United States Department of the Interior

WESTERN FISHERIES RESEARCH CENTER
BIOLOGICAL RESOURCES DIVISION
U.S. GEOLOGICAL SURVEY
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April 4, 2008

Dear Chair Booth, Vice Chair Measure, and Members of the Northwest Power and Conservation Council:

The U.S. Geological Survey (USGS) genuinely appreciates the opportunity to provide suggestions and amendments to the Northwest Power and Conservation Council's (Council) Columbia River Fish and Wildlife Program. As a non-regulatory science agency within the Department of the Interior, our science is unbiased and multi-disciplinary. Our general organizational structure focuses on biology, geography, geology, geospatial information, and water and we are dedicated to the timely, relevant, and impartial study of the landscape, our natural resources, and the natural hazards that threaten us. The USGS is actively engaged in science activities in the Columbia River Basin as demonstrated in its diverse roles in various organizations such as the Lower Columbia River Estuary Partnership, Pacific Northwest Aquatic Monitoring Program, and Columbia Basin Fish and Wildlife Authority.

Our recommendations (enclosed) to amend the Council's Fish and Wildlife Plan build on shared goals of many in the natural resource community to restore habitats and the biological systems within these habitats. Previously we have made recommendations to the Council for enhanced science in support of ecosystem-based management, multi-species approaches, and for greater emphasis on the environmental effects of multiple stressors and invasive species. Our recommendations herein are consistent with those views and focus on key biological resources and habitats, contaminant and invasive species, and groundwater effects on habitat quality. Many of our contaminant discussions are estuarine-based and are presented in the context of early salmon life history and with respect to habitat areas --either existing or candidates for restoration. A broader extrapolation across the Basin is possible regarding this concern.

Six USGS science centers are located in the Basin making this bureau one of the major science providers in the Region. Research and monitoring is conducted with appropriated and reimbursable funding often in partnership and with cost-sharing with others. As an example, the USGS operates a network of 425 streamflow monitoring sites through its National Stream Information Program, 8 water quality monitoring sites through its National Water Quality Assessment Program, and 23 Total Dissolved Gas Monitoring Sites. The USGS is evaluating the competing demands for groundwater within the Basin. Its scientists are developing interpretative products and simulation models that address the connection between groundwater management and instream flows. Biological studies are focused on ESA and resident species, fish passage and survival at dams, invasive species, fish disease, and habitat restoration. Together, and by working with others, these efforts are necessary for sustaining healthy aquatic ecosystems in the future.

On behalf of my USGS colleagues in the Northwest Area, I thank you for the opportunity to provide amendment comments.

Sincerely,

Lyman Thorsteinson
Center Director

NPCC Fish & Wildlife Plan Amendments Comments from the USGS Northwest Area: Western Fisheries Research Center; Oregon Water Science Center, and Washington Water Science Center

April 4, 2008

A. From the WFRC Columbia River Research Laboratory:

I. <u>Comments regarding invasive species.</u>

Understanding the effects of invasive species on recovery efforts for Pacific salmon in the Columbia River Basin

We respectfully suggest that the potential effects of invasive species on the recovery of Pacific salmon receive attention and status in the Fish and Wildlife Program. Invasive species comprise one of the most significant alterations of native ecosystems for fish, wildlife and plants, and are rapidly becoming a dominant component of aquatic ecosystems within the Columbia River Basin. One need not look far for examples of how invasive plants and animals have affected the Columbia River ecosystem. Endangered stocks of Pacific salmon have been subjected to additional predation pressure due to the intentional introductions of non-native game fish (e.g., smallmouth bass *Micropterus dolomieu*, walleye *Stizostedion vitreum*) (Zimmerman 1999). The invasive plants Eurasian watermilfoil *Myriophyllum spicatum L* (Counihan et al. *in prep*) and curlyleaf pondweed *Potomogeton crispus* (Draheim et al. 2003) are now prevalent in certain areas of the Columbia River and estuary and may have confounded habitat restoration efforts and efforts by communities to establish economic alternatives to resource extraction industries. The Asian clam *Corbicula fluminea* is now a significant dietary component of white sturgeon *Acipenser transmontanus* (Muir et al. 1988). The New Zealand mudsnail *Potamopyrgus antipodarum* has been observed in the Columbia River estuary and more recently, in the Deschutes River, an important anadromous and resident fishery. An invasive Asian copepod *Pseudodiaptomus inopinus*, has recently been introduced and is abundant in the Columbia River estuary. The effects of nonnative copepods on Pacific salmon stocks are assumed, but poorly understood. Other invasions are anticipated (i.e., zebra/quagga mussel, hydrilla) that could further affect the status of the Columbia River ecosystem, and thus efforts to recover Pacific salmon.

Invasive species in other areas of the United States have affected the population viability of native species, altered ecosystem function, and caused significant economic damage (Pimentel et al 2003). Approximately 400 of the 958 species that are listed as threatened or endangered under the Endangered Species Act are considered to be at risk, primarily because of competition with or predation by nonindigenous species (Wilcove et al., 1998). Of those 400, 44 native fish species are threatened or endangered by invasive fish (Wilcove and Bean, 1994), and an additional 27 native fish species are negatively affected (Wilcove and Bean, 1994) Rates of aquatic nonindigenous species (ANS) introductions and their social, economic, and ecological impacts are increasing (Cohen and Carlton 1995, Ruiz et al. 2000).

