COLUMBIA RIVER INTER-TRIBAL FISH COMMISSION

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March 11, 2016

Tony Grover, Fish and Wildlife Division Director
Dr. Greg Ruggerone, Independent Scientific Advisory Board Chairman
Northwest Power and Conservation Council
851 SW 6th Avenue, Suite 1100
Portland, OR 972014-1348

RE: Comments on the ISAB/ISRP 2016-1 Critical Uncertainties Report

Dear Mr. Grover and Dr. Ruggerone:

The Columbia River Inter-Tribal Fish Commission (CRITFC) has reviewed the 2016 "Critical Uncertainties for the Columbia Basin Fish and Wildlife Program" (Report) and has provided comments on the 14 Critical Uncertainty Themes listed in the Report (attached).

Overall, CRITFC has few concerns with the information provided in the Report and would be supportive of addressing many of the Critical Uncertainties discussed. However, we must stress that any future directions or actions taken by the Northwest Power and Planning Council (NPCC) to address the updated Critical Uncertainties list, as always, first requires diligent tribal consultation and agreement from the four member tribes. Any prioritization of themes or Critical Uncertainties that will influence research objectives and future Fish and Wildlife Plan (FWP) funding should involve the resource managers separately from the public. The tribes do not, as a rule, submit management priorities and objectives to public review.

At the broad scale, we offer the following comments on the Report:

- **The Report is a significant effort**. With 19 scientists listed as authors to the Report, and assuming a long list of potential scientists reviewing and commenting on the Report, we encourage the NPCC to consider the vast amount of hours and costs associated with this endeavor and hope the eventual product is worthy of this significant effort. Because of the expansive list of critical uncertainties, at this time, the scientists at the tribes were encouraged to refrain from developing specific comments on the Report.

- **The 14 major themes encompass an expansive list of critical uncertainties**; it will be a major undertaking to prioritize among the themes, let alone critical uncertainties under a single theme. A deliberate, structured, collaborative and transparent process

will be important for prioritizing research under each of the prominent themes identified in the Report. Due to the enormity of the effort, this initial round of public comment on the Report will not provide enough guidance to prioritize all research efforts under the FWP.

- **The general themes identified by the ISAB/ISRP should be organized consistently with the Fish and Wildlife Plan.** In order to implement the adaptive management intent of the FWP, it is important that the critical uncertainties be linked to the assumptions and strategies identified in the 2014 Fish and Wildlife Program. The strategies in the FWP could be used to guide how to sort and apply the overarching themes found in the Report. In this way, research would have a direct link to the decisions that NPCC members, BPA managers, and fish and wildlife managers make through implementation of their authorities under the context of the FWP.

- **The next iteration of the NPCC Research Plan should be a work plan** that outlines a series of Science/Policy Workshops based on Critical Uncertainty themes, organized by FWP priorities, over a period of time (e.g.; three or five years). The NPCC could use Science/Policy Workshops to assess the current state of knowledge surrounding a key theme or two, facilitate presentations on state of the science and research efforts within that theme, and identify priority research questions remaining under that theme. Future FWP research could be directed from the results of the workshops (current knowledge, define management questions, Critical Uncertainties, and direct future research priorities).

Scientific research can help with any uncertainty if there is an identified mechanism that can be tested. Given sufficient data, and proper study design, we can establish a relationship between an independent variable and a quantity of interest. Since fish populations are subject to a sequence of events between egg deposition and subsequent spawning of adults, a number of life stages must be considered independently for the sake of identifying the key factors affecting survival to the next stage. If any factor has a strong influence on survival and exhibits a significant amount of variation, it will meet the definition of "critical uncertainty". In this context, the questions becomes, 1) "Can we establish a relationship and predict the magnitude of the effect?" and 2) "Can we do something about it?"

As in the past, CRITFC greatly appreciates the ISAB/ISRP's effort on this assignment, as we and our four member tribes share many of the same concerns. We agree that reviewing the "knowledge gaps about resources and the functional relationships that determine fish and wildlife productivity in the Columbia River ecosystem" is an important and necessary endeavor. As we continue our efforts to protect, rehabilitate, and restore the ecosystem and historic fisheries in the Columbia Basin, CRITFC looks forward to continuing our work with co-managers to address these knowledge gaps.

Thank you for your consideration of our comments. If you have any questions please contact me or Dr. Zachary L. Penney, Fishery Science Department Manager at (503) 238-0667.

Sincerely,

Babtist Paul Lumley
Executive Director

Enclosure

Cc: 15 Tribes, Columbia Basin Tribes Coalition
Michael Ford, Northwest Fisheries Science Center Division Director
Members, Northwest Power and Conservation Council
Erick Merrill, Independent Scientific Review Program Manager
Barry Thom, National Marine Fisheries Service Deputy Regional Administrator

CRITFC Comments on the ISAB/ISRP 2016-1 Critical Uncertainties Report
Critical Uncertainties by Theme

Theme 1. Public engagement:

- This section does not specifically involve the tribes because we are not the public. The recommendations appear to be helpful by continuing to use adaptive management in addressing issues and engaging the public.

