Independent Scientific Advisory Board
for the Northwest Power and Conservation Council,
Columbia River Basin Indian Tribes,
and National Marine Fisheries Service
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Comments on the *draft* Tribal Pacific Lamprey Restoration Plan for the Columbia River Basin

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Contents

Executive Summary

On November 9, 2009, the Columbia River Inter-Tribal Fisheries Commission (CRITFC) requested that the Independent Scientific Advisory Board (ISAB) review the draft *Tribal Pacific Lamprey Restoration Plan for the Columbia River Basin.*[1] CRITFC asked for the ISAB's immediate impressions and suggestions for improvements to the Plan, rather than a detailed scientific assessment. A presentation to the ISAB on October 30, 2009 by CRITFC and its member tribes helped to frame the draft plan and review. This review is not intended as an exhaustive and comprehensive analysis of the state of lamprey science but is, as requested, an assessment of the Draft Plan (henceforth the Plan) intended to improve the next iteration of the Plan and subsequent implementation of its components. The ISAB understands that the Independent Scientific Review Panel (ISRP) has reviewed and will continue to review the various Fish and Wildlife Program projects that are proposed to implement the Plan.

Goals and priorities: The ISAB shares the sense of urgency to complete and implement the Plan. However, the Plan is overly ambitious. It would be improved by explicit separation and elucidation of its goals (as opposed to the proposed actions), as well as further prioritization of objectives and proposed research.

Coordination: CRITFC should explicitly coordinate overall objectives of the Plan to avoid work being duplicated by the various entities and to foster useful comparisons among subbasins by ensuring that data are comparable. Although the Plan is to be led by the Tribes, the ISAB also recommends that the Plan include more interagency planning among co-managers and stakeholders. The Plan should include a clearly defined vision for lampreys at the basin, province, and subbasin levels. Such a vision will yield benefits in terms of planning for research, monitoring, and management. The current document provides a good basis for developing that vision.

Apparent significant and widespread decline: The decline of lamprey is apparently widespread throughout Idaho, Oregon, Washington, California, and British Columbia. However, the history of decline in the Columbia River is difficult to document because of incomplete data on trends in abundance at monitoring locations. The Plan would be improved by showing any available data on trends in harvest and counts at dams.

Dam counts: The ISAB agrees with the Plan's assertion that a critical objective is to improve the accuracy and precision of procedures for counting lamprey migrating upstream past each dam.

Tags to track river migrations: Tagging studies are needed to address most issues of adult and juvenile passage and habitat use in both the mainstem and tributaries. Development of tags suitable for use in juvenile lamprey remains a challenge that should be highlighted in the Plan.

[1] October 30, 2009 Revised Draft for ISAB Review

Limiting factors and monitoring: The Plan's strong emphasis to improve knowledge of limiting factors and to refine methods for monitoring and evaluating status and distribution is appropriate. We agree that it is a priority on developing methods for sampling and obtaining data on lamprey habitat. Without this information, it will be difficult to design restoration efforts that will benefit lamprey. One major immediate restoration effort that appears justified by available information is the restoration of improved passage for adult lamprey. Dam passage has been clearly identified as a limiting factor for upstream migrating adults, and some technological improvements have already proven effective.

Ocean tracking: The Plan identifies estuary and ocean life history for Pacific lamprey as a critical uncertainty. The ISAB agrees that development of tagging systems to track juvenile lamprey in the estuary and near-ocean environment is an essential first step.

Screen impingement and other barrier problems: The ISAB agrees that impingement of juvenile lamprey on existing screens at dams and diversion structures is potentially an important source of mortality, as may be other barriers to movement. The scale of necessary retro-fitting will be so large, however, that until credible information exists on the utility of particular modifications, effort should probably be focused on pilot projects to test a variety of alternatives, rather than devoted to broad implementation of any one design for retrofits or replacements.

Translocation: Supplementation (including translocation and other aquaculture or hatchery-supported introductions) should be regarded as experimental and should proceed only with a clear experimental design and evaluation protocol. The genetic composition and ecological role of Pacific lamprey in specific subbasins are poorly understood; therefore, translocation experiments need to be guided by better knowledge of tributary-specific life history characteristics. Experiments must be accompanied by adaptive management on the basis of information from aggressive monitoring and evaluation.

Contaminants: In view of the freshwater life history of lamprey, and increasing concerns about the modern chemicals being discharged into the Columbia River Basin, the ISAB wishes to emphasize the potential implications of contaminants in lamprey both for lamprey restoration and human health. Contaminant studies must remain within the scope of this Plan, perhaps even figuring prominently, as these fish are subjected to considerable exposure. Lampreys have high lipid content which makes them particularly susceptible to contaminant uptake.

We first offer general comments and then provide specific comments on each section and major objective of the Plan.

ISAB General Comments on Plan Objectives

The ISAB found the research and restoration plan for Pacific lamprey (*Lampetra tridentata)* in the Columbia River Basin to be overly broad and ambitious, given the state of our current knowledge. The Plan would be improved by further prioritization of objectives and proposed research. The document would be more effective if reorganized with the science and factual background presented first. The legal and cultural rationale for restoration should be reduced to remove redundancy and presented in a titled section further back in the report.