Despite the economic and cultural significance of the Columbia River, little is known of the current distribution and abundance of ANS. A baseline (presence/absence data) survey of ANS in the lower Columbia River (LCRANS) was completed in 2004 (Sytsma et al. 2004). The objective of LCRANS was to provide a comprehensive survey and analysis of all ANS present in the tidally influenced, 234-kilometer reach of the lower Columbia River from Bonneville Dam to the Pacific Ocean and the tidal portions of the major tributaries. The project included a review of literature, conducted in 2001-2002, and field surveys, conducted in 2002-2003. Sytsma et al. (2004) documented the presence of 81 aquatic nonnative species below Bonneville Dam and an additional 123 cryptogenic species. The LCRANS report recommended a multi-faceted sampling strategy to detect new invasions and to document invasion rates, effects, and the efficacy of management efforts to control ANS. The LCRANS report recommended a tiered sampling strategy that: annually targets habitats and taxa likely to contain new invaders; a comprehensive survey every five years; and additional sampling to target data gaps and survey limitations (Sytsma et al. 2004).

Invasive species can negatively affect recovery efforts for endangered and threatened Pacific salmonid species and other native fish and wildlife species by altering existing ecosystem dynamics, directly competing with and preying on native species, by altering existing habitats, and/or causing unanticipated results at restoration projects. The development of a long-term invasive species monitoring program in the Columbia River would provide information to help resource managers understand changes and trends in invasive species, the effects of invasive species on ecosystem function, and allow for the early detection of invasions needed to eradicate or contain invasive species before they become established and control becomes technically impossible and/or financially prohibitive. Framing such a monitoring plan in a probabilistic sampling scheme based on a habitat classification system would allow invasive species sampling efforts to be viewed in the context of existing habitat types in the Columbia River and allow valid inferences regarding the success of efforts to control invasive species in the Columbia River. This effort could be coordinated intensively through existing regional monitoring efforts (e.g., PNAMP) to ensure that the sampling design and site selection procedures are consistent with and inform these efforts.

The formulation of a probabilistic habitat based invasive species monitoring program would facilitate the development of the following:

a) an up-to-date periodic list of invasive species that inhabit the Columbia River
b) spatially explicit models of predicted distributions of established invasive species
c) an increased understanding of distribution vectors and pathways for invasive species
d) the development of an early detection program that emphasizes the monitoring of known distribution vectors and pathways but allows for the periodic sampling of other habitats
e) a regional assessment of the risk posed by invasive species in the Columbia River.

The potential effects of invasive species on restoration efforts are specifically noted in the Lower Columbia Subbasin Plan (see pages 7 - 29). The success of efforts to enhance or restore habitats for Pacific salmon could depend on the presence of invasive species or the susceptibility of a particular habitat or restoration technique to invasion. There are many existing or planned efforts to enhance, rehabilitate, or restore habitats in the Columbia River; the focus of these efforts being to provide benefits to endangered or threatened species of Pacific Salmon. For example, invasive plant species could become established and out-compete or displace native species on recently restored sites, depending on the nature of the restoration actions (e.g., construction, dike breaching, grading, channel construction etc.) or habitat type. Some types of sites or types of restoration actions may be more vulnerable to invasion than others because of their position in the landscape, proximity to existing propagule sources, poor structural design of the project, or poor establishment of targeted vegetation. Understanding a site or methods risk to invasion and the implementation of an early detection program would help to ensure that current efforts are efficiently implemented.

Efforts to recover white sturgeon may be confounded by introductions of aquatic nuisance species. Stated biological objectives in the Columbia Gorge subbasin plan include: attaining a level of production (natural recruitment and individual growth) that would allow the sustainable consumptive harvest of 5 kg/ha as suggested in Beamesderfer et al. (1995) and limiting the effects of invasive species on native biota. However, the introduction of the Asian clam, carp, and other invasive species (e.g., Eurasian watermilfoil) has likely affected the production of white sturgeon by altering food web dynamics and/or competition. Efforts to restore production to stated target levels while protecting other native biota could be further negated or negatively affected by future introductions of species such as the zebra mussel, silver carp, and hydrilla. The establishment of an invasive species monitoring program will allow managers to be cognizant of introductions that could affect management strategies. Further, the establishment of an early detection program may help to facilitate control efforts.

To stem the increases in introductions of aquatic nuisance species, in particular the spread of zebra/quagga mussels, westward from the 100th meridian, the 100th Meridian Initiative was created to coordinate actions between state, provincial, and federal agencies. A recent planning effort by this group identified the development and evaluation of ANS habitat modeling tools and the initiation of monitoring (baseline surveys, long term monitoring) as high priority action items for the near future (see: http://100thmeridian.org/ActionTeams/Columbia/100th%20Meridian%20Needs%20beyond%202006%20-%20CRB%20group.pdf).

In conclusion, in the absence of the recognition of the existing effects of currently established invasive species and the potential effects of new introductions on the recovery efforts for Pacific salmon, research that addresses these concerns will not be forthcoming. We feel that this is a shortcoming on the Fish and Wildlife Program that needs to be addressed. To address this shortcoming, we suggest that an amendment be added to the Fish and Wildlife Program that recognizes the potential deleterious effects of invasive species on recovery efforts for Pacific salmon and other important resident fishes such as white sturgeon. The amendment should further recommend that efforts to initiate and implement an early detection monitoring program, to investigate and identify important introduction pathways, to understand the role of established invasive species such as Eurasian watermilfoil and smallmouth bass in ecosystem function, and to assess and monitor the effectiveness of control measures of invasive species, be undertaken.