Theme 2. Human development:

- CRITFC acknowledges the ISAB/ISRP's comments about the influence of human population growth, land use alterations and invasive species on tribal first foods. The impacts of these limiting factors will likely have synergistic and cumulative impacts with climate change. By itself, climate change could impact the conservation status of many Columbia Basin aquatic species vital to tribes and their culture (Portner and Farrell 2009; Luzier et al. 2011). It is likely that climate change will increase the magnitude of threats that tribal first foods are already facing with respect to human population growth and demands, river flow, water quality, ocean conditions disease and invasive species (ISAB 2007-2; ISAB 2007-3;Portner and Knust 2007; McCarty 2001).

- In the past couple of years CRITFC participated in the Willamette 2100 Water Scarcity Project: http://water.oregonstate.edu/ww2100/capstone-workshop. In this forum, different estimates of human population growth under different climate scenarios have been analyzed. For example, the base or current case has the Willamette Valley population trending from a current 2.41 million to 5.37 million while the "extreme" case has the population trending from a current 2.41 million to 8.25 million by 2100. The Project was focused on the human footprint and stressors but only addressed future ecological conditions for fish and wildlife from a very broad perspective. It may be possible to utilize population projections for the entire Columbia Basin and estimate agricultural, municipal and other human water demands in the future and the effects on ecological parameters for fish and wildlife. Other regions in the world are addressing climate change impacts/adaptation to the human ecosystem interface and some of these approaches may be relevant to the Columbia River Basin (Zetland 2014).

Theme 3. Tributary habitat:

- The Report highlights the need to expand understanding of the effects of restoration from the site scale to entire watersheds, and to account for the aggregate effects of combinations of restoration activities and anthropogenic stressors, including upslope habitat in National Forests.

- The Monitoring Recovery Trends project (2009-004-00) is directly addressing these uncertainties by building a comprehensive database of restoration activities from multiple agencies and diverse funding sources from the 1990s to present, and several spatial datasets accounting for land use intensity including road networks, cattle grazing

intensity, and forest loss over time. Additionally, we have initiated research on historical ecology of the study watersheds in order to determine the consequences of sustained stream channel simplification since the 1880s on present day conditions. In combination with local site information obtained from CHaMP surveys, these data are being used in landscape models relating the effects of past and present human pressures—as well as aggregate restoration activities at the watershed scale—on stream rearing salmonids and macroinvertebrates that form the basis of their food web. Creating statistical linkages between land use, restoration activities, and stream biota also forms the basis of the freshwater components of a life cycle model.

Theme 4. Hydrosystem and passage operations:

- No comments at this time. The absence of comment does not indicate agreement or disagreement with the content of this section.

Theme 5. Mainstem habitat:

- No comments at this time. The absence of comment does not indicate agreement or disagreement with the content of this section.
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Theme 6. Estuary, plume and ocean:

- Ocean ecological impacts due to climate change impacts specifically are difficult to understand but progress is being made. Regional assessments and research from the Oregon Climate Change Research Institute, the University of Washington Climate Impacts Group, the National Drought Information Center, NOAA Fisheries and the National Center for Atmospheric Research are attempting to link ocean sea surface temperatures and temperatures at depth to the Pacific Decadal Oscillation, ENSO, and GCMs from tropical and extratropical interactions to improve predictive weather and climate change predictive capacity (Trenberth et al. 2008; Trenberth 1998). Increased monitoring of biological populations is needed, but research funding is limited and scarcity of some populations (i.e. eulachon) is forcing closure of fisheries where bycatch of these populations is no longer available for population assessment. CRITFC is working on a coupled (ocean and freshwater) assessment of climate change impacts on Pacific lamprey and Pacific eulachon through the North Pacific Landscape Conservation Cooperative. The report will be completed by September 2016 and will provide more information on these interconnections.

Theme 7. Contaminants:

- The ISAB/ISRP identified two critical uncertainties (CU #34 and CU#35) under the "Contaminants" theme – one focuses on distribution and concentration of contaminants and the other on impact on fish survival and productivity. Reviewers note that only three current FWP projects actively examine these uncertainties even though the criticality of the theme is considered to be a priority because the potential for contaminants to negate

restoration efforts is high. The Reviewers are correct in asserting that this theme "demands greater attention from the Fish and Wildlife Program".

- Lamprey, mussel, and resident trout projects that currently contribute to resolving these uncertainties should serve as a model for extending the Program's efforts on contaminants. A great deal of progress could be made by adding reasonable contaminant monitoring to current restoration projects as was done in the lamprey effort. Focus on biota with filter feeding life history strategies in particular provides place-based information about the distribution of contaminants in the Columbia River Basin. However, additional work is needed to elucidate contaminant trends over time and there is little integration between the too few efforts that directly address the contaminant theme.