The lack of consistent distinction between "objectives" and "actions" detracts from the clarity of the overall Plan, especially in the appendices. It is generally best to first present the objectives, which are basically what needs to be accomplished and why, before describing the actions needed to achieve those objectives. It is often effective to present the hierarchy of vision, goals, objectives, and sub-objectives.

CRITFC should think more broadly about the whole life cycle of Pacific lamprey and deal strategically with the plethora of possible problems and mechanisms that could affect lamprey survival. A major shortcoming is the lack of clear quantitative evidence for the decline in lamprey abundance, as this is the core problem to be resolved. The available data are limited, but existing data should be brought to bear. Additionally, other statements about the importance of lamprey should be substantiated. In general, broad statements need to be backed up with data (calculations or citations to publications). An example of this is (page 61): "Lamprey feed whole streams with their degrading carcasses …."

The Plan would benefit from prioritization of objectives, greater consideration of the need to continually evaluate progress, and modification or substitution of objectives as required. The ISAB agrees with CRITFC's prioritization of mainstem passage as an important issue but also recognizes that current understanding of the life history and population dynamics of Pacific lamprey is so incomplete that severe mortality during other phases of the life cycle may turn out to be as important as passage-related mortality.

ISAB Comments on Specific Draft Plan Sections

Plan Introduction

Including a Table of Contents would help readers follow the organization and navigate the document.

Cultural and Institutional Context

The ISAB recognizes the importance of Pacific lamprey in tribal customs and as a food source. Traditional ecological knowledge may help guide future research and studies, as mentioned in the Plan and as it did for Pacific lamprey studies in the Klamath River basin (Peterson 2006). Another aspect of the broader institutional and cultural context – the

negative image of lampreys held by the broader American public – is less articulated and could be addressed more effectively. It is unfortunate that, for many people, the lamprey's image is tainted by the deleterious effect of sea lamprey in the Great Lakes. Many people may incorrectly see the decline in lamprey abundance as a benefit to other species and society in general, rather than as a loss of ecosystem and cultural benefits. Attention to correct this broad negative societal bias should be given greater emphasis in the Plan. References and arguments against Pacific lamprey would be more effectively countered with scientific evidence. This approach could help garner additional support for Pacific lamprey studies and conservation.[2]

Life History of Pacific Lamprey

The ISAB found the synopsis of life history information to be a good overview but notes that the synopsis could be improved with additional references. A more focused synthesis is required to develop a strategic approach. Recent information on the marine and estuarine life history phase in the north Pacific Ocean could be added (e.g., Pelenev et al. 2008; Orlov et al. 2008).

Unpublished information also could be gleaned from discussion with fisheries researchers working in the Columbia River Basin. Weitkamp (NOAA Fisheries, unpublished data cited with permission) reported a few Pacific and river lamprey are caught in purse seines during estuary surveys. Some of the fish species caught in the surveys have lamprey scars. Catches of Pacific lamprey in trawl surveys in the Columbia River plume are low and variable (Emmett, NOAA Fisheries unpublished data cited with permission). Biologists working in Intensively Monitored Watersheds might be a source of detailed information on freshwater phases of lamprey.

Ecological Significance

The Plan should consider whether marine-derived nutrients, carried in the bodies of spawning adults, might be important for in-stream productivity, as well as riparian plants. If spawning densities are sufficiently large, at least locally, then these nutrients are certainly used in interior ecosystems, as is the case for salmon-derived nutrients (see Naiman, et al. 2009). Based on historic spawning abundances, nutrient contents, and spawning locations, one could make rough evaluations of the potential nutrient contributions and compare them to other sources.

Another example of the ecosystem services that lamprey might provide is gravel cleaning while spawning. If there are data on that phenomenon, they should be mentioned.

Historical abundance and status (and tribal harvest)

The decline of lamprey is apparently widespread in Idaho, Oregon, Washington, California, and British Columbia (ISAB 2008-5), but the decrease in the Columbia River

[2] See Scarnecchia, D.L. 1992. A reappraisal of gars and bowfins in fishery management. *Fisheries* 17(5):6-12, for a short example of how to approach an image makeover for oft-maligned fish species.

is difficult to document since the times series of abundance are incomplete at several of the dams and other monitoring locations. The Plan would be improved by showing some of the plots from Kostow (2002; cited in the Plan), notably her Figure 30, which shows data from Bonneville Dam and lamprey harvest from the Willamette River. Although incomplete, these data might help to show harvest trends that presumably have followed adult abundance.

Although declines in lamprey in most regions of the Northwest are not generally in dispute, significant questions remain as to the exact causes of the declines in different locations. It would be useful to have as clear an idea as possible of the causes of declines in the various Columbia Basin provinces. A key problem is that there is a serious insufficiency of historical data on Pacific lamprey abundance in the Pacific Northwest. A review of the data presented in Kostow (2002; cited in the Plan) seems to clearly suggest that dams are the dominant factor in the decline of fish in the Snake and Upper Columbia, as well as in the Willamette River. It is less clear what has caused the declines in the lower Columbia River (below Bonneville Dam) and in some coastal streams and rivers. The inferences about declines in the lower Columbia are based on data from two different rivers over very different time periods (higher counts in Gnat Creek from 1956-62 and lower counts in the Scappoose River from 1999-2001, with no data in intervening years (Kostow 2002; her Figure 35 on Page 51). The spatial variation in lamprey abundance makes this comparison difficult to evaluate.

