Columbia River Basin Lamprey Technical Workgroup
Columbia Basin Fish and Wildlife Authority
2501 SW 1st Avenue Suite 200
Portland, OR 97201
columbiariver.fws.gov/lamprey.htm

DRAFT

Critical Uncertainties for Lamprey in the Columbia River Basin: Results from a strategic planning retreat of the Columbia River Lamprey Technical Workgroup

March 17, 2005

Workgroup Coordinator:

Jen Stone, U. S. Fish and Wildlife Service

Workgroup Members:

Abel Brumo, Oregon State University
Christopher Claire, Idaho Fish and Game
Mike Clement, Grant County Public Utility District
David Clugston/Derek Fryer, U. S. Army Corps of Engineers
Debbie Docherty, Bonneville Power Administration
Dan Domina, Portland General Electric
Mark Fritsch, Northwest Power and Conservation Council
Jen Graham, Confederated Tribes of the Warm Springs Reservation of Oregon
Mike Gray, Coast Lamprey Interest Group Liaison
Molly Hallock, Washington Department of Fish and Wildlife
Doug Hatch, Columbia River Inter-Tribal Fish Commission
Jeanette Howard, Confederated Tribes of the Umatilla Indian Reservation
Tom Iverson, Columbia Basin Fish and Wildlife Authority
Bao Lê, Douglas County Public Utility District
Sam Lohr, U. S. Fish and Wildlife Service
Matt Mesa, U. S. Geological Survey
Mary Moser, NOAA Fisheries
Russell Moursund, Pacific Northwest National Laboratory
Chuck Peven, Chelan County Public Utility District
Dave Ward, Oregon Department of Fish and Wildlife

Facilitated by Donna Silverburg, DS Consulting

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Purpose

The purpose of this document is to report the results of a process used by the Columbia River Basin Lamprey Technical Workgroup (Workgroup) to determine and prioritize the critical uncertainties for Columbia River Basin (CRB) lamprey species. These species are: Pacific lamprey (*Lampetra tridentata*), river lamprey (*L. ayresi*), and western brook lamprey (*L. richardsoni*). This document describes the methods used to generate and prioritize the list of critical uncertainties and provides recommendations for how the results should be used. Additionally, this document contains key strategies to address each critical uncertainty.

This document is intended to guide lamprey conservation, management, research, and funding decisions in the CRB. The Workgroup provides technical recommendations regarding the information and actions needed to conserve CRB lamprey in a prioritized and consistent manner. The Workgroup supports using the methods described here to prioritize any new actions in the CRB and acknowledges that any strategies not identified in this report may still have specific importance.

Section I: Identifying and prioritizing the critical uncertainties for lamprey in the CRB

Background

As part of a 1995 Northwest Power and Conservation Council action, the Workgroup was established to serve and guide coordination activities for new and existing lamprey projects and other key issues regarding these species. The Workgroup met as necessary to provide guidance to Bonneville Power Administration (BPA) for project funding. In November 2003, the Workgroup was officially established under the Anadromous Fish Committee of the Columbia Basin Fish and Wildlife Authority (CBFWA). The Workgroup is currently composed of technical representatives from agencies, tribes, educational institutions, and industry within the CRB. The Workgroup formally adopted a Statement of Purpose in December 2003 to:

1. Identify critical uncertainties regarding lamprey conservation: Members of the Workgroup will establish lamprey research, monitoring, and evaluation needs.
2. Prioritize research: Members of the Workgroup will review new proposals and existing projects.
3. Disseminate technical information: The Workgroup will act as a focal point for disseminating technical information and providing guidance on lamprey issues.

The Workgroup's first action in 2004 was to update the 2002 Columbia River Lamprey Program Summary. Only the Critical Uncertainties, Reports and Publications, and Project Tables portions of the document were updated. The critical uncertainties were not prioritized at that time.