- The Reviewers emphasize the need to effectively incorporate contaminant information into the FWP, but at the same time limit the responsibility of the Program to more directly consider contaminants because "other entities are leading research efforts in the Basin related to the themes of contaminants." While "communication, coordination, and collaboration" with the other entities is essential, the FWP should itself establish a cohesive effort that directly develops the link between contaminants and management actions. This theme is one that the Reviewers identified as needing an integrated team of professionals to resolve. The Program could establish an overarching contaminant project to better address the critical uncertainties that would couple mapping, collecting, and analyzing data on key contaminants and fish restoration projects.

Theme 8. Climate change

- Climate change is probably the single largest threat to the survival of the Program's focal species. The ISAB and ISRP identified three critical uncertainties (CU #31, CU#32 and CU#33) under the "Climate Change" theme. Strong and visionary leadership is needed now to bring appropriate focus to this issue in the Program.

The Critical Uncertainties report cites the need to understand:
…actions that could ameliorate the undesirable impacts of climate change. Special attention is needed to secure thermal refuges and sufficient high quality water under predicted landscape-scale changes in hydrology… Future research will be a continuing process of fine-tuning climate models to understand and manage the impacts of climate change on hydrology, habitat phenology, and biota. (Executive Summary, p. 6)

The report itemizes concerns according to two major topics (full report, p. 36):

1. *How will the long-term climate trends predicted for the Columbia River Basin and the northeast Pacific Ocean affect fish and wildlife in the region?*
2. *What strategic actions, alone or in combination and at what spatial and temporal scales, could help ameliorate increased water temperatures, decreased summer river flows, changes in upland plant communities, and other ecosystem changes due to climate changes that will impact fish and wildlife?*

- CRITFC is addressing the impacts of climate change on biota under the Monitoring and Recover Trends project (BPA - 2009-004-00), along with other associated projects through the BIA, in the Grande Ronde and Minam Basins. Using the combination of remotely sensed topography and water temperature information, streamflow data, potential natural vegetation maps, and existing climate change predictions, CRITFC has developed several riparian and river channel morphology restoration scenarios used in the Heat Source model to predict the consequences to water temperature and juvenile chinook salmon. Remotely-sensed information of water temperature—in addition to ground-based surveys—were also used to identify and map thermal refuges that may be sites targeted for restoration. The project is providing information on how variables tightly linked to climate change—stream temperature and flow—are related to metrics of aquatic food web vulnerability and how aquatic food webs are predicted to change under various climate change scenarios. CRITFC expects that findings from this analysis will have implications to similar streams and rivers outside of these basins, and the myriad of fish and other species that depend on macroinvertebrates for their survival.

- The Reviewers note that "In the summer of 2015, fish kills in the Basin due to increased water temperatures in streams made the national news" and "the extent and severity of fish kills are likely to increase." The Reviewers conclude that the Program's effort is "too small to make significant progress toward addressing the uncertainties" even though the "effects of climate change are already being experienced and are likely to escalate in a relative short period of time." They note that there are only two projects that currently address climate change directly, and none appear to moving toward the development of imminent actions.

- The Reviewers specifically recommend in the "Moving Forward" section that climate change should be taken into account when setting Program objectives and identification of thermal refuges should commence. These recommendations fall short of the need to begin implementation of actions that address warming temperatures. While it is necessary to recognize that "Other entities are leading research efforts in the Basin related to the theme(s) of … climate change", there is room here for the Program to provide the strong and visionary leadership that is needed to develop a cohesive program and fully address this issue and its response. A stronger focus on actions to limit the impact of warmer stream temperatures is needed from the Program and there is little time to delay until working partnerships are formed to initiate modeling.

- CRITFC appreciated the opportunity to share the project goals, objectives and description of the CRITFC Information System (CIS) river operations model to the ISRP/ISAB members during the review process. In reviewing the Report, CRITFC believes the questions raised are addressed in the CIS manual and that an actual demonstration of the CIS model will add further clarity. The uncertainties in the CIS model are due to model limitations that are complex and involve ratio methods for constructing climate change volume forecasting, construction of ecosystem rule curves and data limitations.

- Based on the list of climate uncertainties in this Report it appears that comments CRITFC previously sent to the ISRP in 2011 are still relevant.

- With respect to estuary conditions under different climate change scenarios, there is current modeling of different hydrological scenarios from downscaled general circulation models (GCMs) from the Coastal Margin Observation and Prediction Center (CMOP) to which the CIS model should be able to provide updated climate hydrological data and temperature projections to assist in defining changes to estuarine habitat for fish and wildlife. Proposed studies by the USGS and others to estimate estuarine habitat in collaboration with CMOP from climate hydrology and geological subsidence are other potential collaborative efforts that should address climate uncertainties, hyporheic exchanges and priority habitats to place in conservation easements. A similar approach for mainstem habitat could be possible again using climate scenario hydrology and temperature outputs from the CIS model. Certainly the CIS model hydrological outputs should assist in defining floodplain restoration potential- widely identified as a key ecological adaptation opportunity (Beechie et al. 2013).