The extent of homing in Pacific lamprey will have an influence on the most appropriate courses of action for restoration. If they do not home, declines in some coastal areas and the lower Columbia may reflect the fact that fewer lamprey are being recruited into the whole region or watershed. Dams may be preventing adults from reaching spawning grounds, or the spawner-recruit relationship may be impaired by habitat conditions. These hypotheses need testing. We discuss the homing issue in detail below in the context of translocation and note that evidence may yet be produced that lamprey do show homing behavior.

Evidence that the overall decline in lamprey abundance is coast wide suggests that the cause is not specific to the Columbia River Basin and may not be entirely associated with the freshwater portion of their lifecycle. The Plan could be more compelling if CRITFC thoroughly addressed the extent and possible causes of declines up front. Besides a drastic decline at Winchester Dam on the Umpqua River in coastal Oregon between 1996 and 2001 (cited in Close et al. 2004; cited in the Plan), no other complete data on declines are presented. Lamprey abundance from the Umpqua River is still being monitored, so that data are a valuable out-of-basin reference. Pacific lamprey were once harvested in large numbers at Willamette Falls (see Kostow 2002, Fig 30; cited in the Plan). It is not clear if harvest data are available from other subbasins. It would be prudent to begin detailed monitoring of Pacific lamprey abundance at strategic locations as soon as practicable. Abundance data from the Willamette River would be particularly informative, as the Willamette is below major dams.

Objective 1: Improve Mainstem lamprey passage efficiency, survival and habitat

- Sub-objective A: Adult Passage and Habitat

Much of the research to date has concentrated on identifying mechanical and hydraulic impediments to the passage of adult lamprey through fishways at mainstem Columbia hydropower dams. This work has led to practical and effective improvements in fishway design. Because improvement of dam passage has already proven effective, and is not dependent upon the development of new "breakthrough" technology, the Plan appropriately emphasizes continuing this work at other mainstem hydropower projects and implementing the findings of research to date. Improving the accuracy and precision of counting procedures for upstream migrants at each dam is also identified as a critical objective. The ISAB agrees with this conclusion.

Existing PIT-tag and radio-tag technologies, adapted from use with juvenile salmonids, have been used successfully to track adult lamprey during dam passage and after migrating into spawning streams. However, the effects of radio-tags on lamprey behavior, physiology, and survival have not been extensively studied. Such studies, which are not mentioned as an objective in the Plan, are important. Discovery of deleterious effects of tagging at a future time could weaken or invalidate conclusions based on earlier research and could be damaging to lamprey recovery. Laboratory studies can be valuable, but alone cannot establish whether tagged fish behave differently or survive at a lower rate than untagged fish. Well-planned field studies are necessary and should be undertaken as soon as possible.

The Plan addresses the setting of passage objectives and performance standards in several places. In the absence of information on what can practically be achieved, setting generic performance standards are a bit premature at this time. In particular, the application of salmonid performance standards to lamprey passage and survival rates seems unjustifiable. For example, it is stated (p. 26) that, "The range of system passage and survival [for adult lamprey] should be similar to that of steelhead," and (p. 44), "...some basin hydro projects have established passage survival goals for salmon fry as high as 98%. There is no reason not to expect the same for juvenile lamprey and adopt this rate as a goal and standard." In light of the very different biological characteristics of salmonids and lamprey, passage and survival performance standards for lamprey should be developed independently. One approach to setting goals for lamprey passage is to base them initially on performance levels shown already to be achievable (e.g., p. 26 of the Restoration Plan: "Identify and apply scheduled structural and operational improvements to achieve volitional adult passage standards approximating the best known achievable rates at Mainstem dams and reservoirs...."). They can be adjusted upward as we learn more and/or as needed.

- Sub-objective B: Juvenile Passage and Habitat

Critically important questions about passage of juvenile lamprey through hydroelectric projects on the Columbia and Snake rivers cannot be addressed without tagging studies. The lack of a suitable internal tag for juvenile lamprey is a major impediment to research that might lead to improved dam-passage efficiency and survival for these animals. As noted in ISRP/ISAB 2009-1, because of this limitation, natural tags (genetic markers, otolith, and statolith), microstructure and microchemistry are the only feasible methods available at present for long term marking of juvenile lamprey. Genetic markers have been investigated (see below), but more work is urgently needed. The Plan summarizes some earlier work that found serious shortcomings with adaptation of existing (pre-2000) tag technology for use with juvenile lamprey and identifies the Juvenile Salmon Acoustic Telemetry System (JSATS) acoustic tag as the most promising candidate for future use. CRITFC may wish to refer to ISRP/ISAB 2009-1, where acoustic tag technology and development for fish is discussed in some detail. Technological problems with tags for juvenile lamprey generally need to be overcome, as research has found that the risk of disease is increased by surgical implantation of PIT tags in juvenile lamprey (Mesa 2009).