On August 25, 2004 the U. S. Fish and Wildlife Service (USFWS) requested that the Workgroup provide recommendations to prioritize the information most needed to assist in lamprey conservation. A Lamprey Summit (http://www.critfc.org/wana/lamprey.html) was held in Portland, Oregon on October 22 to gather regional support for lamprey conservation. At the Lamprey Summit, panelists expressed support for a technical workgroup to clearly describe the state of the knowledge about lamprey, identify gaps in knowledge, and prioritize needed research. Following the Lamprey Summit, several agencies, including the Columbia River Inter-Tribal Fish Commission (CRITFC), requested that the Workgroup continue to develop guidance for regional lamprey conservation.

Requests to Workgroup:

"…I would like to formally request that the Lamprey Technical Workgroup prioritize, from a technical perspective, what information is most needed to assist or inform in lamprey conservation. In addition any assistance in helping prioritize the most significant threats to the continued existence of lamprey would be useful to us. While we are most interested in Pacific lamprey for the Summit, we would appreciate your efforts on river and western brook lamprey as well…"

Vicki Finn, USFWS

"…The tribes are looking to the Technical Work Group to provide recommendations on lamprey conservation to policy makers. Our understanding is that the Technical Work Group is meeting on December 1 and 2. The tribes hope that the Technical Work Group will be able to provide a recommended list of prioritized projects, which includes a brief description of the project and how it fits in a regional conservation plan, budgets, and timelines. The Technical Work Group should also identify data gaps and technical uncertainties. The tribes see, among other things, a need for basic abundance, distribution and population structure information…"

Olney Patt, Jr, CRITFC

Process

The Workgroup met on December 1-2, 2004 in Stevenson, WA at a facilitated retreat sponsored by BPA and CBFWA. The purpose of the retreat was to 1) refine and agree on the list of critical uncertainties, 2) develop a process for prioritizing the list, 3) prioritize the list, 4) define how the list should be interpreted and used, and 5) establish and strengthen professional connections that would support on-going, successful efforts of the Workgroup.

Vision

The Workgroup began their efforts at the retreat by agreeing on five-, ten-, and twenty-year vision for lamprey conservation in the CRB. This was important to establish the context for prioritizing uncertainties. As actions are implemented and the knowledge base grows, the priorities may change over time. The Workgroup agreed that the current prioritized list of uncertainties specifically addresses lamprey conservation over the next five years (2005-2010).

Five Years:

- Better understanding of status, distribution, and genetic structure
- Development of standardized sampling and monitoring methods
- Comprehensive summary of historical data
- Coordinated lamprey management plans
- CRB lamprey conservation plan

The Workgroup offers to review lamprey management plans for regional consistency. These plans should be integrated into an adaptive conservation plan that provides feedback for future planning efforts. All actions should include education and outreach components to help transfer knowledge regarding lamprey conservation to the public.

Ten Years:

- Understanding of stock structure and population delineation
- Established conservation goals and objectives for populations
- Assessment of the effectiveness of management and conservation efforts
- Updated CRB lamprey conservation plan

Twenty Years:

- Achieved conservation goals and objectives

- Continued implementation of adaptive management and conservation actions

Refined List of Critical Uncertainties

The Workgroup spent considerable time refining the list of critical uncertainties provided in the 2004 Updated Lamprey Program Summary. The Workgroup strongly emphasized that the resulting list did not represent all the uncertainties and potential issues related to lamprey conservation in the CRB; however, the most critical uncertainties were prioritized. The Workgroup recognized that addressing all of the critical uncertainties below is essential at this time.

The Workgroup generated two separate prioritized lists of critical uncertainties; one for anadromous species (Pacific lamprey and river lamprey) and one for resident species (western brook lamprey). The lists included:

- Lamprey Status
- Biology/Ecology
- Population Delineation
- Passage
- Population Dynamics (predictive analysis)
- Limiting Factor Analysis
- Restoration Activities

Prioritizing the Critical Uncertainties

Methods

The framework used by the Workgroup to prioritize the list of critical uncertainties was based on an approach developed during the subbasin planning process for the Entiat Subbasin Plan[1]. The critical uncertainties were ranked by the potential biological benefit and the level of knowledge that exists for each uncertainty.

The biological benefit was defined as "The degree to which gaining the information/response from the critical uncertainty will benefit the species", where 5 equaled a high benefit and 1 equaled a low or no benefit. The knowledge gap was defined as "The level of current knowledge regarding each critical uncertainty", where 5 equaled very little knowledge and 1 equaled extensive knowledge.

