Independent Scientific Review Panel
for the Northwest Power and Conservation Council
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Step 1 Review of Pacific Lamprey Master Plan

"Master Plan: Pacific Lamprey Artificial Propagation, Translocation, Restoration, and Research – Conceptual phase to address Step 1 Master Plan review elements"

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ISRP Step 1 Review of Pacific Lamprey Master Plan

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Background

In response to the Northwest Power and Conservation Council's March 29, 2018 request, the ISRP reviewed the document *Master Plan: Pacific Lamprey Artificial Propagation, Translocation, Restoration, and Research – Conceptual phase to address Step 1 Master Plan review elements* (hereafter Lamprey Master Plan or Master Plan). This Master Plan was prepared by the Columbia River Inter-Tribal Fish Commission (CRITFC), the Confederated Tribes and Bands of the Yakama Nation (YN), the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), and the Nez Perce Tribe (NPT). This is a Step 1 review in the Council's Three Step review process for proposed artificial production projects. The Master Plan is intended to address objectives and review conditions for CRITFC's *Implement Tribal Pacific Lamprey Restoration Plan* project (#2008-524-00) and the *Yakama Nation Ceded Lands Lamprey Evaluation and Restoration* project (#2008-470-00), regarding artificial production activities in the projects.[1] The CTUIR also collaborate through their *Pacific Lamprey Research and Restoration Project* (#1994-026-000).

The Master Plan's preface states:

> This plan describes ongoing and proposed adult translocation and artificial propagation activities, as well as existing and proposed facilities needed to meet artificial propagation objectives. The plan focuses on activities of the YN and the CTUIR; however, to provide a comprehensive description of supplementation activities in the Columbia River Basin, the plan also describes ongoing adult translocation activities being conducted by the NPT. Actions described herein will work together and provide synergy with other actions such as improvements to passage, habitat, and water quality to help meet restoration goals for Pacific Lamprey in the Columbia River Basin.

Documents submitted for review:

- Cover letter from CRITFC, March 27, 2018
- *Master Plan: Pacific Lamprey Artificial Propagation, Translocation, Restoration, and Research; Conceptual phase to address Step 1 – Master Plan review elements*, March 23, 2018

The ISRP recently reviewed the report *Synthesis of Threats, Critical Uncertainties, and Limiting Factors in Relation to Past, Present and Future Priority Restoration Actions for Pacific Lamprey in the Columbia River Basin, November 15, 2017* (hereafter Lamprey Synthesis) prepared by CRITFC, CTUIR, YN, and the Confederated Tribes of the Warm Springs Indian Reservation (ISRP

[1] Select the hyperlinks for the Council's conditions and a summary of the Council and ISRP review history for those projects.

2018-2). The ISRP found that the Lamprey Synthesis provided a comprehensive account of current knowledge about Pacific lamprey and its conservation status in the Columbia River Basin. It concisely described the history and scope of partnerships, collaborative research, management, and ongoing restoration efforts. It also provided substantial guidance toward identification of critical uncertainties, limiting factors, and priority management actions that should inform future research and restoration efforts within the Fish and Wildlife Program. The ISRP noted one fundamental question that warranted further attention, which applies to this Master Plan review: Do Pacific lamprey exist as partially reproductively isolated, locally adapted populations within the Columbia River Basin or do they exist in a single regional population?

This is the ISRP's initial Step 1 review of the Lamprey Master Plan. The Master Plan addresses one component of Pacific lamprey conservation: the use of supplementation techniques to prevent extirpation and restore abundance in historically occupied habitats. Parallel efforts are needed to quantify the relative importance of the factors limiting Pacific lamprey throughout the Columbia Basin. If the proponents are successful at rearing and releasing propagated juvenile lamprey, serious issues will still remain about the quality, quantity, and distribution of habitat that can provide long-term support of this species. Additional challenges associated with upstream and downstream passage and the possible effects of contaminants on lamprey vitality also exist in the Basin. A coordinated, multifaceted effort is underway through the Columbia River Basin Tribes' programs, USFWS, US Army Corps of Engineers, the broader Pacific Lamprey Conservation Initiative, and others that will need to be continued to ensure that self-sustaining populations of Pacific lamprey can be maintained throughout the species' historical range.