Literature cited:

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Wilcove, D.S., Rothstein, D., Bubow, J., Phillips, A., Losos, E.,. 1998. Quantifying threats to imperiled species in the United States. Bioscience 48 (8), 607– 615.

Zimmerman, M. 1999. Food habits of smallmouth bass, walleyes, and northern pikeminnow in the lower Columbia river basin during outmigration of juvenile salmonids. Transactions of the American Fisheries Society 128:1036-1054.

II. <u>Comments regarding American shad—a non-native anadromous fish</u>

Non-native adult American shad now outnumber adult salmonids counted at Bonneville Dam and juvenile shad are now known to reside year-round in Columbia River Reservoirs. American shad juveniles and adults are prey for fish, mammals and birds, and they are vectors for disease (Petersen et al. 2003, USGS unpublished data). American shad provide commercial and recreational fisheries. They distribute marine derived nutrients to reservoirs and riparian areas (U.S. Geological Survey, unpublished data). They potentially compete for the same foods as outmigrating juvenile salmon. Despite knowledge of their increasing abundance in the Columbia and Snake rivers, they were not mentioned in the 2000 Fish and Wildlife Program or the 2003 Mainstem Amendments. In addition, we have preliminary data that show a very high prevalence of the parasite responsible for ichthyophonus in Columbia River shad (> 70%). This suggests that shad may be a primary vector for this disease and its transmission to salmon and other species in the region. We believe that the Fish and Wildlife Program should be amended to include Research, Monitoring, and Evaluation studies to better understand interactions between American shad and endangered and threatened species throughout the Columbia River Basin.

Literature cited:

Petersen, J.H., R.A. Hinrichsen, D.M. Gadomski, D.H. Feil, and D.W. Rondorf. 2003. American shad in the Columbia River. Pages 141-154 in K.E. Limburg and J.R. Waldman, editors. Biodiversity status, and conservation of the world's shads. American Fisheries Society, Symposium 35, Bethesda, Maryland.

III. <u>Specific comments regarding white sturgeon</u>

The 2000 Fish and Wildlife Program and 2003 Mainstem Amendments broadly described biological objectives for white sturgeon in the Columbia Basin and strategies to restore them. Research, monitoring, and evaluation (RM & E) studies conducted since these documents were written show that refinements to the broad objectives and strategies are needed to provide clarity for future sturgeon RM & E studies and mitigation for losses due to hydropower system construction and operation.

To our knowledge, no funding has been allocated for sturgeon projects proposed through the Mainstem and Systemwide Province. Instead, the provincial nature of funding for sturgeon investigations has resulted in an interesting dichotomy of funding for sturgeon restoration activities across the Columbia Basin that could be likened to the sturgeon "haves" and the "have nots". That is, the types of monitoring and evaluation studies and mitigative actions funded in areas where sturgeon are abundant differ from the types of studies funded where sturgeon populations are failing. While it would seem obvious that studies should be conducted to understand what makes some populations successful while others decline, funding of sturgeon projects since 2000 has not followed this logic. In areas where sturgeon are abundant (i.e. the Columbia River downstream from McNary Dam), recent efforts have focused on management and assessment of stocks for harvest, with little effort to understand why juvenile fish are present. In contrast, areas (e.g. the Kootenai River) that have few or no juvenile sturgeon are limited in the types of studies that can be done locally to provide information needed to reestablish self-sustaining populations. Fishery managers in these areas are geographically restricted in their activities and have not proposed R M & E projects outside their local province.

Since white sturgeon range throughout the basin, the Fish and Wildlife Program should highlight the need for R M & E projects to understand sturgeon ecology and population drivers within the Mainstem and Systemwide Province. Several recent publications show the utility of studies that have broad applicability to white sturgeon populations across the basin. Coutant (2004) examined sturgeon populations and habitats across their highly modified range and presented a "riparian habitat hypothesis" for variability in sturgeon success. Jager (2006a and 2006b) used population viability analysis modeling to simulate effects of upstream passage and translocation of fish. Parsley et al. (2007) showed that some white sturgeon (>0.95 m fork length) readily pass upstream through the east fishway at The Dalles Dam and that downstream passage occurs primarily through open spillways. It is notable that none of these efforts were funded by the Fish and Wildlife Program even though each addressed explicitly stated objectives and strategies outlined in the 2000 Program and 2003 Mainstem Amendments.

We encourage the Council to continue funding RM & E studies to understand the capacity of the current hydropower system to produce sturgeon. This capacity is not static; ongoing changes in operations or physical structures of dams will in all likelihood influence white sturgeon. In particular we urge the Council to emphasize the importance of understanding the role of connectivity among sturgeon populations. There is ample evidence from past BPA funded studies that white sturgeon move downstream among reservoirs and that fish pass downstream over open spillways (Parsley et al. 2007). The installation of removable spillway weirs at dams may reduce downstream passage by white sturgeon via spillways. We suggest that the Council consider studies to determine the magnitude of downstream movement of fish at dams with and without removable spillway weirs. Studies should also be done to determine mortality by size for fish that pass over spillways and removable spillway weirs and those that pass downstream through turbines. The magnitude and mortality of small (e.g. < 0.5 m long) white sturgeon passing downstream at Columbia Basin dams has not been assessed. Although larger fish are precluded from passing downstream through turbines by trash racks, smaller fish may be passing through turbines. If these fish are being killed, the Fish and Wildlife Program should describe how these losses will be mitigated.

