeddedness, particularly downstream of the dam, and that, "Logging, road building, agriculture, and residential and commercial development also influence local river mechanics and habitat suitability for fish, which compounds the harmful effects of dam operations on the aquatic environment." In future reporting, there should be more discussion of how these factors, occurring mostly in upslope locations, are being addressed in the overall HHM program, at both the watershed and subbasin scales. Although addressing them is complex and difficult, it appears to be a key component for successful long-term protection and restoration of riparian and aquatic habitat.

Other important elements to be included in future reports are a more complete discussion of past coordination with land owners/managers and details of potential future improvements. In the case of the South Fork Clearwater River, more than 70% of the land is in federal ownership. Future reporting should include additional emphasis on opportunities for better coordination with federal land managers to achieve long term goals for protection and restoration. The ISRP believes that such coordination is a critical component for the long term success of the program.

Finally, although there is a good deal of monitoring and trend information provided for some projects, future reporting would benefit from additional discussion about an overall approach for monitoring and applications to adaptive management. The retrospective report does note on page 66 that “the 1993 implementation plan established many strategies for monitoring the effectiveness of fish passage or habitat improvement activities that are still followed today.” Table 15 provides a very general listing of monitoring approaches, but little additional information is provided. Also, future reporting should include progress and status of habitat projects. It should be made clear which projects are completed, in progress, or being developed. A link to a website or spreadsheet that provides the details would be very helpful to the ISRP and others in assessing progress. For this project there are general goal statements such as “increase available habitat for spawning and rearing westslope cutthroat trout and bull trout by incorporating large woody debris (LWD) in a section of stream previously harmed by the now outdated logging” and “the goal in constructing large woody debris aggregates, channel spanning logs, and single log veins was to restore natural stream habitat and to increase bull trout and westslope cutthroat trout recruitment” (page 68). Linking these goal statements to specific, time sensitive objectives would enable a more comprehensive evaluation of project performance relative to expectations.

For fish passage, a good deal has been accomplished and a full listing of completed fish passage work is provided in Tables 16 and 17 (pages 66 and 67). Additional discussion, however, is needed in future reporting of approaches being used to monitor and evaluate the effectiveness of past fish passage restoration or any results/findings from that work. This was not provided in the Retrospective Report.

The ISRP has concerns regarding HHM actions to remove beaver dams to improve fish passage. Research has shown that beavers are critical engineers of fish habitat (Naiman et al. 1988). Removing beaver dams has been shown to have long-term negative consequences not only to fish carrying capacity and productivity but also to broader ecosystem-scale characteristics. Furthermore, research has shown that beaver dams are not barriers to native fish and can actually restrict migration of invasive fish (Lokteff et al. 2013), though passage will vary among native species. Some clarification of the rationale for removing beaver dams is needed in future reporting, justifying and demonstrating the potential benefits of removal against the numerous ecological costs.

The restoration actions on Coal and Dayton creeks are laudable and clearly have involved considerable effort. These sites appear to be “hotspots” for maintaining the productivity of bull trout and other species of management concern. However, the ISRP has reservations about the strategy of focusing considerable restoration activity on a limited number of sites that represent a very small percentage of total stream length in the Flathead catchment available to species of concern. It was not clear why a wider portfolio strategy has not been adopted in the basin. The current approach may be the most reasonable one, but the rationale for why it was the chosen should be reported.

The Retrospective Report effectively identifies the importance of easements and title acquisitions as mechanisms to protect habitat and notes that these activities are always approached with the goal of restoring self-sustaining ecological processes. It is stated that acquisition is opportunistic but the proponents also attempt to make strategic purchases with the most pristine habitats receiving the highest priority. Although it is understandable that some degree of opportunism will guide acquisition, development and description of a more structured prioritization plan would make this valuable program more effective over the long term. A prioritization plan would include a discussion of specific criteria and the process used to rank individual projects. It would provide a valuable context for better understanding the overall habitat program.

