ISAB

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Review of the Estuary Recovery Module

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A. Assignment Background

On November 27, 2007, the ISAB received an assignment from NOAA's Science and Research Director Dr. Usha Varanasi to provide a scientific review of the Columbia River Estuary ESA Recovery Plan Module for Salmon and Steelhead. The module was prepared under contract for NOAA's Northwest Regional Office to provide consistent treatment of the factors in the estuary that affect all listed salmon and steelhead in the Columbia River Basin. To inform the ISAB's review, Phil Trask (P.C Trask and Associates), the consultant that prepared the estuary module, gave a presentation to the ISAB in Portland on January 25 2008 and verbal responses to comments posed by ISAB members in their preliminary review.

The estuary module is intended to complement all Columbia River Basin salmon and steelhead recovery plans. Specifically, the purpose of the module is to identify and prioritize habitat-related management actions, that, if implemented, would reduce threats to salmon and steelhead in the Columbia River estuary and plume. The estuary module was prepared to link with the upstream recovery plans of the Federal Columbia River Power System (FCRPS) Biological Opinion as the estuary is a common area for all stocks in the Columbia River Basin.

In the context of the lower Columbia River management plans, the estuary module is said to be consistent with information in the Council's "Mainstem Lower Columbia River and Columbia River Estuary Subbasin Plan (NPCC, 2004), the Lower Columbia River Estuary Partnership's Comprehensive Conservation and Management Plan, and the Columbia River Estuary Study Taskforce's Columbia River Estuary Data Development Program. In addition, other ongoing planning processes will be using information from the estuary module to various degrees. These include the FCRPS Biological Opinion remand collaborative process and activities of the Lower Columbia Fish Recovery Board and Lower Columbia Stakeholders Group.

The importance of the Columbia River estuary habitats for juvenile and adult salmonids and our lack of scientific data from these areas have been recognized in several recent reviews by the ISAB and/or ISRP. These include a report on how estuary management fits into the Columbia River

Basin Fish and Wildlife Program (ISAB 2000-5) and the subbasin plans review (ISRP/ISAB 2004-13). The estuary also featured prominently recently in the ISAB report on human population impacts on Columbia River Basin Fish and Wildlife because of the concentrations of urban development in the lower river and estuary (ISAB 2007-3). The need for additional research, monitoring, and evaluation of estuarine restoration projects has been noted in recent ISRP Retrospective Reports (e.g., ISRP 2005-14).

To provide a focused review of the estuary module, NOAA proposed six questions, as per below. The ISAB responded to each in depth, as time allowed, and also provided a detailed Appendix providing specific comments on the document.

B. NOAA Questions for Estuary Module Review and ISAB Responses

1. In general does the document make logical connections between limiting factors, threats and actions, and has it made appropriate use of available information? Are assumptions and uncertainties adequately characterized? Is the analytical process used in the document adequately transparent?

We do find that in general the document adheres to the conceptual ecological framework adopted by the Council and explained in detail in Williams et al. (2006). This framework, meant to be a general guide on how to approach applied research and management, sets out the inferential connections between limiting habitat factors and salmon survival in the Columbia River Basin.

The ISAB had concern about the use of the words "limiting factors" in the document, given that the terms have a very significant meaning in ecological science. Limiting factors are known as conditions or processes that have been proven by scientific investigation to have actually influenced survival of a population. There has been insufficient research in the Columbia River estuary, or indeed any estuary on the northeast Pacific, that has identified limiting factors for salmonids. In many ways, the list of factors in the estuary module is a reflection of what has been studied, not a proven list of what has in fact limited salmon populations in the estuary. Therefore in our review below we use the term potential limiting factors. This use of terminology might also be advisable in the module. Such a usage would imply that at least at some scale, within some range of values, the factor might be a limiting factor (as opposed to the other factors, which would not be limiting at that scale or range).