- Ocean ecological impacts due to climate change impacts specifically are difficult to understand but progress is being made. Regional assessments and research from the Oregon Climate Change Research Institute, the University of Washington Climate Impacts Group, the National Drought Information Center, NOAA Fisheries and the National Center for Atmospheric Research are attempting to link ocean sea surface temperatures and temperatures at depth to the Pacific Decadal Oscillation, ENSO, and GCMs from tropical and extratropical interactions to improve predictive weather and climate change predictive capacity (Trenberth et al. 2008; Trenberth 1998). Increased monitoring of biological populations is needed but research funding is limited and scarcity of some populations (i.e. eulachon) is forcing closure of fisheries where bycatch of these populations is no longer available for population assessment. CRITFC is working on a coupled (ocean and freshwater) assessment of climate change impacts on Pacific lamprey and Pacific eulachon through the North Pacific Landscape Conservation Cooperative. The report will be completed by September 2016 and will provide more information on these interconnections.

- Socio-economic assessments of climate impacts in the Columbia River are limited. A project funded by the coalition of 15 Columbia Basin Tribes has begun that will compare estimates of ecosystem function economic benefits basin-wide based upon current river operations and alternative operations under climate change futures. CRITFC expects that the CIS model will provide input on climate change, hydrology, fish survival and other metrics to assist in this effort.

- CRITFC is concerned about uncertainty related to loss of salmon, steelhead and lamprey genetic diversity from continued passage through the CRB hydrosystem with the synergistic and cumulative impacts of climate change. It is likely that either selective (dam bypass screens) or non-selective mortality will continue to occur in the hydrosystem. Climate modeling indicates that increased intensity, duration and magnitude of drought, and increased water temperatures, will likely increase predation,

disease, contaminant exposure, proliferation of exotic species and competition for lost primary and secondary productivity. CRITFC suggests that the ISRP/ISAB provide focus to this important uncertainty.

- CIS Model Updates to Address Climate Uncertainties
  CRITFC is currently incorporating daily time steps into the CIS model in order to integrate the following assessments by the end of 2016:

  - Updated hydrological data sets for the Columbia River Basin (CRB) from the Coupled Model Intercomparison Project 5 global climate models downscaled for the PNW. The University of Washington's Land Surface Hydrology Group will complete these sets for the River Management Joint Operating Committee project

  - Estimates of daily flood risk from the updated basin climate hydrological data sets.

  - Temperature modeling using simple equations initially (i.e.: NOAA COMPASS model) and then more robust modeling using climate change hydrology to create estimates of water temperature in CRB tributaries and the mainstem (i.e. RMB-10 temperature model; Yearsley 2012). As a high priority in the future the CE-QUAL W-2 model [1] (Cole and Wells 2015) that is two-dimensional and has bioenergetic components could be used, but will require additional funding and completion of work in the Hanford Reach and Wanapum reservoirs, model calibration, and quality review.

  - Relative comparisons of salmon and steelhead reach survival and smolt-to-adult returns under different river operations including climate change hydrology and water temperature using methods, parameters and equations from the NOAA COMPASS model (Zabel 2008) and the interagency Comparative Survival Study (McCann et al. 2015).

- CRITFC will continue to develop the CIS model with supporting science information through collaboration with the tribes, states, federal agencies and regional and national climate, hydrological and ecological scientists. The CIS model will help in identifying climate impacts to the Columbia Basin mainstem ecological systems and in the development of adaptation measures to address these impacts consistent with appropriate guidelines (Snover et al. 2013). This work will be particularly focused to protecting and sustaining tribal First Foods.

- Discussion of non-native species in the CU report captures the essence of the problem in the Columbia River basin, and the perils of attempting to manage them. As described in the Future Concerns section of the ISAB 2008-4 report, non-native species impacts are linked to the two largest concerns for the future of fish and wildlife in the basin; climate change and human population growth.

- The CUR summarizes these concerns in the first section of the report, specifically:

    1. *To what extent is the viability or abundance of native fish and wildlife species in the Columbia River Basin jeopardized by non-native species?*

- It is very likely given existing information, both published and anecdotal that native fish and wildlife species are at greater risk than they were previously. Climate change and continued impacts to remaining habitat from human development are key factors. Warmer waters, milder winters, and overall climate shifts in the regional Columbia Basin environment will allow for greater survival and spread of non-native plants and animals, both terrestrial and aquatic. These non-natives can modify, sometimes permanently, terrestrial and aquatic habitats for native species in a myriad of ecological combinations, generally not for the better. In some cases, invasive fish and plants may combine to provide cover for predators and modify aquatic habitats for native fishes. Many such instances have already been documented, but given the rapid pace with which non-native plants and animals can spread and modify habitats and affect native plants and animals, new strategies are necessary to get ahead of the invasion.