ISRP Review Summary and Recommendations

Meets Scientific Review Criteria (Qualified)

The Lamprey Master Plan largely meets the conceptual requirements for a Step 1 review. The proponents recognize that there is still much to be learned about how, or if, artificial propagation and translocation can be used in Pacific lamprey conservation and restoration. For instance, uncertainty about the genetic effects of adult translocation and out-planting of propagated larvae on the Basin's Pacific lamprey population segments is acknowledged. The Master Plan, however, provides a strong rationale for employing both of these recovery options. To help resolve this and other questions, they propose a four-phased program that is comprehensive and well presented. Nevertheless, in Step 2, the Master Plan should include considerably more detailed information on the monitoring and evaluation components of the program, including statistical analyses and how this information will be used in an adaptive management framework.

Specifically, more information is needed to address the following issues:

- Quantitative performance objectives were developed for Phase 1 of the Master Plan to describe expected survival rates of artificially cultured lamprey from fertilization to release. The Master Plan, however, does not describe how survival and growth of propagated lamprey will be monitored in the hatchery. In Step 2, the proponents should clearly describe the methods they will use to make these assessments.

- Phase 2 of the Master Plan evaluates the survival and growth of propagated lamprey that have been transplanted into natural environments. In Step 2, the proponents should describe the analytical approaches taken to evaluate the effectiveness of out-planting propagated lamprey that have different life stages.

- The overarching goal of Phase 3 of the Master Plan is to compare and evaluate the effectiveness of different lamprey supplementation strategies to ascertain which are the most successful, e.g., translocation versus artificial propagation involving release at one or more life stages. A clear definition of what success represents is needed. Additionally, in Step 2 the Master Plan should include details of the statistical approaches that will be used to compare the effectiveness of the supplementation strategies.

- The proponents should consult with the USFWS to determine if a document that is functionally equivalent to NOAA Fisheries' Hatchery and Genetic Management Plan (HGMP) is required for this project. The ISRP believes such a document would be beneficial.

- The Master Plan should specifically state what aspects of the proposed artificial propagation and translocation efforts are being implemented to identify and protect adaptive genetic diversity within the Columbia Basin. For example, identify protocols that will be followed to reduce potentially deleterious effects of genetic drift, inadvertent domestication, and disruption of spatial or temporal adaptations among population segments within the Basin.

- As acknowledged by the proponents in the Master Plan, an Environmental Assessment will need to be included in Step 2 due to the geographic scope and number of juvenile lamprey that are scheduled for release.

ISRP Comments on Step 1 Review Elements

The Council has emphasized that an important part of the Three Step Review Process includes an ISRP review of the responses to the technical elements listed below. The ISRP comments on how the Master Plan addresses each Step Review element follow below. The Master Plan sections that address each Step question are listed in *italics*.

A. All Projects

Does the Master Plan:

1) address the relationship and consistencies of the proposed project to the 2014 Fish and Wildlife Program's six scientific principles (Step 1)?

The Scientific Principles:
1. Healthy ecosystems sustain abundant, productive, and diverse plants and animals distributed over a wide area.
2. Biological diversity allows ecosystems to adapt to environmental changes.
3. Ecosystem conditions affect the well-being of all species including humans.
4. Cultural and biological diversity is the key to surviving changes.
5. Ecosystem management should be adaptive and experimental.
6. Ecosystem management can only succeed by considering people.

Master Plan Section 6.1 addresses the six scientific principles.

ISRP Comments:

The intended supplementation and restoration actions for Pacific lamprey described in the Master Plan support the six scientific principles of the Council's Fish and Wildlife Program. Each principle is specifically addressed in Section 6 of the Master Plan. For example, restoring and maintaining sustainable populations of Pacific lamprey: (a) requires "healthy" ecosystems (Principle 1), (b) increases biological diversity and imports marine nutrients into the Basin (Principles 2 & 4), and (c) provides likely prey for native species and harvest opportunities for the Tribes (Principle 3). Additionally, the Master Plan presents an outline for how adaptive management will proceed and describes a multi-agency group that will interpret monitoring data collected to guide future actions by the project. It is also clear that close cooperation is occurring among the Yakama Nation, the Confederated Tribes of the Umatilla Reservation, and the Nez Perce Tribe to use translocation efforts or refine artificial propagation methods for Pacific lamprey restoration. These actions support Principles 5 and 6.

2) describe the link of the proposal to other projects and activities in the subbasin and the desired end-state condition for the target subbasin (see 2014 Columbia River Basin Fish and Wildlife Program, Part Three, Section II) (Step 1)?