The first steps in prioritizing the list of critical uncertainties were to assign numeric values to the biological benefit and knowledge gap for each critical uncertainty by consensus of the Workgroup. This exercise was performed for anadromous and resident categories separately.

[1] Peven, C. M. 2004. Prioritization framework for strategies under the Entiat Subbasin Plan. Submitted to Northwest Power and Conservation Council during the second phase of the subbasin planning effort.

The next step in prioritizing the critical uncertainties was to sort the two lists by each critical uncertainties' biological benefit. Knowledge gap scores were not ranked and were only used to break ties. Remaining ties were discussed and decisions to rank one over the other were made by Workgroup consensus. The Workgroup relied on best professional judgment of everyone present to place uncertainties into four priority categories:

Category	**Biological Benefit**	**Definition**
Imminent	4.5 – 5.0	Addressing these uncertainties immediately is imperative. Lack of addressing these uncertainties will likely result in further and considerable detrimental impacts on lamprey populations.
Highly Important	4.0 – 4.5	Addressing these uncertainties is a high priority. Lack of addressing these uncertainties will likely preclude restoration and enhancement of lamprey populations.
Important	3.0 – 3.5	Addressing these uncertainties is important, but less so than those considered imminent or highly important. Lack of addressing these uncertainties will likely limit opportunities for restoration and enhancement of lamprey populations.
Needed	<3	Although critical, lack of addressing these uncertainties is unlikely to limit or preclude opportunities for restoration and enhancement of lamprey populations. These uncertainties should be addressed, but under a limited budget this could be delayed temporarily without significant loss.

As a final step, the Workgroup developed specific strategies to articulate the actions necessary to address each critical uncertainty. Sections II and III of this report provide explanations of each critical uncertainty with examples of strategies.

Results and Conclusions

Although rankings differed between resident and anadromous forms, the critical uncertainties were distributed among the four categories (Tables 1 and 2). The Workgroup affirmed that even those uncertainties that were categorized as "needed" are still very critical to lamprey conservation.

Table 1. Prioritized critical uncertainties for anadromous lamprey in the CRB.

Ranking	Critical Need	Category
1	Lamprey Status	Imminent
2	Passage	Imminent
3	Population Delineation	Highly Important
4	Limiting Factor Analysis	Highly Important
5	Restoration Activities	Important
6	Biology/Ecology	Important
7	Population Dynamics (Predictive Analyses)	Needed

Table 2. Prioritized critical uncertainties for resident lamprey in the CRB. Passage was included as a component of Limiting Factors.

Ranking	Critical Need	Category
1	Lamprey Status	Imminent
2	Restoration Activities	Imminent
3	Biology/Ecology	Important
4	Limiting Factor Analysis	Important
5	Population Dynamics (Predictive Analyses)	Needed
6	Population Delineation	Needed

The Workgroup recommends that management and funding agencies refer to Section II of this report to develop CRB lamprey conservation strategies, requests for proposals, and initial project review criteria. There was also strong consensus among Workgroup members that future actions should include an education and outreach component.

Section II: Suggested strategies to address the prioritized critical uncertainties for anadromous lamprey in the CRB

Background

The Workgroup developed strategies to address each critical uncertainty for anadromous species. Individual strategies are not prioritized and should not be considered inclusive.

Anadromous Lamprey Status

Ranking: Imminent (Biological Benefit = 4.5; Knowledge Gap = 3)

Justification: Until more is understood about the status of anadromous lamprey species it will be difficult to evaluate the relative importance of management actions. The USFWS recently determined that a petition to list four species of lamprey does not contain sufficient information to warrant further review because "little detailed information is known about these species…we are asking interested parties to continue to gather data and conduct research that will enhance the understanding of lampreys and the nature of their conservation needs".

One suggestion of the Workgroup is that a cohesive adaptive management plan for lamprey is developed within the next five years. This will require a better understanding of distribution and abundance. For anadromous lamprey, it will also require a better understanding of population structure.