- A fair amount of work has been conducted in this arena, much of it by agricultural departments on noxious weeds and by the 100th Meridian Columbia River Basin Team for invasive aquatics, particularly for Quagga and zebra mussels. Prevention, education and enforcement have held the line to date for the invasive mussels, with contaminated watercraft already being discovered at newly opened state line check stations in 2016. The threat is all around the basin, with new invaders being confirmed annually from commerce, recreational, industrial, and agriculture being key pathways. Greater permanent funding and increased intra- and inter- coordination between appropriate agencies in tribal, state, federal, and academia is critical to holding the line on new invaders.

- Among the three critical uncertainties, the current distribution and abundance uncertainty is most important element, given that much information is likely available, but has not been sufficiently exploited for control efforts. Databases, such as the one operated by the USGS offer an excellent point to begin control and containment efforts when and where practical, particularly for terrestrial invaders. The Report discusses in detail about creating "cost-effective studies to test hypotheses to provide solid, implementable management recommendations on native and non-native interactions and how best to manage those interactions". This focus is an excellent starting point, but given the rapid pace of some invasive species, much ground can be lost via multi-year studies. Some criticism regarding management actions was leveled as not being effective, yet in many

cases, once the organism is established in the environment, particularly the aquatic environment, options for eradication are extremely limited, so rapid response planning is as essential as complex trophic level studies. In some situations, non-native species can be a benign non-invasive element for decades and then the population explodes and permanently alters the environment and the native species therein.

Theme 10. Predation:

- The ISAB frequently mentions population resilience, which is a term used to described behavior of coupled ecosystem dynamics. The idea behind resilience is that ecosystems, as we perceived them, have "evolved" into an apparent balance of consumer/resource dynamics in concert with environmental conditions, and along with all the spatial dynamics and disturbances inherent to them. Ecological resilience means that the interplay between factors that would increase or decrease birth and survival processes have a tendency toward keeping abundances within ranges, or ratios, or some sort of balance. The presumption is that if things are left to themselves, we should expect abundances to have a tendency toward a certain number, i.e., there is an "attractor". There is no requirement that there be only a single "attractor" however. It's possible that if you start at an abundance less than X, that the population will tend downward to Y, but if you start at an abundance greater than X, the population will tend upward to Z. Resilience only means that there is a tendency to "attract" toward some balance of ecosystem levels, but it's possible that several such balances exist. A system is more resilient if you need to exert more force to push it into another domain/balance, and less resilient if it requires less force (e.g., predators and prey coexist at one equilibrium abundance until prey are reduced until they fall into a "predator pit" at a lower equilibrium level).

- Predators and salmon are an interesting example of resilience when it comes to Columbia River salmon, because salmon are subject to many sources of mortality, not just one. Juveniles have to survive mortality caused by hydro dams, avian predation, and pinnipeds, and adults have to survive harvest and pinniped predation. What makes the situation interesting is that the natural causes of mortality are affected by human impacts, creating predation dynamics that are different from historical dynamics. Island formation in the Columbia River mainstem is a byproduct of changes to flow patterns caused by the FCRPS reservoir system. Island formation created breeding grounds for bird populations, which caused an increase in bird abundances, and subsequently increased the predation rate on juvenile salmon. Additionally, Bonneville dam created a pinniped/adult salmon predation dynamic that is unlike that of a free flowing system. A large concentration of adult salmon at the base of the dam creates a situation where sea lions can more easily prey on salmon, making it more desirable for them to include salmon in their diet.

- Since there currently (as of 2015) appears to be an increasing trend in the number of sea lions in the Columbia River, it is important to formulate predation not only in terms of salmon killed, but in terms of salmon killed per predator. Central to the study of the effect of predators on their prey is the measurement of the functional response, the kill rate, or the predation rate, which are more or less interchangeable when abundances and kills are

known, but the functional response, which is the number of prey killed per predator per unit time, is the most informative measure of predation. It provides the means to predict the long-term trend in prey abundance across a range of predicted predator abundances (if other prey dynamics are known). For example, if we know the number of adult salmon killed per sea lion during spawning migration, and we know the abundance of salmon migrating, then we know the number of salmon killed per sea lion at a given number of salmon migrating. As the predator population increases, we can then estimate the increase in the number of salmon killed, which translates to a predation rate. Characterizing the functional response involves estimating two parameters with samples of the kill rate at different predator and prey abundances.

- The resilience of predator and prey populations is intrinsically linked to the functional response, but only if the recruitment rate of predators is linked to the functional response, i.e., if the birth rate and/or survival rate is higher at higher feeding rates of the prey species. Resilience is also linked to the productivity and capacity of the prey population. In fact, in the absence of a predator, a prey population will have an equilibrium abundance at which it is in balance with its carrying capacity (e.g. availability of spawning habitat). The productivity will only affect how quickly abundances return to equilibrium if disturbed.