For some potential limiting factors, the ISAB found the document made well-founded connections between threats and actions. However, for others, because of gaps in our understanding of how the estuary functions to support Columbia River salmonids, inference and expert opinion was perhaps relied upon too heavily. The studies cited in the report show that mortality rates determined by tagging and predation by birds and non-salmonid fish are the only factors that have been quantified and hence amenable to numerical analysis. Micro-acoustic tagging studies of juvenile salmonid survival through the lower river and estuary, such as the Bonneville-funded Pacific Ocean Shelf Tracking (POST) and the Corps-funded NOAA Fisheries work, have only been implemented within the last several years, and thus the results have not yet appeared in the primary scientific literature. The other potential limiting factors, especially some of those relating to habitat (e.g., flow-related changes in access to off-channel habitat, Table 4-1), have not been studied enough in the estuary to develop quantitative relationships with survival. The ISAB realizes that professional judgment needs to be relied upon under these circumstances but points out that using a rather informal procedure to develop rating schemes adds another layer of uncertainty on top of the scientific uncertainty.

The ISAB was therefore concerned about the transparency of the process used to develop relationships, score factors and threats, and estimate possible survival gains from restoration. No information was given on who the scientists were that provided feedback to the contractor who wrote the report, they are simply identified as “area experts” (p. 3-1). An acknowledgment section should have been provided and would be useful in future drafts. The personal citations and telephone call references in the literature cited section (page 8-1 to 8-7) show that all regional estuarine experts may not have been involved in the process. How many scientists participated in the meetings, how were the final scores arrived at, was consensus reached, and were there any dissenters/minority opinions? A formal “expert” process such as the Delphi method (Ziglio 1996) was not used to develop group consensus on ranks or weights used on factors and threats in Table 4-1.

In addition, some estuarine experts working on estuaries and salmonids on estuaries other than the Columbia River estuary were consulted (e.g., those working on the Skagit River estuary), and some literature references to other out-of-basin studies were cited. However, given the paucity of published information available from the Columbia River estuary, the ISAB suggests that a major think-tank process involving estuarine scientists from around the region might have provided more insight into methods for achieving an estuary recovery plan.

The module is a good summary of the importance of the estuary and the various factors that ***could*** influence production and diversity of anadromous salmonids in the Columbia River Basin. It is, however, a review of reviews as the authors of the report relied heavily on three internal agency documents – Fresh et al. (2005), Bottom et al. (2005), and NPCC (2004). These were considered key documents (p. 3-1), but a review of reviews generally does not meet ISAB standards as a scientific document. A review of reviews might be acceptable when citing generally accepted scientific knowledge. Where the science is weak and scarce, such as in the estuary, primary references are preferred so that the reader can get a sense of how reliable the science actually is. If there are few primary citations, caution is advised when applying the science to management questions. Other questions arise from citations to telephone conversations, citations without dates, and citations in the text but not in the references. This suggests that the module was not reviewed by prominent estuarine biologists at NOAA's Northwest Fisheries Science Center and was not written for a critical scientific review.

Chapter Four of the module describes a model of the estuarine ecosystem that is under development by the Corps of Engineers (Fig 4-1 in the module). Although apparently very complex, the model might supplement the expert opinion approach that was used to identify threats in the module. However, the model is no longer available on a public website and hence was not available for review.

2. Have limiting factors and threats been completely and credibly identified?

Chapter 3 outlines and discusses potential limiting factors that affect juvenile anadromous salmonids in the Columbia River estuary and plume. The included factors in the text and in the summary Table 3-1 are recognized in this draft and in other papers as important in the estuary. We believe the major potential limiting factors have all been listed. However, some of threats of these factors have not been completely identified. Potential limiting factors that should receive more attention in the module are 1) climate change and temperature, 2) hatchery releases, and 3) impacts on adult salmonids.

Although climate change is addressed in the module (p.5-3) and water temperature is cited as a threat, we believe it should be more clearly recognized as a threat. With the extant trend of heated reservoir temperatures and climate scientists' predictions for even warmer water below Bonneville Dam, and increasing tributary temperatures, this will be a major limiting factor in the future, both for the survival of smolts as well as returning adults. The influence of increased water temperatures on predation rates by fishes is also a factor and was not discussed.