Strategies:

- Develop methods to differentiate among species at all life stages (field-based)
- Develop standardized sampling protocols and conduct systematic basin-wide surveys to assess adult and juvenile abundance and distribution
- Review historic databases to better understand historic distributions and abundance
- Define, improve, and continue historic distribution and abundance indices (e.g., dam counts, tribal harvest records, smolt trap collections, etc)
- Coordinate information exchange with existing and future projects not targeting lamprey specifically

Anadromous Lamprey Passage

Ranking: Imminent (Biological Benefit = 4.5; Knowledge Gap = 3)

Justification: Anadromous lamprey actively migrate from estuarine and marine waters to freshwater spawning areas as adults. Upon metamorphosis, juveniles participate in both active and passive emigration from freshwater rearing areas. In the CRB, lampreys may migrate hundreds of kilometers through both mainstem and tributary habitats. Consequently, they encounter a variety of obstacles to passage that could negatively affect their populations. Recent research has indicated that large hydropower dams delay and obstruct adult passage. These facilities may also delay, obstruct, injure, or kill juveniles. Because mainstem hydropower dams can negatively affect all populations that

spawn upstream from them, tasks associated with providing safe passage at these facilities are a high priority. The effects of low-head structures (e.g., culverts, irrigation diversion dams, and weirs) and other potential barriers to passage (e.g., thermal or contaminant plumes, dewatering) are largely unknown but may also significantly limit lamprey population growth. When an obstacle is identified, its effects on all life stages should be considered. The priority of subsequent actions should reflect the relative effects of the structure on each life stage.

Strategies:

- Identify potential obstacles to passage (e.g., loss of recruitment upstream from a potential obstacle, observation of lamprey aggregations or mortalities at potential obstacles during migration periods)
- Assess passage efficiency, direct mortality, and/or other metrics that relate to loss of fitness (i.e., stresses or injuries that reduce ability to reproduce)
- Determine the specific structures or operations that delay, obstruct, or kill migrating lamprey
- Develop aids to passage (e.g., modify structures or operations, provide lamprey-specific fishways, or bypasses)
- Monitor lamprey passage to evaluate aids to passage and to identify any new passage problems that might occur

Anadromous Lamprey Population Delineation

Ranking: Highly Important (Biological Benefit = 4; Knowledge Gap = 4.5)

Justification: Understanding population delineation and structure is important for management and conservation of anadromous lamprey. This information will be paramount in developing the scope of restoration and conservation programs. Some preliminary genetic analysis has been attempted with Pacific lamprey with little success. We envision building on this effort to specifically delineate CRB population structure. Protein electrophoresis has yielded no discriminating data. Existing genetic markers, developed primarily for salmonids, yield little to no variation in lamprey. Therefore, genetic markers and potentially other methods specific to lamprey must be developed. After these tools are developed they need to be applied to better understand homing, population delineation, and population structure.

Strategies:

- Supplement existing libraries of genetic markers for lamprey (e.g., microsatellites, single nucleotide polymorphisms)
- Build and maintain lamprey tissue collections from the CRB and neighboring basins
- Investigate other methods to delineate populations

- Determine if anadromous lamprey in the CRB represent a panmictic population (completely mixed)

Anadromous Lamprey Limiting Factors

Ranking: Highly Important (Biological Benefit = 4; Knowledge Gap = 4)

Justification: Documenting potential factors limiting the growth of lamprey populations will be critical to continuing conservation efforts. Knowledge of limiting factors will identify problem areas that can be targeted for mitigation or corrective actions.

Strategies:

- Document habitat preferences and habitat availability for all life stages of anadromous lamprey
- Evaluate the physiological and behavioral responses of lamprey to a variety of environmental stressors (e.g., capture and handling, elevated temperatures, contaminant exposure, sedimentation)
- Assess trophic relationships (e.g., predation by exotics, reduced host availability)

Anadromous Lamprey Restoration

Ranking: Important (Biological Benefit = 3.5; Knowledge Gap = 3)

Justification: The apparent declining trend in abundance of anadromous lamprey has highlighted the need for restoration activities. The intent of implementing restoration activities is to improve the status and likelihood of long-term persistence of anadromous lamprey.