Development of a suitable tag for juvenile lamprey should be given high priority. To be suitable, a tag should not significantly alter behavior or survival. Appropriately, this is the first action task listed in the Plan's Table 3, "Summary of juvenile passage and Mainstem habitat actions" (p. 47). Improved tagging technology is also necessary to achieve other activities listed in Table 3. In particular, the activity "Develop route-specific dam passage and survival estimates" will require the use of an improved tagging system. Another obstacle to this (and some other) actions is that, without the ability to rear large numbers of juvenile lamprey in hatcheries, relatively small numbers of experimental animals will be available. For these reasons, the performance schedules given in Table 3 for the various proposed actions are overly optimistic. The use of, "existing tagging technologies and other tools to determine dam impacts" can, on the other hand, be accomplished in the next few years, assuming the tag implanting problems can be overcome. Tagging studies should provide useful information on turbine and spillway survival rates.

Some work has been done at a few dams to quantify juvenile lamprey impingement on turbine intake screens, but little real progress has been made toward mitigating this mortality source. This is a daunting problem, because the turbine intake screening systems now in use were developed to divert juvenile salmonids from the intakes, and perform this function moderately well. Design of a system that would simultaneously protect juvenile salmonids and juvenile lamprey is an engineering design problem that could take years to solve. The proposed action to "remove or modify turbine intake screens that cause impingement" (McNary 2009; Snake River dams 2010) cannot be achieved within a short time frame (see also ISAB 2008-5) and needs to be balanced against the requirement to protect ESA-listed juvenile salmon and steelhead. The effectiveness of surface bypass devices for passage of juvenile lamprey should be investigated.

Implementation of improved mainstem flow regimes is an action item in Summary Table 3 (and is discussed on p. 43). This action is scheduled for 2009-2018. Although several decades of research efforts have been undertaken to test the hypothesis that, augmented spring and summer flows improve the survival of migrating juvenile salmonids (with benefits shown for some stocks but not for others), no parallel studies have been done with juvenile lamprey. Therefore, it would be difficult at this time to argue for flow augmentation specifically for the benefit of migrating lamprey. Summer flow augmentation undertaken for the benefit of juvenile fall Chinook salmon may also, of course, benefit juvenile lamprey. Similarly, reduction of avian, piscine, and marine mammal predation on lamprey will continue to be a corollary benefit of existing programs to reduce predation on juvenile salmonids. The method used to estimate avian predation pressure on juvenile salmonids (recovery of PIT-tags from bird colonies) is not presently applicable to similar studies with juvenile lamprey. Large numbers of juveniles are unavailable for PIT-tagging, and we have already discussed the PIT tag implanting issue.

Specific Comments:

(1) On p. 19, paragraph 3 of the Restoration Plan, it is stated that: "[The ISAB]... Recommended passage standards and targets... (ISAB 1999; cited in the Plan). Among other things, the ISAB recommended against installation of extended length, fixed (not rotating) bar turbine screens at John Day Dam *because of* [italics added] the demonstrated impacts of the screens on juvenile lamprey." In the References, this ISAB 1999 report is cited as Report 99-5. The recommendation regarding the John Day screens was actually made in ISAB 98-4 and ISAB 99-4 (the cited ISAB Report 99-5 is a report on the "Lake Pend Oreille Kokanee Net Pen Alternative"). The ISAB did, for a variety of reasons, recommend against installation of new extended bar screens at John Day Dam, but not based primarily on concerns about lamprey, which were given a cursory mention.

(2) P. 42, paragraph 1. The description of the effect of bar-screen gap width on impingement of juvenile lamprey entering turbine gatewells should be clarified, given that smaller gaps are thought to be beneficial (see ISAB 2008-5). Two statements in this paragraph seem to be contradictory: (1) "as impingement persisted, recommendations were made to mitigate these impacts by reducing screen gap size from 3.175 to 1.75 mm..." and (2) "screens... had already been installed... with the smaller gaps that cause impingement."

Objective 2: Protect and restore tributary habitat and passage

- Sub-objective A: Tributary Passage

Because juvenile lamprey rear in lower-elevation tributaries for 5 to 7 years, we can expect that survival will be strongly affected by water quality and habitat conditions. Unfortunately, no assessment of water quality, stream flow, and temperature problems in tributaries used by lamprey for spawning and rearing (other than in the context of translocation) is currently included in the Plan. It needs attention.

The Plan provides some evidence that the irrigation diversion screens used extensively throughout the basin to minimize entrainment of juvenile salmonids are not effective for juvenile lamprey. Modification or replacement of those screens could be very important in minimizing losses and an anticipated inventory of the potential impacts could be useful in understanding the relative magnitude of the problem. It is not clear how important other barriers such as culverts in tributaries may be to movements of adults and juveniles, but presumably many of the issues for salmonids (e.g., flow, temperature, improperly designed culverts) could be relevant for lamprey as well. The Plan indicates that an inventory of potential problems was implemented in 2008 but does not refer to any results of that work. The removal of potential barriers could be justified where they are clearly impediments to movements of lamprey or other native species, but we believe priorities should focus on securing or expanding habitats that lamprey currently live in rather than on the creation or restoration of areas that have not supported lamprey in recent years. That objective can come later, as we learn more.

The activity, "assess impacts of irrigation screens and tributary blockages and make improvements", could provide significant benefits over a relatively short time frame. The engineering problems presented by the need to exclude juvenile lamprey as well as juvenile salmon from irrigation diversions should be tractable, and studies to evaluate the magnitude of the problem and develop new screen designs have already begun. We encourage a focus on screen development and demonstration of both salmon and lamprey passage effectiveness before a wide ranging program of retrofitting existing screens is undertaken.