Master Plan sections:
Section 4.4 - Relationship to Other Lamprey Restoration Efforts or Processes;
Section 4.5 - Consistency with Other Regional Plans;
Section 4.9 – Relationships to Ongoing Projects

ISRP Comments:

The Master Plan provides a comprehensive explanation for how its proposed actions support and are coordinated with ongoing efforts by federal, state, tribal, PUDs, and other entities to maintain and recover Pacific lamprey. The threats that Pacific lamprey face are presented first. A primary one is passage over mainstem dams. Numerous threats also exist in tributary subbasins. They include passage over irrigation diversions, dewatering, juvenile entrainment in irrigation canals, loss of side channel and floodplain habitat, high water temperatures, poor water quality, sedimentation, and predation. Contaminants are prevalent throughout the Basin and may also impact larval lamprey due to their long tenure (up to nine years) in freshwater sediments.

Regional plans produced by federal, tribal, and state entities have been developed to help mediate the impacts of these limiting factors. The proponents describe how their proposed efforts to supplement Pacific lamprey through translocation and artificial propagation support regional plans. For example, the translocation and artificial propagation activities being proposed will maintain Pacific lamprey in interior Columbia Basin subbasins until improvements in mainstem dam passage are completed by the US Army Corps of Engineers. The project will also provide juveniles that can be used to assess the effectiveness of renovations made for juvenile passage at mainstem and tributary dams. The translocation of adults and use of artificially produced larvae to supplement or reintroduce Pacific lamprey is also consistent with the USFWS's Assessment on Pacific Lamprey, the Tribal Pacific Lamprey Restoration Plan, and the multi-agency Lamprey Conservation Agreement. The Council's Fish and Wildlife Program calls for the acquisition of more information on population sizes and the limiting factors faced by Pacific lamprey, their safe passage over dams, and for self-sustaining populations within their historical range. All of these goals are also expressed in the Master Plan.

Thirteen subbasin plans for interior Columbia River tributaries were reviewed. All indicated that Pacific lamprey were a "species of interest" or of "concern" and that more information was needed. The proposed work will help answer some of the information gaps and address several of the uncertainties presented in the subbasin plans. Currently, BPA funds five Pacific lamprey projects in the Basin. The restoration strategies, research questions, and monitoring and evaluation tasks offered in the Master Plan were largely generated by results and questions from three of those projects: the CTUIR Lamprey Research and Restoration Project, the Yakama Nation Ceded Lands Lamprey Evaluation and Restoration Project, and the Tribal Pacific Lamprey Restoration Plan. The Nez Perce Tribe is also researching and evaluating the effects of its lamprey translocation efforts in the Clearwater, Salmon, Grande Ronde, and Asotin subbasins.

Although the Nez Perce studies are not supported by BPA, their program has similar goals to those of the proponents, including the maintenance and eventual establishment of self-sustaining populations of Pacific lamprey. Close cooperation between Nez Perce investigators and the proponents is taking place.

3) define the biological objectives with measurable attributes that define progress, provide accountability and track changes through time associated with this project (see 2014 Fish and Wildlife Program, Part Three, Section III) (Step 1)?

Biological objectives are covered in Master Plan Section 5.4 Phased Approach and Objectives for Artificial Propagation.

ISRP Comments:

Yakama and Umatilla tribal scientists have propagated and reared juvenile Pacific lamprey under laboratory conditions. They have also been successful at holding adult lamprey for multiple months before translocating them into a number of interior Columbia River subbasins. This research was performed to develop methods that could be employed to help restore and maintain Pacific lamprey population segments. The proponents recognize that there is much still to be learned about how, or if, artificial propagation can be used in Pacific lamprey conservation. To help resolve that question a four-phased program was developed. Phases 1-3 are scheduled to last approximately nine years, and each phase has one or two overarching goals. Phase 4 is programmed to continue until Pacific lamprey have re-established self-sustaining populations that can provide harvest opportunities to Tribal members.

Phase 1 (laboratory phase) began in 2012 and has two goals. One is to develop and implement best practices for adult holding and fertilization. The other is to discover and utilize the best methods for larvae and juvenile rearing, handling, and for tagging or marking. Explicit quantitative objectives were established for most of the tasks in these two goals. For example, the proponents expect that: (a) survival in collected and transported adult lamprey will exceed 95%, (b) survival of adults to maturation will likewise exceed 95%, (c) factorial crosses (either 3 x 3 or 4 x 4) will be used during artificial mating, (d) fertilization success will be 80% or higher, and (e) survival of prolarvae to the feeding stage will be greater than 75%. Similar quantitative objectives for survival of feeding larvae to various ages and for retention and visibility of tagging/marking methods were not presented but should be produced. Additionally, a few implementation objectives should be added to help with adaptive management. For instance, were tagging trials and evaluations conducted as planned? Were suitable numbers of broodstock collected? and so on.