Strategies:

- Identify ongoing restoration activities and their effects on lamprey
- Develop, implement, and evaluate lamprey-specific restoration projects (restoring natural processes in the absence of information on limiting factors)
- Develop, implement, and monitor reintroduction methods (e.g., transplantation, hatchery production)

Anadromous Lamprey Biology/Ecology

Ranking: Important (Biological Benefit = 3; Knowledge Gap = 4)

Justification: Identifying the biological and ecological processes of CRB lamprey populations is critically important in guiding many of the other critical uncertainties. Currently, there is a modest quantity of sound biological/ecological information pertaining to the life-history of Pacific lamprey outside of the CRB. The knowledge of river lamprey biology/ecology is even more limited.

Strategies:

- Understand the ecological function of anadromous lamprey (e.g., predator/prey relationships, linkages to other aquatic and terrestrial organisms)
- Understand the biology of anadromous lamprey (e.g., reproduction, feeding)
- Develop methodology for gender identification in the field and laboratory (e.g., identify spawning sex ratios, sex related behavioral characteristics).
- Develop aging techniques
- Assess life history characteristics of freshwater and ocean-phase anadromous lamprey (e.g., age, growth, timing of metamorphosis, movement, basin-specific comparisons)

Anadromous Lamprey Population Dynamics

Ranking: Needed (Biological Benefit = 1.5; Knowledge Gap = 5)

Justification: Current knowledge of anadromous lamprey population dynamics (e.g., recruitment and mortality rates) is limited, yet is necessary to fully understand temporal and spatial variations in density and abundance of lamprey populations. Population dynamics can be used to predict the effects of conservation strategies.

Strategies:

- Estimate demographic rate parameters capable of changing the size of populations such as birth, death, immigration, and emigration rates
- Build life tables
- Develop a predictive model to assess the rate of increase/decrease of lamprey populations in the CRB including abiotic and biotic factors

Section III: Suggested strategies to address the prioritized critical uncertainties for resident lamprey in the CRB

Background

The Workgroup has developed strategies to address the critical uncertainties for resident lamprey. Individual strategies are not prioritized and should not be considered inclusive.

Resident Lamprey Status

Ranking: Imminent (Biological Benefit = 4.5; Knowledge Gap = 4.5)

Justification: Even less is known about the status of resident lamprey than about anadromous species. Until more is understood about the status of resident lamprey species it will be difficult to evaluate the relative importance of management actions. The U.S. Fish and Wildlife Service recently determined that a petition to list four species of lamprey does not contain sufficient information to warrant further review because "little detailed information is known about these species…we are asking interested parties to continue to gather data and conduct research that will enhance the understanding of lampreys and the nature of their conservation needs".

One suggestion of the Workgroup is that a cohesive adaptive management plan for lamprey is developed within the next five years. This will require a better understanding of distribution and abundance of resident lamprey. A better understanding of status will lead to a better understanding of the effects of specific restoration activities.

Strategies:

- Develop methods to differentiate among species at all life stages (field-based)
- Develop standardized sampling protocols and conduct systematic basin-wide surveys to assess adult and juvenile abundance and distribution
- Review historic databases to better understand historic distributions and abundance.
- Define, improve, and continue historic distribution and abundance indices (e.g., stream surveys, smolt trap collections, etc)
- Coordinate information exchange with existing and future projects not targeting lamprey specifically

Resident Lamprey Restoration

Ranking: Imminent (Biological Benefit = 4.5; Knowledge Gap = 3)

Justification: Although the status of resident lamprey in the CRB is unknown, the wide-spread extent of aquatic habitat degradation and declines of other fish species implies that the abundance and distribution of resident lamprey has likely declined. The intent of implementing restoration activities is to improve the status and likelihood of long-term persistence of resident lamprey.

Strategies:

- Identify ongoing restoration activities and their effects on lamprey
- Develop, implement, and evaluate lamprey-specific restoration projects (restoring natural processes in the absence of information on limiting factors)
- Develop, implement, and monitor reintroduction methods (e.g., transplantation, hatchery production)

Resident Lamprey Biology/Ecology

Ranking: Important (Biological Benefit = 3; Knowledge Gap = 4.5)

Justification: Identifying the biological and ecological processes of CRB lamprey populations is critically important in guiding many of the other critical uncertainties. There is a limited quantity of sound biological/ecological information pertaining to the life-history of resident lamprey in the CRB. The current thought is that resident lampreys probably exist in isolated populations and may have diverse life history strategies. Consequently, understanding the biology/ecology of fish in different watersheds may preclude generalized management strategies.