- However, if the prey does not represent a significant amount of energy to the predator, then there is nothing resilient in the dynamics for the predator, because the predator is not limited by the presence or absence of the prey. This is likely the case with the sea lion/salmon dynamics, which can be problematic for salmon if sea lion abundances continue to increase independently of salmon availability. It is not accurate to say that sea lions are contributing to the resilience of salmon unless it can be shown that there is two-way interplay between salmon and sea lion abundances.

- The Report, after cautioning against predator control as a management strategy, states that "… as a strategy for recovering depleted populations, a focus on first maintaining a diversity of habitat seems more in keeping with the "resilience thinking" approach…". However, any "resilience thinking" should first acknowledge the dynamics in which species abundances are apparently being resilient, and should also acknowledge the historical baselines for the abundances to which species are resiliently attracted.

- In the absence of fishing or sea lion predation, salmon resiliently reach an equilibrium abundance set by the carrying capacity and productivity, and there are uncertainties associated with both of these. If the uncertainties in both of these are contained in freshwater, and if sea lion predation is isolated below Bonneville Dam, then there can't be any feedback between sea lions and salmon, and there is nothing resilient about the dynamics. This implies that there is some compensation in salmon survival occurring below Bonneville Dam, such as density dependent survival in the estuary, density dependent adult pre-spawn mortality, or a negative feedback between predation rates and salmon abundance.

- The rise of pinniped numbers in the Columbia River in recent years is alarming. Adult in-river mortality rates are increasing with pinniped abundances, it is uncertain if the functional response is linear or non-linear, and it is uncertain the functional response predicts anything in the migration rate of pinnipeds into the Columbia River. This means there is no way of knowing if there is any balance or resilience in the predator prey dynamics of pinnipeds and salmon. There is a case to be made that establishing the functional response of pinniped predation on salmon should be listed as a high priority critical uncertainty. This would involve estimating abundances of sea lions, and estimating the number of salmon killed. Since the abundance of returning salmon is already estimated at Bonneville, but not elsewhere in the river, it would involve estimating the number of salmon killed at assumed salmon abundances where kills occurred. A statistical model could be designed to estimate relative abundances where kills are assumed to occur. Kills can be estimated using PIT tag recovery records, where PIT tags are deployed on samples of returning salmon (as a recent NOAA study has done in recent years). Kills can also potentially be inferred from accelerometer equipped tags deployed on pinnipeds, where movement patterns could be analyzed and used to infer killing behavior.

- To fully understand the effect of predation on salmon, it is essential to understand the functional response and to estimate the direct population consequences of predation on salmon survival and on predator abundance. Since pinnipeds are unlikely to experience any direct effect on birth and survival processes as a result of consuming salmon for one month of the year, it is even more important to understand the dynamics. If pinniped abundance in the Columbia River does not decrease when salmon abundance decrease, then the mortality rate of salmon will increase, leading to a further decline in salmon abundance. There are many possible mechanisms that predict the functional response, and there are also mechanisms that predict numerical responses of predators to prey abundances, and the combination of these predict predator population trends. Some mechanism predict stable dynamics between predators and prey, some predict the effects of alternative prey abundances on predation dynamics, and others predict negative feedback in predator abundances on predation rates. To fully understand predator-prey dynamics, the essential first step is to understand the functional response.

Theme 11. Fish propagation:

- The section on Fish Propagation focuses on purported risks of reduced fitness to natural populations resulting from associated supplementation hatchery programs. However, this focus is misplaced. The section requires a preface/caveat that supplementation is enacted to obtain the benefits of rebuilding and maintaining abundance of natural populations – populations for which abundance has been severely reduced due to effects of hydrosystem development and habitat alteration. Restoration, properly speaking, will only come via actions to reverse the hydrosystem and habitat effects, including climate change. That hatchery programs should be judiciously managed is obvious, but inference that restriction or cessation of hatchery programs to reduce/eliminate associated “risks” and facilitate “restoration” is erroneous.

- Omit inclusion of disease as a risk to natural populations associated with current Columbia basin hatchery programs. The authors here (and in other reports) provide no published or grey literature support for this statement – because essentially none exists.

- A "risk" for loss of genetic diversity or of "local adaptation" among populations of white sturgeon, and particularly of Pacific lamprey in the Columbia basin, associated with hatchery supplementation or adult translocation is exaggerated. Hydrosystem development and habitat alteration have severely diminished effective populations sizes and other VSP parameters among these populations (and have even extirpated fish from some systems). The risk of not enacting these programs far exceeds the hypothesized risks described here.