The recovery plans should recognize the potential for various factors to interact. Recovery may depend on summed or synergistic effects of several actions. For example temperature could interact in different ways with various types of restored habitat – for example increased water temperature might affect a transplanted eelgrass bed differently than a restored riparian habitat.

We believe more recognition should be given to the impact of large releases of hatchery fish as a threat to survival of wild fish. Although density-dependence between wild and hatchery fish was discussed and Competition and Predation are cited in Table 3-1 as potential limiting factors under Food Web-Related Factors, this issue deserves more attention in the module. If rearing habitat is limited in the estuary and massive pulses of large hatchery fish displace small wild fish, this could be a significant limiting factor. Disease transmission may also be a factor. We agree that this issue merits research. The future module that describes planned estuary research, monitoring, and evaluation (p. 6-5) will be a critical addition to the module.

The estuary module focuses on juvenile ocean- and stream-type salmonids, not on returning adults that also transit the estuary and are impacted by many of the same factors: flows, temperature, predation, disease, toxicants, etc. Steelhead kelts also pass through the estuary on their return to the ocean. Returning adults and kelts deserve more recognition in the module.

3. The module prioritizes limiting factors and threats. Is the approach to prioritization appropriate and do the rankings seem accurate?

The usage of the term "limiting factors" implies that there is a proven or strongly implied relationship between how much of one of their listed so-called limiting factors is present and either the abundance or survival (mortality) of the salmonids. To say that a factor limits salmonids in some way implies a strong relationship between the two factors, *at least at some identified scale.* For fish populations, many habitat factors can be considered limiting *over a wide scale*, because ultimately more habitat is usually better than less. But within a given narrower range of habitat variability that exists *or is realistically likely to exist*, some other more specific factors such as predation may actually be limiting. As an example, water temperature or flow-related estuary habitat changes, access to off-channel habitat, and plume changes all rated very highly in impact (score = 8). At a large scale, over orders of magnitude of variation in them, these are clearly potentially limiting factors. However, within a narrow range of the above factors as might exist today, and is likely to exist, native birds, fish, and pinnipeds might be more limiting, in that over the range of factors now existing, there might be a clearer, stronger correlation between bird, predatory fish, or pinniped numbers and salmon abundance and survival/mortality rate than would be found between abundance and mortality and the existing variations in habitat factors. Although predation might be easier to measure in the estuary compared to the complex effects of habitat, the ISAB recognizes that both deserve attention as potential limiting factors.

To adequately prioritize limiting factors, it would seem to be necessary to understand the nature of the mortality associated with the estuary that acts on salmonids as they pass through the estuary. That is, if one so-called limiting factor is the one that most clearly limits abundance or survival, it would be the higher priority factor. However, on page 3.1 the authors state that "Estimates of salmon and steelhead mortality in the estuary and mainstem are not well supported in the literature." On the next page we read "How much density-dependency is taking place in the estuary compared to the ocean is unclear." The shortage of information on mortality may change as tagging studies yield some meaningful results. However, without more specific information than is given in the document, it is not possible to clearly prioritize the limiting factors based on mortality. This seems to be the situation for the authors, in that there is very little range of variation in ranked importance for most of the variables. Instead, it might be more desirable to prioritize them based on which would be *potentially limiting at which scale or over a certain range of values.*

Beyond these issues, the items identified Table 3-1 seem to be the potentially limiting factors. However, it would be especially useful if an additional column were added to the table (on the right) listing the specific primary references that were used by the authors to identify each factor as a potentially limiting factor. The use of primary literature is often lacking, especially in this portion of the document.

4. The recovery plan module establishes a target of 20 percent for improved survival of salmonids in the estuary and plume. The survival improvement target is intended to serve as a planning tool useful in characterizing the potential results of actions and was based largely on professional judgment (see 5-35 of the module). Does the module adequately characterize the development and utility of this target and its limitations?