- Sub-objective B: Tributary Habitat

The Plan proposes substantial work to restore habitat. The Tributary Action Plans summarize very general guidance by tribal areas and subbasins. The most specific guidance includes actions such as restoration of riparian vegetation and stream banks (Warm Springs); implementation of lamprey specific habitat restoration (Willamette); enhance stream and floodplain habitat throughout subbasins (Umatilla); assess habitat and restore target areas (Nez Perce); and implement and evaluate restoration projects with respect to changes in habitat characteristics, habitat use and productivity (Yakima). By far the most common direction is to improve knowledge by (1) identifying limiting factors, important habitat, and patterns of use and (2) by documenting and monitoring population distributions and abundances.

The similar and very general actions proposed in each tribal area and subbasin suggest that there remains no clear understanding of the most important limiting factors in habitat beyond obviously important barriers to migratory passage. There is undoubtedly important local knowledge of habitat characteristics that influence lamprey distribution and habitat use. For example, Hyatt et al., (2007; cited in the Plan) associated lamprey occurrence with lateral scour pools and watersheds with generally good or excellent habitat conditions. This association suggests that broad features of habitat that constrain salmonids, and tributary stream communities in general, also constrain lamprey. Until

more detailed information can be developed, the logical priority would be to focus on restoration activities already targeted for salmon and other species which overlap production areas also known to be important for lamprey, and to focus on restoration of watershed processes potentially benefiting whole communities. It would be useful to initiate some pilot habitat restoration work to refine or test specific hypotheses about lamprey habitat use and limitation.

The Plan's strong emphasis to develop better knowledge regarding limiting factors in tributary habitats and to refine methods for monitoring and evaluation of status and distribution is important, and these remain very challenging issues. We agree with recent ISRP reviews of proposed lamprey work in tributary habitats that the critical first step is development of effective sampling methods and sampling designs associated with specific questions about lamprey status, habitat use and long-term trends. Considerable effort has been devoted to sampling of lamprey throughout the basin. Hyatt et al. (2007; cited in the Plan), for example, summarize extensive electrofishing and some screw trap sampling in the Clearwater and Salmon River basins, for example. They also provide important information about the occurrence of lamprey at sampling sites replicated across time. Despite their acknowledgement that environmental variability makes the detection of any trends difficult they conclude that lamprey are extinct in some habitats. They fail to consider, however, the limitations of sampling efficiency and bias that are often problematic for rare or patchily distributed species, particularly across a substantial range in habitat characteristics such as stream-river size. Problems of strong variation in detection efficiency with stream size, discharge, temperature, and sampling methods could seriously limit the utility of such information.

A broad synthesis of tributary sampling results from various studies and a critical evaluation of the common or suspected limitations of ongoing sampling are not yet available. Mesa et al. (2007b, cited in the plan) propose to summarize existing data available across the basin and develop standardized sampling methods. A project like that proposed by Mesa et al., and the continuation of the Lamprey Technical Work Group, could provide an important mechanism for and coordination of a critical review.

Logical steps might include the following: (1) a synthesis and review of existing sampling methods focused on identifying or resolving critical uncertainties in sampling and methodological problems, this should include a critical evaluation of the efficiency and bias associated with traditional methods to help resolve where and when those methods can provide useful information; (2) a summary of all available occurrence information to explore broad patterns in distribution and develop new insights into important environmental gradients or habitat associations across a range of scales; (3) use of that information to refine monitoring and inventory, guide research into new methods, and focus hypotheses regarding habitat limitation for further research.

There are undoubtedly important opportunities for continued work on lamprey across each area and subbasin, but it may be particularly useful to focus development of methodology in one or a few areas where lamprey are still relatively abundant. It would make more sense to invest heavily in the development of methods, sampling design and

effective inventory, and supportable fine- to broad-scale habitat association information, before investing in extensive restoration efforts (with the exception of passage restoration) specifically to benefit lamprey.

Objective 3: Supplement lamprey by reintroducing and translocation in areas where they are severely depressed or extirpated

Without a clear understanding of factors affecting the declines of lamprey, and no identification and implementation of actions to improve survival (i.e., improving conditions that lead to declines in the first place), it is difficult to see how translocation, per se, could be of great value in population recovery. Luzier et al. (2009) concluded, "whether or not adult Pacific lampreys home to their natal streams or are attracted by larval pheromones is unknown. The lack of this critical information makes translocation a potential threat to Pacific lamprey populations." Although some juvenile lamprey have been produced by translocation of spawning adults to a stream in the Umatilla Basin (Plan appendix page xi), results are preliminary and have not been published.

Since passage and dam-to-dam survival are viewed as the dominant issues, perhaps emphasis should be placed on them, rather than the translocation of fish to habitats above several dams. Even if the translocated adults spawn successfully, and even if the juveniles survive well in upstream habitats, they still have to migrate downstream and later upstream again as adults to contribute to population viability. Translocation might well improve viability at such (future) time as the passage problems have been surmounted.