- The Columbia River Treaty Tribes responded to the ISAB's density dependence report (ISAB 2015-1) in a letter to Dr. Naiman date July 22, 2015 and the points we made in that letter are incorporated here by reference. In addition, the ISAB comments on Fast et al. (2015) ignore findings in that study that the Naches reference/control population, in the absence of supplementation, is at best maintaining itself and may well be declining. Density dependence is not a new issue and was evident throughout the Yakima Basin long before the supplementation program began in the upper Yakima River. Irrigation diversion and hydrosystem dams have dramatically altered natural flow regimes and these altered flow regimes have in turn affected food webs and species composition (e.g., increased warm water predators, shad, etc.) throughout the Columbia River Basin (e.g., Hinrichsen et al. 2013; Haskell et al. 2013). In addition, a number of other factors such as agricultural, industrial and urban effluents, climate change, etc., continue to impact natural productivity. It is important to note that all of these factors are virtually unrelated to hatchery effects. As the ISAB stated in Programmatic Comment 6, density dependence signals a need for restoration actions to improve capacity and productivity of the habitat. Unfortunately, the ISAB also continues to suggest that "the goals and size of supplementation programs be regulated" based on the current juvenile and adult carrying capacities of these highly altered river systems that we have created. This ignores the laws that created these hatchery programs to begin with. There is a reason these programs have names like "Lower Snake River ***Compensation***" and "John Day ***Mitigation***" – they were created with the specific intent to compensate and mitigate for the losses in natural production and productivity that we knew would occur when we proceeded to dramatically alter natural environments throughout the Basin. The Columbia River Treaty Tribes, as well as many other organizations, have stated on numerous occasions that it is unacceptable to allow populations to dwindle to museum or extinction levels as we see happening with Naches River spring Chinook. That is why we continue to support concerted habitat restoration efforts to restore natural productivity in combination with hatchery supplementation and mitigation to offset the losses to our treaty-reserved fisheries that have occurred due to historical and continued development throughout the Basin.

- The Fish propagation section should be prefaced by a brief acknowledgement of a "critical certainty" – which is that effects of hydrosystem development and habitat alteration are at the source of what has led to the reduction (sometimes severe) in VSP

parameters of natural populations of Columbia basin anadromous fish. Initially hatchery production was carried out simply to replace of natural production coming from throughout the basin with production from segregated mitigation hatcheries in the lower river – to serve the non-tribal lower river commercial and sport fishery. Over time, additional production has come from hatcheries further upstream, some of them supplementation hatcheries that serve the dual beneficial purposes of providing a modest level of harvest and additional adult escapement to rebuild and maintain abundance of depressed interior populations. Supplementation was not conceived as a means to solve the problems (hydrosystem and habitat-related) that were (and continue to be) the cause of the population declines.

- There are several unjustified inferences in the Fish Propogation section that hatchery impacts are always negative, thus disregards beneficial effects - that are admitted in other statements. Sentence could be reworded as edited.

- There is a unjustified inference in the following sentence, *"Prospective management actions designed to maintain or enhance beneficial effects of hatchery production while also lessening any cumulative negative impacts become possible once the locations, life stages, types of impacts and their potential consequences have been identified.,"* This implies hatchery impacts are always negative, thus disregards beneficial effects that are admitted in other statements within the Report.

- The possibility of spreading disease to natural populations is repeatedly cited (here, the 2014 F&W Program, and elsewhere) without any citation of cases where a Columbia basin hatchery program has had such an effect. Management policy for Columbia Basin salmon hatchery programs proscribes importation of out-of-basin fish (which might carry a non-endemic pathogen). The introduction of non-endemic pathogens is of concern, not through salmon hatchery programs, but from introduction and spread of exotic aquatic species.

- Statements regarding "*lasting demographic benefit*" should be clarified. Supplementation will not correct the hydrosystem and habitat-related issues that constrain natural population productivity. Supplementation beneficially serves to rebuild and maintain a more elevated spawning escapement during the life of the program. Levels of abundance and productivity of a natural population after it is deemed acceptable to terminate a supplementation program, will depend on the extent to which these hydrosystem and habitat issues have been resolved. And importantly, IF there has been any observable reduction in natural productivity in the integrated population associated with a domestication effect, natural selective forces will be able to act to reverse such an effect.

- It may be more appropriate to state "*long-term demographic benefit*" would be more appropriate. "Lasting" makes it sound like the supplementation tool is being turned off and the natural population will ultimately rebound. This will not happen without substantial efforts to reduce the reasons (i.e., hydro/habitat issues) for why the supplementation tool is used in the first place.

- In regards to lamprey supplementation, we reiterate our comments on salmonid supplementation. Supplementation was not conceived as a means to directly solve the problems (hydrosystem and habitat-related) that were (and continue to be) the cause of the population declines, translocation and supplementation only serve to build up and maintain natural production, to provide the time necessary to enact measures to reverse the hydrosystem and habitat effects that constrain natural productivity.

- Pacific lamprey are at low levels essentially everywhere throughout their PNW range. If a fish that is the product of a Columbia basin translocation effort returns as an adult to a different river, this should not be viewed as a failure – the other river likely needs the additional escapement as well. Current evidence infers little if any population sub-structuring in Pacific lamprey, and therefore little if any local adaptation" to disrupt via adult translocation.