Phase 2 (field phase) is being implemented to achieve two goals. The first goal is to evaluate the survival and growth of larvae produced from artificial propagation that were transplanted into natural areas at various ages. The second goal is to provide propagated larvae to researchers performing migration and passage studies. Quantitative objectives similar to those for Phase 1 were not reported but are needed. The ISRP acknowledges that developing expectations for

survival and growth for transplanted fertilized eggs, prolarvae, and juveniles of various ages and sizes is challenging because it will likely vary by life stage and location. If known, we suggest that survival and growth information derived from naturally produced Pacific lamprey at different life stages be used to help establish expected values for transplanted hatchery eggs or fish. The proponents, for example, speculate that hatchery larvae may survive half as well as naturally-produced fish for approximately one year or until they become acclimated to natural conditions. Alternatively, the proponents could approximate a minimum survival (or growth) value for each life stage needed to maintain a sustainable population. Information in Table 5-4 begins to address this issue. Metrics could include juvenile abundance and distribution patterns. Using these types of assumptions would provide the researchers with some basic performance expectations to help identify bottlenecks in survival and recovery. These could be revised when field data become available. Furthermore, quantitative objectives should be established for progeny (e.g., larval densities) produced by translocated adult lamprey.

The overarching goals of Phase 3 (synthesis phase) are to compare and evaluate the effectiveness of different supplementation strategies and ascertain which are the most successful. These analyses would not only evaluate the success of transplanting different larval stages but are also expected to compare the production of juveniles produced from translocated adults to those produced by transplanting propagated larvae. Results will be used to identify the restoration actions that would be implemented in Phase 4 (implementation phase). The Master Plan would be strengthened if details were provided on the statistical approaches being considered for these analyses, e.g., in Step 2. If those haven't been established, we urge the proponents to work carefully with a biometrician to determine how such evaluations should be conducted. Results of those discussions will help determine how releases at various life stages should occur and what field data are needed.

4) define expected project benefits (e.g. preservation of biological diversity, fishery enhancement, water optimization, and habitat protection) (Step 1)?

Master Plan Section 5.9 covers project benefits.

ISRP Comments:

Currently it is not known if supplementation (artificial propagation or translocation) can promote the restoration of Pacific lamprey in the Columbia Basin. The investigations and comparisons presented in the Master Plan will help determine if artificial propagation is a feasible and effective restoration tool for lamprey. Translocation efforts to date appear to have been successful, but more rigorous analyses are needed according to the proponents. The proponents also acknowledge the genetic risks associated with supplementation, but argue compellingly, that these risks will be minimized and are less of a concern than the continuing loss of diversity due to extreme declines in the distribution and abundance of Pacific lamprey.

Planned expansions of lamprey fish culture facilities in the Yakima (e.g. at Prosser) and by the CTUIR at the South Fork Walla Walla (the Water Environmental Center, Walla Walla Community

College) and NOAA's Mukilteo Research Laboratory are being made to expand research capacities. These efforts may lead to additional refinements in the incubation and rearing of larval stages and further understanding of the requirements of each life stage, including the marine stage. As mentioned earlier, the project will also become an important source of larval lamprey for researchers that are addressing questions related to larval entrainment in irrigation canals and passage over irrigation diversions and dams. The results of the planned Phase 3 comparisons will help regional managers formulate and direct efforts designed to recover Pacific lamprey and meet Tribal Trust responsibilities.

5) ensure that cost-effective alternate measures are not overlooked and include descriptions of alternatives for resolving the resource problem, including a description of other management activities in the subbasin, province, and basin (Step 1)?

See Master Plan Section 3.5 Alternatives Considered.

ISRP Comments:

The Master Plan justifies the management alternative that was chosen by presenting the benefits and costs of the four alternative measures that were considered. All four alternatives are described. The first alternative was to maintain the current level of facilities and research activities. Under this option, however, resources needed to release and evaluate the survival and growth of artificially propagated eggs, prolarvae, larvae, and juveniles released into natural habitats would not be available. Progress toward achieving stated goals in the Tribal Pacific Lamprey Recovery Plan (TPLRP) and Lamprey Conservation Agreement (LCA) would continue at present levels, and research into alternative propagation protocols would be limited. The second alternative was to terminate current research on artificial propagation, translocation, and restoration. Current lamprey hatchery infrastructure would be maintained, but no additional collections of adults would occur. Supplementation research would be entirely centered on the effectiveness of translocation. Little or no progress would be made on the goals of the TPLRP and LCA. As in alternative one, no artificially propagated larvae would be available to Basin researchers for passage and migration studies.