Literature cited:

Coutant, C.C. 2004. A riparian habitat hypothesis for successful reproduction of white sturgeon. Reviews in Fisheries Science 12:23-73.

Jager, H.I. 2006a. Chutes and ladders and other games we play with rivers. I. Simulated effects of upstream passage on white sturgeon. Canadian Journal of Fisheries and Aquatic Science 63:165-175.

Jager, H.I. 2006b. Chutes and ladders and other games we play with rivers. II. Simulated effects of translocation on white sturgeon. Canadian Journal of Fisheries and Aquatic Science 63:176-185.

Parsley, M.J. Parsley, C.D. Wright, B.K. van der Leeuw, E.E. Kofoot, C.A. Peery, and M.L. Moser. 2007. White sturgeon (*Acipenser transmontanus*) passage at The Dalles Dam, Columbia River, USA. Journal of Applied Ichthyology 23:627-635.

IV. <u>Comments regarding Pacific lamprey</u>

The Columbia Basin Fish and Wildlife Authority (CBFWA) submitted a document to the NPCC as part of the Plan amendment. The CBFWA document includes a section addressing needs for Pacific lamprey. We support the CBFWA document and have attached the section on lamprey as our Appendix 1.

V. <u>Additional comments</u>

1. The basinwide provisions of 2000 and the mainstem amendments of 2003 were adopted prior to the drafting of the subbasin plans. As is, there is far too little language in the Fish and Wildlife Program that connects the mainstem biological objectives and strategies with the subbasin plans. While the subbasin plans themselves beg for connectivity at the Province level, the mainstem plan should ensure that actions taken are in harmony with individual subbasin goals (e.g., coordination of passage conditions to maximize effectiveness of subbasin actions to increase life history diversity or survival of threatened or endangered stocks of fish).

2. Since the mainstem amendments were adopted, there has been a huge surge in PIT tagging in the subbasins. A critical part of much of this PIT tagging effort is the detection of PIT-tagged fish at mainstem dams. The mainstem plan should explicitly recognize this valuable service and landscape connectivity to research and management goals in the subbasins.

Appendix 1.

The following document is the penultimate draft of the Columbia Basin Fish & Wildlife Authority's recommendations to the NPCC for Fish and Wildlife Plan amendments, and is supported by the Columbia River Research Laboratory.

Section 3.9 Pacific Lamprey

Section 3.9.1 Biological Objectives and Status

Abundance indices of anadromous lamprey are exhibiting severe downward trends in the Columbia River Basin, which underscores the urgent need for action-oriented improvements to passage and restoration of lamprey in the basin. A long-term objective of developing self sustaining and harvestable populations throughout the historical range requires this downward trend to halt and be reversed. Nine strategies and numerous measures have therefore been developed to address limiting factors and threats to production and sustainability of lamprey in the Columbia River Basin.

Objectives

- Attain self sustaining and harvestable populations throughout the historical range still accessible to lamprey passage.
- Restore lamprey passage and habitat in tributaries that historically supported spawning lamprey populations.
- Mitigate for lost lamprey production in areas where restoration of habitat or passage is not feasible.

Mainstem and tributary passage improvements and restoration of anadromous lamprey have been identified as high priorities in reversing the severe downward trends in abundance, and recent efforts to improve passage of adults have been encouraging; therefore, passage and restoration are addressed in the first two strategies. Refinement of these management-oriented strategies is informed and guided by expanding our understanding of the status, diversity, production, biology, and population dynamics of anadromous lamprey. Based upon the critical need for passage improvements and restoration of anadromous lamprey in the basin and on our present state of knowledge, the nine strategies should be viewed in an adaptive management context, whereby passage improvements and restoration actions are informed by continual advances in knowledge of the various aspects of anadromous lamprey status and biology.

Our limited knowledge of the current status of Pacific lamprey across its historical range poses difficulties in identifying solid abundance targets. Although inaccuracies of adult migrant counts at dams exist, available indices indicate severely declining numbers and precarious status. This is especially true for the interior Columbia River Basin, such as the Snake River Basin in Idaho. Similarly, information on adult Pacific lamprey passage efficiencies past dams indicates that proportions successfully passing through the hydrosystem are low and that passage success is poorer for smaller lamprey. Based on

2000-2002 radio telemetry research, passage efficiencies at Bonneville, The Dalles, and John Day dams averaged 47%, 74%, and 53%, respectively. Although passage rates vary among years, patterns indicate that passage rates at some dams (i.e. Bonneville and John Day) is lower than at others (The Dalles). Almost nothing is known on downstream migration survival for juvenile lamprey, although some areas of loss, such as impingement on screens are known, and can be addressed.

Development of a Columbia River Basin lamprey conservation plan was identified in the U. S. Fish and Wildlife Services' (USFWS) Pacific Lamprey Conservation Initiative in 2007. This collaborative effort will facilitate and identify actions that address threats, restore habitat, increase our knowledge of lampreys, and improve distribution and abundance of lampreys within the Columbia Basin. The Columbia River Basin lamprey conservation plan will be part of a larger effort by the USFWS to restore Pacific lampreys throughout their range. While this plan is being developed and adopted, substantive actions based on current knowledge must be implemented to address the immediate threat to Pacific lamprey across vast portions of its remaining historical range within the Columbia Basin.