- We were confused by the statement, "*These constraints, along with low or non-existent natural recruitment, mean that genes from hatchery fish are likely to be disproportionately represented in future generations."* Yes, if natural recruitment is very low, or zero (as has been observed in some reservoir reaches in some years), genetic diversity of hatchery-origin fish will dominate, or be totally reflected by the diversity among these hatchery origin fish. But isn't this a much better situation than to not hatchery supplement and have very little, or zero, genetic diversity because you have very few, or zero, natural recruitment?

Theme 12. Harvest:

- No comments at this time. The absence of comment does not indicate agreement or disagreement with the content of this section.

Theme 13. Population structure and diversity:

- No comments at this time. The absence of comment does not indicate agreement or disagreement with the content of this section.

Theme 14. Monitoring and evaluation:

- The goal of restoring habitat in tributaries and removing barriers is to increase carrying capacity. If there is a possibility that the newly opened habitat would be colonized by hatchery fish or non-native species, it was suggested that there would then be no value for recovering native wild fish. There is no benefit to the wild fish, however, of not opening up this habitat. There is always a possibility in any basin that hatchery fish populations would grow more rapidly and expand their use of habitat than wild fish. If hatchery managers have already committed to using locally adapted stock in a supplementation program, then the actual threat in this case of opening new habitat does not exist. Both hatchery and wild fish of the same stock need increased habitat carrying capacity. If there are no wild fish in this hypothetical basin, then there also is no threat.

- The two statements, "*Are the current procedures being used to identify limiting habitat factors accurate"* and "*Furthermore, because of the large scales, relatively little is known about whether current methods used to measure habitat are accurate"(CU #14)* are somewhat different. One involves procedures to identify limiting habitat factors and the other is methods to measure habitat. Identification of a limiting factor is typically an hypothesis statement. It is made on the basis of what is known about the current habitat conditions and the relationships known between habitat condition and biotic response. If a monitoring program intends to measure trends in habitat conditions taken to be limiting factors, it is important to measure the conditions using methods that accurately reflect the biotic response. The characteristics of methods that can make this possible involve whether measures of habitat quality/quantity at site-specific scales can be integrated across space; whether the best set of indices is selected that work together to reflect population level response.

- Critical uncertainty 16 could also involve the pattern and amount of restoration needed to provide the most efficient improvement in habitat quality/quantity and spatial diversity in these factors. This efficiency may require a pattern of building outward from centers of habitat health, which often is a pattern of starting in the headwaters and working downstream. This issue is separate from long-term viability, but deals with the most rapid rate of improvement and also addressing all key limiting factors from the centers of population strength rather than improving only pools or LWD basinwide and then considering riparian shade improvement.

- In addition to identifying, "*the dominant processes, often occurring at watershed and larger scales, that shape and maintain these sets of habitats,"* the influence of watershed development or land management activities that shape in-channel conditions must be addressed.

- This section of the Critical Uncertainties report repeats some concerns from the prior Tributary Habitat section, namely the desire that projects improve approaches in "measuring the cumulative effects of habitat restoration on fish populations at a large spatial scale," (Executive Summary, p. 9) and that "methodologies for evaluating the cumulative impacts of many small projects are particularly underdeveloped" (p. 133 of full report). Discussed above, the Tributary Habitat section, the Monitoring and Recovery Trends project (2009-004-00) is currently engaged in active research addressing this topic, the foundation being a comprehensive, multi-agency database of restoration activities and intensity from the 1990s to present in the upper Grande Ronde subbasin. We have developed procedures to evaluate several small projects at a watershed scale, including combination of project types or "syndromes" of multiple restoration activities using multivariate techniques. These methods, once refined, can be applied to other Columbia River subbasins.

- By virtue of contributing to the development and adopting protocols of CHaMP, the Monitoring and Recovery Trends project is directly engaged in a common probabilistic site selection procedure, which allows sharing of results and inferences across other Columbia River subbasins where CHaMP data exist. We caution that oversimplified

summaries of habitat conditions at basin scale may be misleading, especially based on the relatively small proportion of the total basin area sampled using CHaMP. We also caution that while data mining can be useful for exploring patterns and developing hypothesis, it should not be a replacement for more rigorous hypothesis testing approaches.

- The Critical Uncertainties report cites the need to employ empirical (e.g., regression) models for "prediction of current abundance or presence-absence of focal species concurrent with the collection of data on status and trends of wildlife and fish populations and habitat…" (p. 136). A table is referenced <http://research.nwcouncil.org/researchQuestionProjects?id=43> listing projects which address CU #43; however missing from the list of projects is Monitoring and Recovery Trends, which employs both (a) structural equation modeling and (b) linear mixed effects models in developing linkages among land use, restoration, and focal species.

- While we agree with the stated caveats for regression models, an approach used in the Monitoring and Recovery Trends project—structural equation modeling—was developed to explicitly address the problem of multiple causal mechanisms where variables are used simultaneously as both predictors and responses. This approach does not completely solve the problem of models extending beyond the measured parameters (e.g., predicting the effects of climate change variables outside their current range); however understanding the direct and indirect empirical relationships provides increased understanding and predictive ability.

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