As the module authors note, the analyses described in Chapter 5 do not fully represent the complexity of factors that influence salmonid survival. The intricacies of the relationships among the various threats and management actions as well as the uncertainties at each step of the analysis mean that the survival improvement targets should be viewed as planning tools only.

For example, the 20 percent target for improved survival of salmonids is proposed for planning purposes only and, as such, represents a hypothetical level of improvement that might be achieved under certain conditions. The authors characterize the development of this target as: "The 20 percent figure is based on overall estimates of juvenile mortality in the estuary, known mortality that can be attributed to specific threats, and professional judgment regarding the efficacy of the different management actions and the likelihood that constraints to their implementation can be overcome." (Estuarine Module, page 5-36) The authors further note the limitation of the 20 percent target in Appendix B (page 1) where they note that the target is not scientifically based but only represents a planning target that will be refined as survival improvement project proceed. The limitations of this target are further characterized by noting that although the targets are intended to be reasonable and plausible the targets could be refined following open discussion of technical, political, and social dimensions.

There would appear to be a danger in exploring only one target amount for improved survival of salmonids. There is much uncertainty surrounding the establishment of the 20 percent target that other levels should be considered. A similar exercise with lower and higher target levels (for example, 10 and 30 percent) could better inform decision makers as to trade-offs under different scenarios. An additional important advantage of specifying multiple targets is to preclude automatic acceptance of one tentatively suggested value being accepted by all interested parties. The consultant apparently requested feedback from NOAA researchers on the target, and some of their scientists (not cited) said it was reasonable and accepted it as a plausible planning number. However, also according to the module authors, life-cycle modelers thought the number was too high. Results from the scientific literature on bird predation in the estuary and several years of unpublished results from micro-acoustic tagging studies were the main information sources.

A survival improvement target for the estuary and plume would be particularly difficult to develop for these two areas since they are not independent. Importantly, how will survival be measured within the estuary and the plume? By what techniques? This is a very daunting task that will have inherent variability. Ocean processes such as upwelling into and under the plume affect the estuary since nutrients are carried upstream in the salt wedge into the estuary proper. Variations in ocean conditions therefore have a strong influence on estuarine productivity and habitat conditions.

Ocean conditions are believed to play a major role in the run sizes and survival of salmonids. Estimates of ocean mortality often include mortality in estuaries, for example, estimates of SARs from Bonneville to Bonneville. To evaluate the import of the estuary, it seems necessary to study the relationship between estuarine and ocean survival. Are they positively linked, negatively linked (compensation), or independent? Partitioning survival among estuary, ocean, and in-river should be recognized in the revised module.

5. The module proposes that the usefulness of the 20 percent target lies not in the number itself but in the distribution of the target across the various management actions as a way of characterizing the relative benefit of the different actions. Is the allocation of benefits among the actions and geographic locations credible and appropriately transparent?

The authors do a good job of describing the allocation of benefits through presentation of a series of tables. This presentation makes the allocation of benefits among the actions clear. The allocation is credible contingent upon one's acceptance of threats, management actions, and constraints that are clearly presented. The allocation benefits among the geographic locations should be more clearly described and justified.

The ISAB felt that distribution of the 20 percent target across the various management actions is overly simplistic. Wild juvenile salmonids display a rearing migration, moving downstream as they grow and hence benefiting from exposure to a sequence of habitat types and food, using them in a size-dependent manner. Therefore, improvement of survival from improvement of a potential limiting factor in an upper estuary habitat (e.g., restoration of riparian habitat in the freshwater tidal zone – 6 percent) would not be successful for the whole life cycle if a potential limiting factor in the lower estuary (e.g., disperse Caspian terns – 21 percent) was not done at the same time.

6. As described on page 6-5 of the module, additional development is anticipated on a research, monitoring, and evaluation program for the estuary, particularly in terms of action effectiveness monitoring. Does the ISAB have any recommendations on developing such a program for the actions in the module?