Knowledge of lamprey status in the Columbia River Basin is limited primarily to counts of adults and juveniles at dams, traps, or other counting structures. In most cases, these facilities were designed for counting salmonids; therefore, counts of lamprey are incomplete. Little is known about additional information critical to evaluating status (e.g., numbers of spawners; survival rate of juveniles, etc.), although juvenile lamprey presence/absence, density and size distribution data have been collected recently in selected tributaries to contribute to the knowledge base regarding their status.

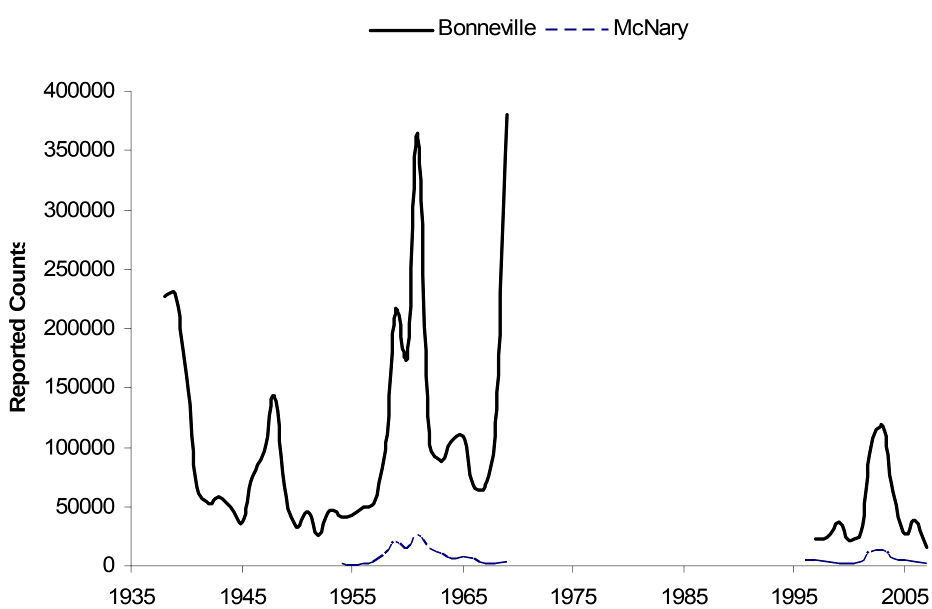

Figure 3.9.1. Annual counts of adult lamprey at Bonneville (start 1938) and McNary (start 1954) dams to present. No counts were made during 1970's and 1980's.

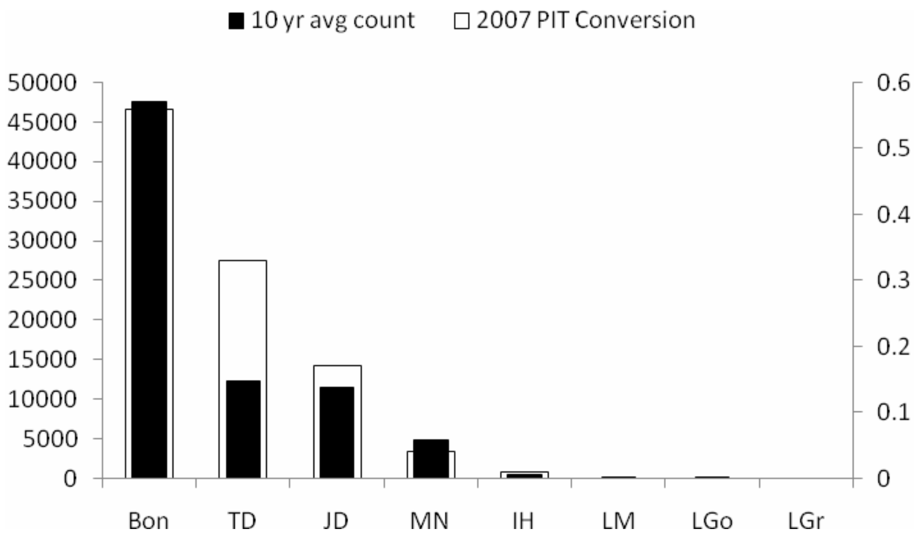

Figure 3.9.2. Comparison of ten year average counts (1998-2007) of adult lamprey at Columbia and Snake River dams (solid bars) and conversion of PIT-tagged adult lamprey through Ice Harbor Dam for fish released downstream of Bonneville Dam in 2007 (Chris Peery University of Idaho, personal. communication). Bon = Bonneville, TD = The Dalles, JD = John Day, MN = McNary, IH = Ice Harbor, LM = Lower Monumental, LGo – Little Goose, and LGr = Lower Granite.

Section 3.9.2 Limiting Factors and Threats

In the Columbia River Basin, 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. Large mainstem and tributary hydropower dams delay and obstruct adult and juvenile passage. Smaller obstacles in tributaries, such as diversion dams and culverts, may also obstruct adult and juvenile lamprey.

Predation may be a limiting factor related to mainstem passage. Juvenile lamprey have been observed in the stomach contents of smallmouth bass and northern pikeminnow from the tailraces of lower Columbia River dams.