Alternative three reflects the proposed activities in the Master Plan and includes a modest increase in artificial propagation, translocation, and restoration research. Adult holding and spawning operations would be maintained, and translocation would be expanded into a few additional areas. Structural improvements in adult holding and juvenile incubation and rearing locations are planned. Additionally, larvae out-planting studies would take place and artificially reared juveniles would become available to Basin researchers. These actions would help fulfill the biological objectives identified in the TPLRP, the LCA, the Tribal Lamprey Framework, subbasin plans, and Columbia River Accords. The proponents indicate that even though this alternative would increase capacity, staffing levels would not need to be substantially increased. The fourth alternative calls for significantly expanding artificial propagation, translocation, and restoration research. Under this option, significant increases in holding and rearing capacities for adults, larvae, and juvenile lamprey would occur. Releases of propagated

lamprey would occur and be evaluated and progress in meeting the objectives in regional Pacific lamprey plans would likely occur.

However, under alternative four, the proponents point out that expansion of existing facilities would be costly. Additionally, they state that the "equipment and facility needs for a large-scale lamprey aquaculture facility are still unclear" making any current decisions about needed infrastructure highly speculative. Additionally, they acknowledge that the rearing protocols for lamprey are just being developed and more should be learned before investing in a large-scale hatchery. Consequently, they chose to adopt alternative three as their preferred option. We agree that this seems to be the most prudent and cost-effective choice. It allows progress to be made on artificial propagation to meet the goals of the TPLRP, LCA, and other regional plans. It will also allow field releases and subsequent evaluations on the effects of releasing propagated juveniles at various life stages and provide researchers with juvenile lamprey for other studies.

6) provide the historical and current status of anadromous and resident fish and wildlife in the subbasin most relevant to the proposed project (Step 1)?

See Master Plan Section 4 Regional and Tribal Context.

ISRP Comments:

The Master Plan provides detailed historical abundance and distribution information on Pacific lamprey in fourteen interior Columbia River subbasins. When known, trends in abundance and status of extant populations in the subbasins are also described. Furthermore, geographic information on each subbasin, as well as the factors currently thought to be limiting lamprey abundance, are presented. Brief summaries and results of the restoration efforts in the subbasins where translocations have occurred are also provided. Supplementation efforts by the YN are taking place in the Yakima and Methow subbasins and two subbasins, the Klickitat and Entiat, are being used as "controls" or un-supplemented locations. CTUIR researchers are translocating adult lamprey into the Umatilla and Grande Ronde and plan to transplant juvenile lamprey into the Walla Walla and Tucannon subbasins. Like the YN scientists, CTUIR investigators are using two subbasins, the John Day and Imnaha, as control locations. For completeness, the Master Plan also provided information on the geographic characteristics, historical abundance, and distribution of Pacific lamprey in the Clearwater, Salmon, Grande Ronde, and Asotin subbasins, where adult Pacific lamprey are currently being translocated by the Nez Perce Tribe. Factors presently responsible for limiting lamprey abundance in these subbasins are also described.

The Master Plan also presents a detailed overview of the supplementation efforts that have taken place in the Basin since 2000, when the CTUIR began its lamprey translocation efforts in the Umatilla River and Meacham Creek. Details on the results of research performed by the YN, CTUIR, USFWS, USGS, and Chelan PUD on the effects of gamete quality, water sources, incubation methods, fertilization protocols, diet formulations, rearing densities, rearing substrates, and the effects of transportation on artificially propagated Pacific lamprey are also

shared. No information on other anadromous species utilizing these subbasins was mentioned. Even though interactions among Pacific lamprey adults and larvae with anadromous salmonids were not directly considered, we suspect the effects will probably be minimal and possibly beneficial, as lamprey larvae could serve as a potential prey for juvenile salmonids.

7) describe current and planned management of anadromous and resident fish and wildlife in the subbasin (Step 1)?

See Master Plan Sections:
Section 4.5 - Consistency with Other Regional Plans;
Section 4.6 - Consistency with Other Supporting Documents;
Section 4.7 - Local and Regional Management Context

ISRP Comments:

As mentioned previously, the goals and objectives presented in the Master Plan are complementary to those expressed in the USFWS's Pacific Lamprey Assessment, the Tribal Pacific Lamprey Restoration Plan, the Lamprey Conservation Agreement, and the Council's Fish and Wildlife Program. Recently, subbasin-specific lamprey supplementation and research plans have been drafted for the Yakima and Umatilla subbasins. These plans are being developed to standardize supplementation methods, data analyses, and reporting formats. No apparent conflicts exist between local and regional plans dealing with anadromous and resident fishes and those expressed in the Master Plan. However, the proponents rightfully emphasize that artificial propagation and translocation alone will not restore Pacific lamprey. Continued improvements in passage over mainstem and tributary dams and irrigation diversions, habitat access and quality, along with efforts to control the impacts of contaminants will also need to occur before restoration can occur.