The approach of improving habitat protection through the acquisition of land and water rights appears, on the surface, to be a justifiable program component, especially when conducted in conjunction with other land stewards (e.g., US Forest Service, The Nature Conservancy) who have the ability to provide realistic protection and management over the long term. However, it is necessary to ensure that upstream practices do not adversely impact the benefits of the acquired properties and water rights. Human population growth and expanded land use will continue in Montana, especially in the Mission Valley, along Flathead Lake, and around Whitefish/Kalispell. Relative to the land and water base in these areas, the acquisitions are small and will be susceptible to changing human values toward land and water in the coming decades. It would be very valuable to evaluate habitat and water conservation efforts in the context of changing land use upstream to prioritize areas that are likely to provide the greatest benefit over the long term.

Recommendations for future reporting – habitat

a. Specific information is needed on coordination efforts, approaches, and roles with cooperating land managers.

b. Development and description of a more structured prioritization plan would make this valuable program more effective over the long term.

c. A description is needed of an overall approach for monitoring, including development of quantitative, time-sensitive objectives for habitat restoration projects.

6. Future plans and activities

The proponents have established program approaches that will serve them well in coming years: 1) scheduling mitigation activities to start and end within reasonably foreseeable, if not yet quantified, timeframes; 2) using completed work to inform future activities (although adaptive management procedures remain vague); 3) avoiding single-species solutions; 4) following Montana's Wild Fish Management Policy for rivers; and 5) working as efficiently and cost-effectively as possible. Moving forward, the proponents may want to consider additional approaches for expanding outreach and information sharing to improve integration of the public and other agencies/organizations (land owners, towns, nonprofit organizations, and government agencies) into activities. This would center on emphasizing that the program uses a landscape perspective and will require a broad base of support from local landowners, state, and federal land managers and other interested parties. It will be aided by a commitment to continue in the development and application of innovative solutions for habitat issues.

It is also clear that the proponents will continue to monitor the effects of reservoir operations on habitat and biota, and that there appears to be good collaboration between dam operators and HHM collaborators. The proponents are aware of, and planning for, additional challenges from climate change and acknowledge that monitoring and changes to dam operations will be needed on an ongoing basis.

Recommendation – Future program activities, as well as reporting, would be strengthened by providing additional information in the following areas:

a. *Overarching program strategic guidance:* An overall, long-term strategy would provide a structured approach for accomplishing protection and restoration of habitat and ecological processes and effectively linking activities occurring among the three primary limiting factors (Impoundment and Hydro Operations, Physical Habitat Alterations, and Non-native Species Introductions). Such a strategy would address multiple scales (subbasins, watershed and site specific); identify key species, processes and geographic areas; and better link activities between the five themes in the Retrospective. If the Subbasin Plan does provide such an overarching, long-term strategic approach for protection and mitigation, it is essential that a general description and summary of key points be provided in future reporting. This information would provide critical context for understanding the last decade of activities.

b. *Mitigation in relation to losses:* A broader discussion would be beneficial as to how the collection of activities is equated with the documented environmental "losses" caused by the construction of Hungry Horse Dam. The process used to determine how much was lost with the closure of the dam appears well documented in previous reports. However, it is not clear how the ongoing restoration actions are quantified relative to replacing the documented losses. A detailed discussion of this process would be very helpful in future reporting.

c. *Limitations and obstacles to progress:* Future reporting should also provide a clear set of ideas or hypotheses about what is currently limiting progress, an evaluation of the effectiveness of the various approaches in addressing them, and what is to be implemented in the future to overcome these limitations. The Retrospective Report will be a useful starting point in any follow-up efforts to provide some long term strategic guidance and a prioritization framework for HHM collaborator activities.

d. *Adaptive management:* Although there is much valuable information in the Retrospective Report about what was done, there is much less on what has been learned. How has newly discovered information on ecological mechanisms, for instance, led to hypotheses and changes in approach for future actions? The proponents list a number of fish habitat and passage improvements (Tables 16 and 17), but information is needed on the levels of success attained or problems encountered. The phrase "adaptive management" appears only three times in the report; the impression is that adaptive management is seldom actively used to evaluate projects and improve future actions. More needs to be said in future reporting about what has been implemented as a result of what has been learned.

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