The ISAB notes that the document states (p. 6-5) that as the estuary module was being completed a process was underway to identify (1) gaps between existing monitoring efforts and needed monitoring for the management actions, and (2) additional recommended monitoring activities to fill those gaps and thus ensure that the necessary monitoring is conducted to support all of the 23 management actions. Another module dealing specifically with monitoring is being prepared, and it would be more effective to read this document before answering this question. The ISAB also notes that an adaptive management approach (ISRP Retrospective 2007, draft) could be a way of using the results of action effectiveness monitoring in assessments of the various management actions listed in Chapter 5.

The ISAB also notes that a number of ongoing or proposed research, monitoring and evaluation (RM&E) projects in the estuary have been reviewed by ISRP recently and their comments are useful for development of an estuary package. The Estuary RM&E Pilot Project (2005-001-00) is intended to study the ecological importance to Snake River fall Chinook salmon of shallow water habitats in the 100-mile tidal freshwater reach of the Columbia River downstream of Bonneville Dam. In their review of the project, the ISRP (ISRP 2006a) reiterated the need for a larger scale investigation of habitats and their use by fish in the upper estuary. While not specifically addressing action effectiveness, the ISAB is of the opinion this research on ecological functioning in the estuary is required to support action-effectiveness work. ISRP (2006b) provides reviews of a number of projects that are relevant to development of an estuary module for RM&E in the lower estuary, e.g., Lower Columbia River and Estuary Ecosystem Monitoring, Effectiveness Monitoring of Estuary Restoration in the Grays River and Chinook River Watersheds.

We also suggest the authors consult ISAB 2000-5 for a comprehensive review of needed action effectiveness work as well as recommended RM&E work in the Columbia River estuary.

We re-iterate the need for coordination among the various groups involved in action effectiveness monitoring. There is a need to continue building a coordinated, integrated "estuary" program among the various funding entities and project sponsors. For example, how will the estuary module dovetail with draft Federal Columbia River Estuary Research, Monitoring, and Evaluation Program (Johnson et al. 2006) and integrate the ongoing or proposed projects? How the agencies select specific projects, how they will be coordinated with other agencies, and how they will conduct research on effectiveness (and on the impact of hatchery releases, for example) are all issues that need to be addressed.

C. Conclusions

The ISAB recognizes the estuary module is a framework plan that visualizes what needs to be done in the estuary over the next few decades and as such is a pioneering effort. Very few estuary management plans for salmonid habitat restoration have had such a broad scope. However, the module leans heavily toward management tools and not to science and therefore should not be couched as a scientific document. The ISAB was concerned about the transparency and credibility of the document and strongly suggests that future versions of the module:

- Consider and incorporate the ISAB's comments,

- Acknowledge the scientists that provided input and review of the module,
- Use a formal expert opinion approach that involves more estuarine experts in the region,
- Provide more rigorous scientific documentation with a focus on primary literature,
- Highlight the interaction between estuary and ocean and indicate that, without long time series of data, ocean variability (e.g., upwelling, regime shifts) could mask the benefits of the recovery of estuarine habitat,
- Document the basis for the 20 percent increase in estuarine survival and how it will be measured,
- Prioritize selected restoration actions with multiple benefits even though fish responses may be difficult to recognize, and
- Incorporate an adaptive management strategy when designing RM&E and action effectiveness studies.

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E. Appendix

Please note that the comments below are examples and are not comprehensive.

Executive summary

Page x - ocean Chinook tend to spend longer times in the ocean than stream-types (is this from Rich 1925? Healey 1991?).

Chapter 1

p. 2 - according to the figures here the estuary has decreased 15% in area and elsewhere in the document "about 20%" is given (Chap 3, p. 3). Was any consideration given to percent change in volume of the estuary (especially at different elevations, related to habitat availability?

p. 8 - salmon have survived in the Columbia River for much more than 4000 years!