8) demonstrate consistency of the proposed project with NOAA Fisheries recovery plans and other fishery management and watershed plans (Step 1)?

See Master Plan sections:
Section 4.5 - Consistency with Other Regional Plans;
Section 4.6 - Consistency with Other Supporting Documents

ISRP Comments:

Lamprey are considered a "species of concern" by USFWS but are not formally listed as threatened or endangered under the ESA. As mentioned immediately above, the actions in the Master Plan appear to be compatible with NOAA's recovery plans for ESA-listed salmonids and with other fishery management and subbasin planning efforts. The Master Plan mentions that lamprey supplementation could be permitted under section 4(d) or Section 10 (1)(A) of the ESA for potential impacts on ESA-listed salmon and steelhead. Analyses for the permitting process

could evaluate interactions between artificially propagated lamprey larvae and listed salmonids and would ensure compliance with NOAA's recovery plans for salmonids.

9) describe the status of the comprehensive environmental assessment (Step 1 and 2)?

See Master Plan Section 7 Environmental Compliance.

ISRP Comments:

The Master Plan states that the development of a comprehensive Environmental Assessment that is compliant with NEPA typically occurs in Step 2. The Plan indicates that current adult translocation and laboratory-based propagation research is covered under BPA's programmatic Environmental Impact Statement. This EIS, however, does not include the proposed releases of propagated larvae into natural locations. Consequently, the proponents acknowledge that the lamprey supplementation program will need to produce an Environmental Assessment in Step 2 because of its geographical scale and the numbers of fish that will be released. They anticipate that the NEPA process would include public outreach to identify key issues and that BPA would be the lead federal agency in this process.

Other possible regulatory approvals anticipated by the proponents include ensuring that the project meets Clean Water Act, National Historic Preservation requirements, and approvals from various state agencies.

10) describe the monitoring and evaluation plan (Step 1, 2 and 3)?

See Master Plan Section 5.5 - Experimental Designs for Phase 2 Projects.

ISRP Comments:

There appear to be three primary goals associated with the Tribal effort to maintain and eventually restore Pacific lamprey populations in Columbia Basin. The first is to establish protocols that can be used in artificial propagation programs that will produce fertilized eggs, prolarvae, and juvenile larvae at various ages. The second is to evaluate if translocation of adults and the out-planting of artificially propagated Pacific lamprey at different life stages increases the abundance and stability of Pacific lamprey population segments. The third goal is to compare the productivity and abundance of lamprey juveniles produced by adult translocation and out-planting of propagated lamprey.

Substantial challenges in the artificial culture of lamprey were addressed by the proponents. Fertilization methods and procedures that facilitate the conversion of non-feeding prolarvae to burrowing and feeding larvae have been established. Longer-term rearing of larvae and juveniles have also been accomplished. Methods that can be used to transfer propagated larvae and juvenile lamprey to release locations are also being developed. The proponents indicate that losses of 30% typically occur when fish are transported and released. These losses are

linked to mechanical damage to lamprey when they are removed from their rearing sediments and siphoned or pumped out of transfer tanks. Recently, CTUIR researchers have tried releasing propagated juveniles while they are still in their rearing sediment. The fish are simply allowed to volitionally exit their medium when placed into natural environments. We urge the proponents to continue researching this approach or other release alternatives, as a loss of 30% at release clearly reduces the benefits that may come from larval transplants. The current Master Plan does not provide any information on how in-hatchery performance or transportation methods will be monitored or evaluated. In Step 2, the methods that the proponents are using to make these assessments should be briefly described.

Translocation of adult lamprey into interior Columbia River subbasins has occurred since 2000. Monitoring of juvenile abundance and adults returning to the subbasins where translocation has occurred have shown increases in larval and adult abundance. The Master Plan indicates that translocation efforts will continue in the Yakima, Methow, Umatilla, and Grande Ronde subbasins. Areas within some of these subbasins have been set aside as control or non-supplemented locations. Additionally, four subbasins – the Klickitat, Entiat, John Day, and Imnaha – have also been designated as control sites. Index areas within the subbasins receiving translocated lamprey, as well as those in the control subbasins, have been established and appear to have been regularly sampled for multiple years. We suggest that the proponents consult with a biometrician to determine the data that need to be collected and the statistical approach that should be employed to most efficiently and robustly evaluate the effectiveness of adult translocation. Seemingly, with control and treated index areas, and possibly pre-treatment data, it may be possible to use BACI designs. Step 2 should describe the analytical approaches that will be taken when the effectiveness of translocation is assessed.