We are still unclear whether or not lamprey exist as locally adapted stocks in the Columbia River Basin. Considering basic evolutionary biology, it is unlikely that there is *no* adaptively relevant biogeographic variation within a fish species occupying a dendritic habitat over the geographic scale of the Columbia River Basin. It is also unlikely that the species would have no ability to track its best environmental options. Adequate genetic markers would allow us to determine whether or not they do home on the natal location, given a choice. If upriver fish from different subbasins are genetically homogeneous, then selected translocation efforts, using known sources of migrants could be timely. On the other hand, if there really is genetic stock structure, then the dam passage issues should have precedence at this time. Lin et al. (2007, cited as in review on page 14 in the Plan, but now published, see Additional References, p. 19) indicates that there is, "no clear pattern of geographical structure within the Northwest" (based on genetic sampling which included the Columbia River Basin). George et al. (2009) recently provided a set of guidelines for propagation and translocation for conservation of freshwater fish. Pending greater clarity on this issue, however (and it needs a lot more work), it would be useful to compare these guidelines with the regionally established lamprey translocation guidelines mentioned in the Plan (page 51).

For these reasons, and as noted in previous reports (ISAB 2003-3; ISRP/ISAB 2005-15; ISRP 2000-4[3]), the ISAB and ISRP have concluded that supplementation (including translocation or other aquaculture or hatchery introduction-type programs) should at this time be regarded only as experimental. They should be done with a clear experimental design and evaluation protocol using local populations. Although the first two reports mentioned above deal with salmon, many of the principles and issues discussed also apply to Pacific lamprey. Because the extent of homing, genetic structure, and ecological role of Pacific lamprey in specific subbasins are poorly understood, even experimental translocation efforts for this species need to be approached with caution. If experimental translocation/reintroduction activities are undertaken without essential supporting data, the Plan should provide much greater planning, monitoring, and evaluation of any such activities.

Should translocation experiments be conducted within the Plan, CRITFC should also integrate knowledge from recent studies on pheromones into the process. Although the authors identify the use of pheromones by lamprey in reaching spawning sites, they do not mention key references on the nature, usefulness, and potential of these pheromones. In particular, the work of P. W. Sorensen at the University of Minnesota seems relevant and worth reviewing carefully but is not indicated in the Plan. Fine et al. (2004) identified a migratory pheromone that was partially composed of bile acids. They concluded that, "production and release of PS (petromyzonol sulfate) and ACA (allo-cholic acid) by larval sea lamprey is not a specialized trait (i.e., not unique to that species), but rather one common to many, and perhaps all, members of the family Petromyzontidae" (pp 2104-2105). Sorensen et al. (2005) followed this work and concluded that stream-dwelling sea lamprey larval release a, "multicomponent steroidal pheromone (PS being one component) that, 'guides adults to spawning streams.'" (p. 1).

It would be useful if the two proposed translocation programs outlined (Nez Perce and Umatilla) indicated how this pheromone work might be used in translocation and reintroduction decisions. For example, it may be possible to use such pheromones to attract and direct pre-spawning fish to streams, habitats within streams, or areas of defined high quality spawning/rearing habitat. A relevant question then would become how to assess and identify "good" spawning and rearing habitats in basins where lamprey no longer exist. Regional lamprey researchers have had limited success investigating pheromones to guide adult lamprey into passage structures at dams, but so far the work has been in the laboratory, and Moser (2009) states that much work is required before the technology is ready for field implementation.

It might also be worth finding out whether such a sea lamprey pheromone is available in sufficient quantities to be practically useful for restoration of Pacific lamprey. For example, are such pheromones manufactured, synthesized, or produced from sea lamprey, and is it economical to do so?

[3] Also see the Confederated Tribes of Umatilla Indian Reservation's Pacific Lamprey Research and Restoration project (199402600):
FY 2007-09 – www.cbfwa.org/solicitation/components/forms/Proposal.cfm?PropID=815;
FY 2002 – www.cbfwa.org/FWProgram/ResultProposal.cfm?PPID=CP2002199402600

Page 49: The text beginning with "Cummings (2007)" et seq. appears twice on that page.

Objective 4: Status Monitoring and Research

- Sub-objective A: Status Monitoring

Focused M&E is required to address key uncertainties and needs to be coordinated with any initial actions. This will require a carefully targeted set of initial and long-term objectives, along with a clear evaluation plan. The ISAB strongly supports the incorporation of an adaptive management framework into the Plan (p. 56).

The ISAB recommends, as a reference, Luzier et al. (2009) (Proceedings of the Pacific Lamprey Conservation Initiative Work Session). This was a conference convened to "bring managers and scientists with various skills together to facilitate communication on the current status and ongoing efforts to conserve Pacific lamprey… and to begin development of a collaborative, range-wide Conservation Plan." Neither the workshop outcomes nor RM&E needs identified at that workshop seem to be included in the Plan. The workshop report is not referenced in the Plan, but the report is a valuable source document for ideas and for justifying suggested RM&E in it. Research needs are listed on page 12 of Luzier et al. (2009).

The ISAB agrees that research, monitoring, and evaluation are in the early stages of development for Pacific lamprey in the Columbia Basin. This realization provides an opportunity to learn from lessons taught by years of salmonid RM&E efforts. For example, the lamprey groups in the Basin need to coordinate their research and monitoring more effectively, much as have been done for salmonids and sturgeon.