Degradation of habitat within subbasins also limits lamprey. Physical habitat quality and quantity has diminished, which may especially limit juvenile rearing. Changes in water quantity exacerbated by irrigation withdrawals, roads, and agriculture practices during critical periods affect lamprey passage and survival. Finally, degradation of water quality (sedimentation and high temperatures) from various land use practices also limits lamprey production.

A final important limiting factor is our lack of knowledge of lamprey population delineation, biology and ecology, and population dynamics. Increased knowledge of lamprey biology and ecology will enhance our ability to evaluate the relative effectiveness of priority management actions. Population dynamics can assist in predicting the effects of various conservation actions.

Section 3.9.3 Strategies and Measures

Strategy 3.9.3.1 Improve adult and juvenile Pacific lamprey passage survival and reduce delays in migration.

Measures:

3.9.3.1a Develop and implement aids to passage at known and suspected lamprey passage obstacles.

3.9.3.1b Identify additional specific structures or operations that delay, obstruct, or kill migrating lamprey.

3.9.3.1c Monitor lamprey passage to evaluate passage improvement actions and to identify additional passage problem areas.

3.9.3.1d Assess passage efficiency, direct mortality, and/or other metrics that relate to migratory success.

Strategy 3.9.3.2: Continue restoring freshwater spawning and rearing habitat for anadromous lampreys

Measures:

3.9.3.2a Develop, implement, and evaluate lamprey-specific restoration projects (restoring natural processes in the absence of information on limiting factors).

3.9.3.2b Identify ongoing habitat restoration and safety-net activities and evaluate their effects on lamprey.

Strategy 3.9.3.3: Reintroduce and restore lamprey production to suitable habitats where they no longer occur, and monitor results.

3.9.3.3a Develop, implement, and monitor restoration actions.

Strategy 3.9.3.4: Develop a collaborative lamprey conservation, restoration, and management plan.

Measures:

3.9.3.4a Improve our understanding and documentation of critical uncertainties by updating the Columbia River Basin Lamprey Technical Workgroup Critical Uncertainties document as part of a Columbia Basin lamprey conservation plan.

3.9.3.4b Support development of a Columbia Basin lamprey management plan. The plan should include: (1) abundance targets measured at mainstem dams and tributaries, and (2) adult and juvenile passage efficiency targets and performance standards for mainstem dams.

3.9.3.4c Identify research and analyses that address critical uncertainties regarding lamprey habitat, status, distribution, and genetic structure.

3.9.3.4d Develop and maintain a regional Pacific lamprey data base for housing and accessing historic, current and new literature on distribution, life history, ecology, status, restoration, and cultural values.

Strategy 3.9.3.5: Better understand lamprey status

Measures:

3.9.3.5a Compile and evaluate current and historical information on Pacific lamprey distribution, abundance and status within the Columbia Basin.

3.9.3.5b Develop methods to differentiate among species at all life stages (field-based).

3.9.3.5c Develop standardized sampling protocols and conduct systematic basin-wide surveys to assess adult and juvenile abundance and distribution.

3.9.3.5d Define, improve, and continue historic distribution and abundance indices (e.g., dam counts, tribal harvest records, smolt trap collections, etc).

3.9.3.5e Coordinate information exchange with existing and future projects not targeting lamprey specifically.

Strategy 3.9.3.6: Determine anadromous lamprey population structure

Measures:

3.9.3.6a Supplement existing libraries of genetic markers for lamprey (e.g., microsatellites, single nucleotide polymorphisms).

3.9.3.6b Collect and maintain lamprey tissue samples from the Columbia River Basin and neighboring basins.

3.9.3.6c Investigate and determine population characteristics.

Strategy 3.9.3.7: Determine anadromous lamprey limiting factors

Measures:

3.9.3.7a Document habitat preferences and habitat availability for all life stages of anadromous lamprey.

3.9.3.7b Evaluate the physiological and behavioral responses of lamprey to a variety of environmental stressors.

3.9.3.7c Assess trophic relationships.

3.9.3.7d Assess the potential magnitude and effect of predation on lamprey productivity.

Strategy 3.9.3.8: Describe anadromous lamprey biology and ecology

Measures:

3.9.3.8a Describe the ecological function of anadromous lamprey.

3.9.3.8b Describe the biology of anadromous lamprey.

3.9.3.8c Develop methodology for gender identification in the field and laboratory.

3.9.3.8d Develop aging techniques.

3.9.3.8e Assess life history characteristics of freshwater and ocean-phase anadromous lamprey.

Strategy 3.9.3.9: Describe anadromous lamprey population dynamics

Measures:

3.9.3.9a Estimate demographic rate parameters capable of changing the size of populations such as birth, death, immigration, and emigration rates.

B. From the Oregon Water Science Center:

I. Protection of Habitat and Habitat Restoration

The beneficial role of the estuary in the early life history of salmon has been clearly articulated in NOAA's Technical Memorandum titled "Role of the Estuary in the Recovery of Columbia River Basin Salmon and Steelhead[1]. The need for additional estuarine habitat is paramount to enhancing viability; also, a viable life cycle must include estuarine habitat where salmon are free from exposure to waterborne and sediment-associated chemical contaminants. Contaminant exposure can occur within existing estuarine habitats. Chemicals are introduced to tributaries and to the mainstem from point and non-point sources. Ultimately, they are transported in water and on suspended sediment to sensitive habitat areas supporting juvenile salmonids. Secondly, exposure can occur when estuarine habitat is reclaimed. Prior to reclamation, former wetlands are often subject to contamination from local agricultural activity, agricultural runoff, urban runoff, highway runoff, and atmospheric deposition. Once reclaimed, these habitats can become sources of contaminant uptake to sensitive species. The U.S. Geological Survey supports the conservation of habitat quality within existing wetlands and the reclamation of former habitat areas, buts asks ***that consideration be given to the concept of using contaminants as a metric for evaluating habitat quality in the early life history of salmon.*** Such consideration would include a screening process whereby toxics in water, sediment, and aquatic biota would be assessed and evaluated against standards and guidelines protective of juvenile salmonids. Such information would assist in prioritizing candidate wetlands for reclamation and would furthermore avoid the introduction of contaminants in the early life history of salmon.