The Master Plan indicates that the proponents plan to release multiple life stages of propagated Pacific lamprey into a number of subbasins. These life stages include fertilized eggs, newly hatched prolarvae, 3- and 6-month old larvae, and 1+ and older juveniles. Comparing the benefits of releasing different life history stages into the natural environment is a key monitoring objective for the project. Results from such assessments may have a major impact on how the program proceeds in the future. For instance, if monitoring indicates that transplanting life stages that are less than 6 months old have little or no effect on juvenile lamprey abundance, then a substantial change in the program would likely be needed. The proponents have indicated in the Master Plan that it is difficult to rear larvae beyond the 3-month stage due to space requirements. As the fish grow, rearing densities increase, and additional rearing area is needed. Consequently, if the proponents wished to continue to transplant older and larger propagated larvae, they would need to expand the rearing capacities at their hatcheries. Conversely, if fertilized eggs were just as effective as older juveniles, then the program could use existing infrastructure and may expand its transplanting efforts.

The proposed approach for assessing the effectiveness of out-planting various life stages of lamprey introduces different life stages of fish into different locations. For example, in the Yakima subbasin during the first year of the transplant study, a site at Cle Elum would receive

fertilized eggs or newly hatched prolarvae, a site in the lower Wenas would receive two-year-old larvae, and the Eschbach site would receive 1+ larvae. This approach ignores potential interactions among year of release, habitat location, and life stage released. This may have occurred because of logistical constraints that make it difficult to obtain dissimilar life stages at the same time. As with the translocation evaluation, we urge the proponents to consult with a biometrician about the statistical and analytical approaches that should be taken to make such evaluations. If, for example, it is possible to simultaneously obtain Pacific lamprey at different life stages, a mixed nested ANOVA design might be appropriate if fish from each life stage were differentially marked (e.g., PBT) or tagged. Such an analysis would allow the researchers to determine the amount of variation in survival that could be explained by the test's two random factors (i.e., year and release area) and its fixed variable (life stage). Interactions among these factors could also be examined. In Step 2 the analytical approach taken to evaluate the effectiveness of out-planting propagated lamprey should be described.

Additionally, the statistical approach that will be used to compare and evaluate translocation and larval out-planting should be described in Step 2. The Master Plan should also consider monitoring and evaluating adult lamprey returns to the treated and control rivers, in addition to evaluating larval and juvenile stages. Potential factors that might confound interpretation of the findings, e.g., sediment and water quality, should also be discussed.

Finally, the Klickitat River is proposed as a control site where supplementation would not normally occur. However, Section 5.5.2.3 states that "some limited translocation may occur in lower and mid reaches of the Klickitat River to evaluate passage at Lyle Falls and the Klickitat Hatchery weir." This reportedly "limited" supplementation should be re-considered as it could jeopardize the use of the Klickitat as a control watershed.

11) describe and provide specific items and cost estimates for ten fiscal years for planning and design (i.e. conceptual, preliminary and final), construction, operation and maintenance and monitoring and evaluation (Step 1, 2 and 3)?

See Master Plan Section 5.8 Summary of Cost Estimates.

ISRP Comments:

The Master Plan provides cost estimates for the proposed program that are summarized in Tables 5.12 and 5.13.

B. Artificial Production Initiatives

Does the Master Plan:

1) address the relation and link to the artificial production policies and strategies (see 2014 Fish and Wildlife Program, Part Three, Section IV, B and C1, 2, 4, 5, and 6) (Step 1)?

See Master Plan Section 6.2 Consistency with NPCC Principles for Hatcheries.

ISRP Comments:

Proposed artificial propagation actions presented in the Master Plan are consistent with the Council's principles for hatcheries. The Plan indicates that the life history of Pacific lamprey is being used to guide portions of the program. Holding facilities for adult lamprey, for instance, are designed to provide conditions similar to those they would experience under natural conditions. Release locations for translocated adults are typically located where lamprey have been observed spawning and rearing in the past. Additionally, prospective out-planting locations for hatchery-produced fish were chosen on the basis of previous occupation or on habitat characteristics known to be selected by juvenile lamprey. Risk assessments are also part of the program. Genetic analyses, for example, indicated that naturally spawning Pacific lamprey typically mate with four other individuals. As a result, factorial matings, either 3x3 or 4x4, are being employed at fertilization to provide genetic heterozygosity to the propagated fish.