A primary need is for more effective methods of trapping downstream migrants. It could be very useful to work closely with manufacturers to try to improve the design of the screw traps to retain lamprey ammocoetes and macrophthalmia. Screw traps are believed to be less damaging than electrofishing for other species, and that may well be the case for lamprey. More meaningful tributary sampling and monitoring should be possible once trap retention is improved. Monitoring effort in the lower Columbia River and Estuary might be increased by capitalizing on trawl surveys for PIT-tagged salmon – Beamish and Levings (1991; cited in the Plan) used 3 mm codend mesh in trawl surveys on the lower Fraser River. The method seemed to be effective for juvenile lamprey. If the salmon trawl cannot be used as it is, a small mesh "trouser" could be added to the codend.

The validation and verification of statoliths, or other aging methods, should also be considered a high priority. It does not appear that much has been done with statoliths in the Columbia River Basin, although Meeuwig and Bayer (2005) have provided a good start with their work on larval lamprey from the river. A good source in the Great Lakes for age determination efforts in sea lampreys is www.glfc.int/research/scr.php. There is a list of papers at that site related to age estimation methods. Age determination methods

for Pacific lampreys developed by Beamish, as well as other relevant life history information are available at this site: www.criticalimprov.com/index.php/gir/article/viewArticle/61/127.

Protocols for sampling juvenile lampreys in streams should consider the use of the EMAP protocols for stream surveys (ISRP 2009-45) as well as the sampling efficiencies and potential for bias across methods and environmental gradients.

Cowx et al. (2009) present a possible scheme for setting abundance performance standards for lamprey conservation projects. They also present a large scale quadrat sampling method if electrofishing is to be used for enumerating juvenile lamprey.

The Plan proposes to build a data management system to make all key monitoring data on the health, abundance and distribution of lamprey populations compatible, regardless of origin. Collaboration with all cooperating tribes and agencies is envisioned, but no details are provided to suggest how this will be accomplished. The ISAB suggests that lamprey data management systems take advantage of current data management systems in the region, whenever possible, to make the lamprey system as effective and efficient as possible.

- Sub-objective B: Research

It will be critical to evaluate the contaminant loads of Pacific lamprey at various life stages as well as at various locations in the Columbia River Basin. Due to their usually high fat content and their modes of feeding, there is a strong possibility that they may bioaccumulate contaminants to a greater degree than other fish species. Additional suggestions for this high priority research area are given below.

The Plan calls for research into the genetic makeup of Pacific lamprey, with a goal of maintaining genetic integrity of the populations. The ISAB strongly agrees with this recommendation in principle. However, the Plan does not provide enough details concerning methods to be used, sample size considerations, and spatial distribution of efforts to allow an effective evaluation at this time.

The ISAB is concerned that the narrative in the Plan suggests a commitment to an aquaculture facility. A research focus to develop technology for establishment of a lamprey aquaculture facility seems premature. There are too many unknowns to actively pursue an aquaculture facility at this time. Other priorities are more pressing.

The Plan calls for investigation of estuary and ocean life history for Pacific lamprey, to shed some badly needed light on a critical uncertainty with respect to restoration. The ISAB agrees that development of tagging systems to track juvenile lamprey in the estuary and near ocean environment are essential, but not enough details are provided in the Plan to evaluate the scientific merit of this particular investigation.

Comparative studies are needed to help interpret the lamprey population data. Such an approach could strengthen the interpretation of the limited data on Pacific lamprey and might help to better reveal and justify good initial steps in a restoration plan.

Anadromous river lamprey (*Lampetra ayresi*) are also found in the Columbia River system. What is known about their status, compared with that of Pacific lamprey? They are found in the plume. Also, are brook lamprey (*Lampetra richardsoni*), a non-anadromous species, declining too? As mentioned in a presentation to the ISAB by CRITFC, the ammocoetes of all three species are difficult to distinguish, indicating an urgent need to develop genetic methods such as bar coding as an alternative to standard taxonomic procedures. Within each species, it may also be possible to find genetic markers that will allow identification of stock and geographic differences.

Can we identify ocean versus freshwater factors affecting abundance of lamprey? There are no good time series of data (as far as is known) on ocean catches. However, the spawning biomass of one of their primary host fishes, Pacific hake, has declined since the 1970s and 1980s, and interestingly had a minor peak in 2002-2006, some of the same years in which counts of lamprey increased at Bonneville. How important is availability of marine hosts to adult run sizes? Recent papers describing lamprey bites on salmon in the Columbia River estuary, the north Pacific Ocean, and the distribution of lamprey around the North Pacific (including off the Oregon coast) may be informative (Pelenev et al. 2008; Orlov et al. 2008; Weitkamp; cited above).

The marine phase is a major portion of the Pacific lamprey's life history, and the only phase shared by many of the apparently declining populations in the Pacific Northwest. Are these trends in abundances related to ocean conditions and prey availability? For example, it is suggestive that dam counts of lamprey in the Columbia River and at Winchester, the only mainstem dam on the Umpqua River, (Geyer, 2003; Fig 3-12), were high in the 1960s and early 1970s, a period of relatively cool and productive ocean conditions, and lower in more recent years. What are the ages and sizes of returning adults? Are there diseases, parasites or contaminants that could be affecting ocean or freshwater survival?

Predation in the ocean and estuaries may also be a factor for long term lamprey declines and warrants further investigation. Lamprey have been reported by Stansell et al. (2009) to be the second most common prey in California Sea lions at the Bonneville dam tailrace. Roffe (1980) found that lamprey was the most common prey in the diets of both California sea lions and harbor seals in the Rogue River and estuary. It is worth noting that the populations of sea lions and harbor seals in the Columbia River estuary have increased significantly in the past 30 years (NOAA, 1997; ISAB in preparation).