The U.S. Geological Survey supports the strategic approach to restoration and coordination called for in the Federal Columbia River Power System Biological Opinion issued October 21, 2007 --specifically RPA's 34-38. This approach recognizes the importance of habitat restoration activities in both tributary and main stem environments. With respect to the main stem, RPAs 36-37 support the critical linkage between the recovery of listed salmon species and the need to maintain and restore critical estuarine habitat. The food-rich environments of existing estuarine habitats must be protected because of their importance to salmonid life history which includes an expanded stay in estuarine wetlands in preparation for the transition from fresh to salt-water. The same considerations with respect to contaminants apply to RPAs 34-35.

Similar to RPAs 36-37, the 'Pile and Dike Removal Program' (RPA-38) provides additional opportunities to increase quality habitat in areas segmented from the estuary by the construction of pile dikes. Pile dikes can be a detriment to the early life history of salmon through: (1) the release of pentachlorophenol from treated pilings; (2) hydrologic alterations created by piling placements which favor slack water and the deposition of contaminant laden, fine-grained streambed sediment; (3) acting as a niche for salmonid

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[1] Role of the Estuary in the Recovery of Columbia River Basin Salmon and Steelhead: An evaluation of the Effects of Selected Factors on Salmonid Population Viability, NOAA Technical Memorandum NMFS-NWFSC-69, 106 pp.

predation by avian populations and northern pike minnow; and (4) acting as a general impediment to salmon seeking shallow water habitat. The U.S. Geological Survey ***supports the removal of pile dikes of low economic and navigational value, but asks that consideration be given to assessing contaminants which may affect the early life history of salmon.*** A prudent course of action would involve an assessment of contaminants prior to the removal of a pile dike structure, monitoring of contaminants released to the water column during pile dike removal, and effectiveness monitoring (including status and trends) to ensure the reclaimed habitat is beneficial to juvenile salmonids into the future.

Research and Monitoring

As stated in the 2000 Columbia River Fish and Wildlife Program, "the purpose of the monitoring and evaluation strategies is to assure that the effects of actions taken under this program are measured, that these measurements are analyzed so that we have better knowledge of the effects of the action, and that this improved knowledge is used to choose future actions." Considering the Council's understanding of the beneficial role of the estuary in the early life history of salmon and their significant commitment of resources on behalf of habitat restoration, the USGS encourages the Council to ***integrate RPA 60 "Monitor and Evaluate Habitat Actions in the Estuary" or Effectiveness Monitoring into the Fish and Wildlife Program.*** It is important, through RPA 60, to assess trends in specific habitat areas which can be used to track the recovery of juvenile salmonids, their prey species, and key habitat metrics. This type of monitoring can provide trending metrics for specific habitat sites as well as information on which restoration techniques perform better in certain habitat types. Metrics would include, but not be limited to: primary and secondary productivity, certain salmonid prey species, conventional water quality measures of water temperature, dissolved oxygen, turbidity, chlorophyll-a, and specific conductivity, and measurements of contaminants affecting the early life history of salmon.

Water Quality and the Movement of Contaminants up the Food Chain

Data depicting contaminants in Columbia River water, suspended sediment, streambed sediment, resident and anadromous fish, clams, aquatic insects, and avian populations have been collected by some federal and state agencies as early as 1980. Contaminants have been identified at all points of the aquatic food web and some are found to significantly bio-magnify in top level predators such as Bald Eagles and Osprey. Some too are found in concentrations exceeding thresholds protective of salmon health. The presence of contaminants in the Columbia River Estuary is especially important given the role played by the estuary habitat and tributary habitat in the early life history of salmon. Habitat has been singled out in the Council's Fish and Wildlife Program as a measure to conserve, protect, and enhance in order to recover listed salmon species. With this emphasis in mind, the U.S. Geological Survey recommends that the Council ***amend the Fish and Wildlife Program to address issues of contamination in estuarine and tributary habitat in the Columbia River Basin.***

The USGS is conducting long term water quality monitoring in the Willamette, Upper Snake, and Yakima River Basins at four locations as part of its National Water Quality Assessment Program and similarly at one location in the lower estuary (RM 54) as part of the USGS National Stream Quality Accounting Network. These water quality sampling sites provide streamflow and contaminant concentration data used to measure seasonal and annual loads as well as concentration trends for several water quality measures. With respect to contaminants, these measures are limited to a select suite of current use pesticides. This suite represents only some of the contaminants known to reside within the Columbia Basin. Many of the basin's contaminants were identified through "one-time sampling efforts". Eleven such sampling efforts have been completed by USGS, NOAA, the states of Oregon and Washington, USEPA, and others. Key findings from the most recent report, a collaborative effort by NOAA Fisheries, USGS, and the Lower Columbia River Estuary Partnership[2] include:

- PCBs in salmon tissue exceed estimated thresholds for delayed mortality, increased disease susceptibility, and reduced growth.
- Copper was detected in water at concentrations known to interfere with the normal function of key sensory systems in salmon, such as imprinting, homing, schooling, shoaling, predator detection, predator avoidance, and spawning behavior
- Exposure to flame retardants (PBDEs) is on the rise throughout the Pacific Northwest, and salmon in the vicinity of Portland have levels within the top 10% of those reported for resident fish in the region.
- Juvenile salmon from the Portland area exhibit vitellogenin, an estrogen-regulated yolk protein, which is normally absent in juvenile fish. Water and sediment samples from this area contained known endocrine disruptors, which may be inducing vitellogenin production.

The aforementioned study as well as other one time studies have been effective in framing the contaminant issues within the Columbia River estuary and in selected tributaries. However, what's lacking is: (1) knowledge of the relative contributions (concentrations and loads) of these contaminants from different sources (municipal, industrial, agricultural, etc.); (2) an expanded contaminant suite which reflects the breadth of contaminants of concern in the Columbia River (brominated flame retardants, pharmaceuticals, personal care products, and other waste water contaminants in addition to the trace elements copper and mercury); and (3) more strategically located status and trend monitoring sites on the main stem and within key tributaries.

The USGS is in the planning phase of a four-year study (2008-11) of brominated flame retardants and endocrine disrupting chemicals. This work will be conducted at multiple locations in the lower Columbia River Estuary main stem and at a single "effectiveness monitoring" site. This study will initially screen for contaminants using passive sampler technology. From the screening, two problematic sites will be selected for an in depth food chain study. Contaminant movement up the food chain (aquatic insects to

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[2] Lower Columbia River and Estuary Ecosystem Monitoring: Water Quality and Salmon Sampling Report, 2007, 70 pg.

resident/anadromous fish to the fish eating Osprey) will be assessed at these sites; in addition, a battery of fish biomarkers (thyroid and gonadal histology, sex-steroid hormones, 17β-estradiol (the major estrogen in fish), 11-ketotosterone (the major androgen in fish), gonado somatic index (a measure of gonad development), hepato somatic index (a measure of liver function), vitellogenin (a precursor of egg yolk), and two measures of sperm quality (sperm count and distribution of sperm maturation stages) will be measured to gage the degree of endocrine disruption. Also, cDNA microarray technology will be used to monitor stress-responsive pathways and it is likely that gene expression "fingerprints" can be developed for exposure to environmental toxicants, thus making microarrays useful for identifying biomarkers.

The U.S. Geological Survey is committed to assessing the quality of our Nations waters. Fiscally however, the USGS can't provide contaminant data for status and trends monitoring at the number of sites necessary to collaborate or refute management actions such as Strategy 12 of the Main stem Lower Columbia River and Columbia River Estuary Subbasin plan which seeks to limit the effects of toxics contaminants on salmonids. The U.S. Geological Survey recommends that the Council ***address the effects of contaminants through strategy 12 which seeks to limit the effects of toxics to juvenile salmonids.***

C. From the Washington Water Science Center:

I. Protection of Habitat and Habitat Restoration

Metrics currently used by the WWSC to evaluate habitat would be encompassed by the current program and support the following recommendation:

Explicitly identify surface water – ground water interactions in freshwater systems and submarine ground water discharge as a habitat characteristic in performance matrices. This recommendation is consistent with the Primary Habitat strategy: "Identify the current condition and biological potential of the habitat, and then protect or restore it to the extent described in the biological objectives." Ground water discharge is in implicitly referenced in many objectives in Appendix D: Provisional Statement of Biological Objectives for Environmental Characteristics at the Basin Level, and in Subbasin Level Characterization of Ecological Conditions and Processes for Geologic characteristics (3.1.2), Hydrologic characteristics (3.1.3), Water Quality (3.1.4) and Riparian condition (3.1.5). The quantity and quality of ground water discharging to stream is of particular importance to endangered and threatened species. Since the last review, investigations in the Methow River Basin have indicated the connection between the river flow and use of irrigated water (Konrad and others, 2003). The quality of the ground water discharge to surface waters is also important. In spring and summer, ground water is usually cooler than the surface waters and may provide a refuge to endangered and threatened fish species. In contrast, the quality of the discharging ground water may be degraded if the majority of ground water originates from drainage of agricultural lands. In some instances, ground water discharge is easy to identify. The differences in near-bottom temperature along the length of streams and rivers have used to identify stream reaches where ground water is discharging (Vaccaro and Maloy, 2006). Submarine groundwater discharge is also important in the lower estuary. The seepage of freshwater in the intertidal zone prevents dehydration of the early life stage of fish species and intermediate salinities.

Literature cited:

Konrad, C.P., Drost, B.W., and Wagner, R.J., 2003, Hydrogeology of the unconsolidated sediments, water quality, and ground - water / surface - water exchanges in the Methow River basin Okanogan County, Washington: U.S. Geological Survey Water-Resources Investigations Report 03-4244, 137 p.

Vaccaro, J.J., and Maloy, K.J., (2006) A method to thermally profile long river reaches to identify potential areas of ground-water discharge and preferred salmonid habitat: U.S. Geological Survey Scientific Investigations Report 2006-5136, 16 p.