Analyses performed by CRITFC geneticists suggest that Pacific lamprey do not exhibit strict homing and instead exist in a single gene pool within the Columbia Basin. If this is true, then translocation of mature adults and out-planting of artificially propagated larvae to productive but underutilized habitat could be effective methods for increasing the distribution and abundance of juvenile lamprey and for preventing extirpation in habitats that have become difficult for adult lamprey to reach naturally. These supplementation strategies could be especially useful as stopgap measures to stave off extirpations until current dam passage issues can be solved in the longer term. The discussion in Section 4.10.1 (Genetic Monitoring and Analysis) is reassuring because the proponents acknowledge the uncertainty about the spatial scale of genetic adaptations in Pacific lamprey and that translocation could disrupt spatial patterns of genetic adaptation. They argue convincingly, however, that the risk of disrupting adaptations is likely less serious than the risk of losing genetic diversity through continuing and extreme declines in distribution and abundance. The Master Plan is cautious in that the proposed experimental approach identifies a number of natural "stronghold" watersheds as untreated controls for evaluating the effects of supplementation. Surveys of neutral genetic variation indicate that gene flow has been high enough to homogenize neutral gene frequencies throughout the basin, implying natural selection would have to be relatively strong to maintain putative local adaptations in the face of that gene flow. If that is true, local adaptations inadvertently disrupted by this Program might still re-evolve or be rescued by gene flow from the stronghold watersheds, provided sufficient genetic diversity is preserved there.

Another key hypothesis is that adult lamprey collected at mainstem dams would be more valuable as broodstock to artificially propagate juveniles in underutilized habitats above barriers than they would be if left in the mainstem to attempt to spawn naturally. On the single gene pool hypothesis, a primary consideration must be to determine which approach (collection and artificial propagation or not) will produce the greatest abundance and diversity of juveniles. It may be counterproductive to artificially stock inaccessible habitats with juveniles if their pheromones will lure adults upstream, likely imposing additional mortality and diminishing natural reproduction in more accessible habitats downstream. The Master Plan indicates that translocations will primarily be to the most accessible habitats within each of the study watersheds.

If blockage of adult migration is considered the primary threat to Pacific lamprey in the Columbia River, then the strategy of pursuing supplementation as a stopgap measure until passage can be improved is logically more coherent than pursuing habitat restoration in underutilized areas.

2) provide a completed Hatchery and Genetic Management Plan (HGMP) for the target population(s) (Step 1)?

Not completed. See Section 2.1 – Northwest Power and Conservation Council Step Review Process.

ISRP Comments:

An HGMP was not provided. The proponents have suggested that one may not be needed since Pacific lamprey are not an ESA-listed fish. We suggest they consult with the USFWS and develop a document that is functionally equivalent to an HGMP for their program. Although the Master Plan is largely complete it does lack some important details. For example, it's not clear if a 4x4 matrix of parental crosses would provide larvae for out-planting in multiple subbasins or just one? A modified HGMP could also establish a limit on the annual percentage of adult lamprey that could be removed for translocation and artificial propagation. These kinds of details will be important for judging risk to natural population segments and for determining appropriate statistical designs.

3) describe the harvest plan (see 2014 Columbia River Basin Fish and Wildlife Program, Part Two, Section II) (Step 1)?

Not applicable. See Section 2.1 – Northwest Power and Conservation Council Step Review Process.

ISRP Comments:

The Master Plan is not being developed to support lamprey harvests, at least in the near-term. Harvest is currently constrained to Tribal members only and typically represents a very small fraction of the lamprey population (~1 to 2%) and just occurs in a few lower Columbia locations. A harvest management plan is not needed by the lamprey program.

4) provide a conceptual design of the proposed facilities, including an assessment of the availability and utility of existing facilities (Step 1)?

See Master Plan Section 5.6 Conceptual Design of Lamprey Facilities.

ISRP Comments:

The Master Plan provides adequate details about existing and proposed facilities. The CTUIR proposes some additions to NOAA's Mukilteo Marine Research facility. These additions are being made to facilitate research on lamprey during their marine stage. For completeness, the Master Plan should provide a brief explanation of the proposed marine work and why it is important for lamprey conservation.

5) provide a preliminary design of the proposed facilities (Step 2)?

Not applicable see Section 5.6 Conceptual Design of Lamprey Facilities.

ISRP Comments:

Not applicable for this review; this is a Step 2 issue.

6) provide a final design of the proposed facilities, including appropriate value engineering review, consistent with previous submittal documents and preliminary design (Step 3)?

Not applicable see Section 5.6 Conceptual Design of Lamprey Facilities.

ISRP Comments:

Not applicable for this review; this is a Step 3 issue.