Habitat preferences in fresh water require more study. Abundance and distribution of juvenile lamprey in reservoirs should be investigated, although this may require specialized sampling gear. Stream mouths might be good locations to sample. Increased reservoir (and river) temperatures, owing to climate change, could affect growth and survival of the juvenile forms, as well as the maturation rate of adult lampreys.

Objective 5: Public Education

The Plan lacks sufficient indication of specific actions to achieve Objective 5. This objective is to establish coordinated public education and other outreach programs to communicate and establish: (1) an awareness of the importance of the Pacific lamprey and their current status; (2) the need to implement action in this plan to restore them throughout the Columbia River Basin; and (3) the consequence of failing to act.

See other comments under Cultural Context.

Objective 6: Evaluate and Reduce Contaminant Accumulation in Lamprey

In view of the freshwater life history of lamprey, and increasing concerns about the modern chemicals and emerging contaminants being discharged into the Columbia River Basin, the ISAB wishes to emphasize the potential implications of contaminants in lamprey both for lamprey restoration and human health. Contaminant studies must be within the scope of this investigation as the fish are subjected to considerable exposure in their rearing habitats. The analyses of a few adult lampreys and eggs from ovaries for a series of contaminants will provide some information on contaminants arriving from the ocean. Then, evaluating ammocoetes of various sizes for selected contaminant residues, and brain cholinesterase activity (for the cholinesterase inhibiting contaminants) will quickly provide a measure of exposure. The brain studies will need control (reference) values from an uncontaminated location for comparisons. (See also ISRP 2009-45). These studies may require (and could profit from) partnering with aquatic toxicology scientists at USGS, NOAA, or EPA. The recent article on contaminants in European eels (Geeraerts and Belpaire 2009) is also informative for a glimpse of potential problems for lamprey, although we acknowledge the significant differences between Pacific lamprey and European eel.

Additionally, efforts should be made to determine contaminant loads associated with the habitats of juveniles. The Pacific lamprey has the potential to become an “early warning” for alerting the public to the dangers of toxins in the environments, especially those toxins that are lipophilic. The contaminant evaluations being conducted at present will be critical in setting the monitoring and research agenda on this subject for the near future.

Plan References

The references need to be checked thoroughly to improve the scientific credibility of the Plan. Some are cited but not referenced fully (e.g., ISAB 2008). In all cases, a source (e.g., publisher location and/or website) needs to be provided. If a paper mentioned as “in press” or “in review” is now available, a full citation should be given.

Plan Appendix - Tribal Action Plans

- Warm Springs Tribes' Tributary Action Plans

The words "goal", "objective", and "action" are not used consistently within this section or the appendix generally. Although a semantic issue, it contributes to confusion and undermines strategic thinking about the problem (see overall comments). For example, seven "actions" are listed as needed in the Willamette Basin, but the first ("sustainable harvestable levels") is not an action, and some of the others seem more like objectives. Six "goals" are listed in the next section (Deschutes River) and a number of "objectives" are listed separately in the following sections (John Day, Hood River and Fifteen mile Creek). Why these lists should be so different among subbasins (disregarding for the moment whether the items listed are called objectives or actions) is unexplained and confusing. It seems better to first describe the overall strategy that applies to all the sub-basins, and then to explain any differences among subbasins, either in objectives or opportunities for action. The current repetitious format also limits the amount of detail that can be provided, so that the action plans remain vague. In other words, an opportunity for richer content may be wasted.

In all the tables between pages iv and xxix, the column headings "Action" and "Objective" seem to be reversed. For example, "Status" and "Biology/Life History" are not actions. Moreover, the tables are typically completed separately for each subbasin, which renders the location column useless (every entry is "subbasin wide"). Again it would be more efficient and informative to present a single large table outlining a complete (potential) plan for the whole basin, and to use the location column to highlight differences among subbasins in the actions that are actually being proposed.

- Umatilla Tribes' Tributary Action Plans (xi)

The Confederated Tribes of the Umatilla Indian Reservation (CTUIR) plans seem to have a goal to, "restore lamprey to harvestable self-sustaining levels within the basin" (i.e., for Walla Walla, John Day, Grande Ronde and Tucannon) but "continue" to do so on the Umatilla. All the other components are RM&E components. In general, both the actions and goals are very general, and there is much duplication. More specificity is needed.

In the Appendix to the Plan (p. xi) it is stated that CTUIR was, "the first to restore lamprey into a Columbia River tributary using adult transplantation." The Plan's credibility would be improved if these data were published.

- Nez Perce Tribe Tributary Action Plans

Fourth paragraph, page xvi states an objective to annually translocate adult lamprey from the Mainstem Columbia into five or six Snake Basin tributaries, but nine are listed in the following table. That needs clarification.

Second paragraph, page xvii does not provide any detail on how monitoring sites would be selected. The ISRP has previously noted this concern (ISRP 2009-24, ISRP 2009-45).

Note previous comments about column headings in tables, and the inefficient use of tables when completed individually for each subbasin.

- Yakama Nation Tributary Action Plans (xxii)

The ISAB suggests that data from Yakama Nation streams could be useful for an interbasin comparison of lamprey ecology.

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