Strategies:

- Understand the ecological function of resident lamprey (e.g., predator/prey relationships, linkages to other aquatic and terrestrial organisms, congeneric interactions)
- Understand the biology of resident lamprey (e.g., reproduction, feeding)
- Develop methodology for gender identification in the field and laboratory (e.g., identify spawning sex ratios, sex related behavioral characteristics).
- Develop aging techniques
- Assess life history characteristics of resident lamprey (e.g., age, growth, timing of metamorphosis, movement, basin-specific comparisons)

Resident Lamprey Limiting Factors

Ranking: Important (Biological Benefit = 3; Knowledge Gap = 4)

Justification: Documenting potential factors limiting the growth of lamprey populations will be critical to continuing conservation efforts. Knowledge of limiting factors will identify problem areas that can be targeted for mitigation or corrective actions. Current thought is that resident species have limited home ranges, and thus all life stages may be exposed to and affected by the same limiting factors.

- Document habitat preferences and habitat availability for all life stages of resident lamprey

- Evaluate the physiological and behavioral responses of lamprey to a variety of environmental stressors (e.g., capture and handling, elevated temperatures, contaminant exposure, sedimentation)
- Assess trophic relationships (e.g., predation by exotics, reduced host availability)
- Assess and improve passage for all life stages of lamprey (e.g., mainstream and tributary dams, culverts, irrigation diversion, fish screens, flow and thermal barriers, etc).

Resident Lamprey Population Dynamics

Ranking: Needed (Biological Benefit = 1.5; Knowledge Gap = 5)

Justification: Current knowledge of resident lamprey population dynamics (e.g., recruitment and mortality rates) is limited, yet is necessary to fully understand temporal and spatial variations in density and abundance of lamprey populations. Population dynamics can be used to predict the effects of conservation strategies.

Strategies:

- Estimate demographic rate parameters capable of changing the size of populations such as birth, death, immigration, and emigration rates
- Build life tables
- Develop a predictive model to assess the rate of increase/decrease of lamprey populations in the CRB including abiotic and biotic factors

Resident Lamprey Population Delineation

Ranking: Needed (Biological Benefit = 1.5; Knowledge Gap = 4.5)

Justification: Current thought is that resident lamprey populations are highly structured due to their relatively non-migratory life history. Given this assumption, gaining information on population delineation will have little benefit in guiding near-term management actions. We recognize there is some potential for populations to mix in the lower reaches of watersheds, therefore work may be needed to identify the potential for structure at different scales. This information will be useful in developing the scope of restoration and conservation programs. Some preliminary genetic analysis has been attempted with resident species with limited success. We envision building on this effort to specifically delineate CRB population structure. Genetic markers and potentially other methods specific to lamprey must be developed. After these tools are developed they need to be applied to better understand population delineation and structure.

Strategies:

- Supplement existing libraries of genetic markers for lamprey (e.g., microsatellites, single nucleotide polymorphisms)

- Build and maintain lamprey tissue collections from the CRB and neighboring basins
- Investigate other methods to delineate populations

Appendix 1

Columbia River Basin Lamprey Technical Workgroup
Columbia Basin Fish and Wildlife Authority
2501 SW 1st Avenue Suite 200
Portland, OR 97201
columbiariver.fws.gov/lamprey.htm

March 14, 2005

Memorandum

To: Columbia River Basin Fish and Wildlife Authority, Anadromous Fish Committee
From: Jen Stone, Columbia River Lamprey Technical Workgroup
Subject: Response to AFC concerns regarding Critical Uncertainties document

The Columbia River Lamprey Technical Workgroup (Workgroup) would like to address the concerns of the Columbia River Basin Fish and Wildlife Authority, Anadromous Fish Committee (AFC) regarding the Critical Uncertainties document. The AFC's concerns are italicized and in bold, followed by the response of the Workgroup.

1) Why was population delineation ranked lower than Lamprey status or passage? It appears that in order to address status it would be important to first identify the population structure or at least attempt to address both issues. Population delineation also had a strong influence on the listing decisions for Pacific lamprey. The AFC would like the Workgroup to reconsider the ranking of Population Delineation or give a more detailed explanation of their considerations.

A question was brought up by the AFC concerning the Workgroup's ranking of three anadromous lamprey critical uncertainties, namely "*lamprey status*", "*lamprey passage*", and "*population delineation*". Briefly, the AFC argued that "*population delineation*" was an extremely important uncertainty for lampreys (perhaps the most important?) and they were concerned that the Workgroup ranked it lower than "*lamprey status*" and "*lamprey passage*". For clarification, "*lamprey status*" addresses issues associated with the abundance, distribution, run timing, etc., of lamprey populations; "*lamprey passage*" addresses a variety of passage-related problems for these fish; and "*population delineation*" is primarily concerned with lamprey genetics and stock structure.

The Workgroup spent considerable time and effort prioritizing the critical uncertainties and members agreed that it would be inappropriate to change rankings now. However, further clarification regarding the ranking of these uncertainties may be warranted.

The majority of characteristics (e.g., abundance, distribution, run timing, population trends, density) associated with CRB lamprey "*status*" are unknown. The same can be said for "*population delineation*"—not much is known about lamprey genetic structure. Because of recent work by the USACE and NOAA-Fisheries, more information is available on issues associated with "*lamprey passage*", but much of this is relevant to only lower Columbia River mainstem dams. The main reason "*lamprey status*" and "*lamprey passage*" were ranked higher than "*population delineation*" was because the former critical uncertainties have more immediate near-term management implications. For restoring lamprey populations, information on abundance, distribution, and passage problems is important *now*. For listing lampreys under the ESA, information on genetics of lampreys is important. In our opinion, knowledge of aspects such as population abundance, distribution, run timing, trends, etc., will help identify streams or watersheds where lampreys may be having problems and are in need of immediate assistance—irrespective of information on lamprey genetics. Similar reasoning can be used for lamprey passage: problems with passage (juveniles and adults) comprise a significant limiting factor for lamprey populations and are issues that can be addressed *now*—irrespective of lamprey genetics. Thus, in summary, the Workroup determined that further population declines and decreases in CRB lamprey distribution were fully undesirable conditions relative to lamprey conservation, again irrespective of population structure.

In reality, the issue brought up by the AFC will be minimal since the Workgroup will work to ensure that research addressing "*lamprey status*" and "*population delineation*" will occur simultaneously. It should also be noted that the ranking of uncertainties will likely evolve over time. The vision of the Workgroup is that information on status will be collected in the near term, and that the need for information on population delineation will become imminent.

2) In the section for Anadromous Lamprey Passage, would the group please differentiate between strategies for juvenile and adult passage migration.

In regard to comments received from the AFC on the anadromous lamprey passage strategies, the Workgroup resolved not to specifically prioritize juvenile vs. adult passage needs. This was based on the fact that each structure will potentially have different priorities based on its effects on each life stage. Two sentences were added to the justification section to clarify this point. In addition, Tom Iverson commented that there needed to be more support for the high priority given to this critical need. A sentence was added (in the justification section) to emphasize the fact that most concerns are with mainstem hydropower dams. This is based on the fact that they are known to delay and obstruct adult lamprey and can result in juvenile mortalities as well. Moreover, they potentially affect all upstream populations, regardless of population structure.

3) In the section for Anadromous Lamprey Population Delineation, we believe it would be useful for the group to recommend adding to existing genetic marker libraries (such

as the project Margaret Docker has developed) than developing one from scratch. The AFC would like the Workgroup to consider this change.

The Workgroup agreed and changes were made to the document to address AFC's concerns.

4) It would be helpful if the Workgroup could add a section on how the knowledge gaps were ranked (similar to the table for biological benefits).

Critical Uncertainties were ranked based on Biological Benefit scores. Knowledge Gap scores for each Critical Uncertainty were not ranked, and were used only to break a tie.

The Workgroup has modified the Methods portion of the document to make this portion clearer.

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