Chapter 2

p. 1 - third line, insert "anadromous" before salmonid.

p. 1 - second paragraph concerning juveniles released within the estuary and plume return in greater numbers, is this from Solazzi et al. 1991? Also what is the specific reference for Casillas 1999 (only general reference to a Symposium Proceedings is given)?

p 2 - the authors state 65-75% of returning adults are hatchery fish. It would be helpful to focus on wild fish at this point in the document. Later on (page 5-34) it is stated only juveniles of wild fish are considered in their analyses.

Is it correct then to assume that hatchery fish do not "count" toward recovery goals? If they do, then does this whole analysis have to be re-done using hatchery fish?

Since many of the studies of juveniles in the estuary in the past (i.e., pre-PIT tag days) have found it difficult to separate wild and hatchery fish, is it possible that much of our knowledge of estuarine ecology is in fact based on a mixture? E.g., see authors' comment on p. 4 –"Today juveniles tend to arrive in pulses and are more uniform in size" (these must be hatchery fish?).

-comment: predation is really the only factor with hard data that applies to mortality.

p. 3 - are the data on pike minnow predation behind pilings now published? (The citation from Casillas 2007 is a phone call.)

Chapter 3
p. 1 – how was EDT used and how much reliance was placed on the mortality estimates (18-58%) derived via EDT?

p. 2 - Within the estuary, partitioning of survival among reaches in the estuary from the recent acoustical estimates would also be relevant to assess where mortality was highest and where actions may be more effective.

p. 5 (and also Chapter 7-5) - References on the importance of off-channel habitats to stream type salmon and steelhead are needed. Why is breaching dikes and levees important for stream-type Chinook in the estuary? Documentation for protecting high quality off-channel habitats is needed.

p.6 (and also CRE-10, page 5-38) - How will sea level rise in the estuary affect tidal flooding, shallow water habitats, dike removal, and restoration efforts? Mr. Trask said that continental uplift will counteract sea level rise. Please provide a reference relevant to this region.

p. 7, Executive Summary - Do Schabetsberger et al. (2003) state that the plume is more important as a feeding area than offshore waters? Figure 4 shows that *Cancer* megalopoe are common in frontal areas, not zooplankton as cited in text.

p. 11, last line – insert “less” before susceptible.

p. 13 – mortality estimates are given for bioaccumulation toxicity but not short term toxicity. This section is somewhat confusing because aren’t PAHs bioaccumulated too?

p. 14, Figure 3-4: please indicate where the “confluence” and “hatchery” are located.

p. 15 and 16 – was a formal and structured method (e.g., Delphi or similar) used in the meetings of experts that developed the scores for potential limiting factors and other metrics? How many persons participated? How were the final scores arrived at, was consensus reached, and were there any dissenters/minority opinions?

Chapter 4

p. 1 – can a reference be provided for the USACE model?

p. 4 – why not cite IPCC 2007 instead of IPCC 2001?

P. 4- 6: “Ocean-type juvenile salmonids are affected by sediment-related changes in habitat in the estuary. Stream-type juveniles are affected by reduced turbidity (which can increase predation) in deeper waters in the estuary and plume” – ocean type would be affected too as they migrate through the estuary and into nearshore waters.

p. 7 – is there any directly mortality to juvenile salmonids from dredging?

p.10 – this is the first place in the document where cumulative effects are explicitly mentioned. Can the authors give any perspective on the importance of cumulative effects approach rather than factor-by-factor approaches to threats?

p. 10 – comment - Beamer et al. 2005 deals with intra-specific competition not inter-specific competition.

Chapter 5

p. 1 – how will this recovery plan be integrated with an estuary management plan (we assume there is one but it is not referred to)?

p. 5 – the statement is made “….hydrosystem operations that affect estuarine habitat are unlikely to be addressed in recovery plans being developed for upstream areas of the Columbia River Basin.” Is the present draft document designed to try and remedy this? It is a key issue.

p. 5 – as per above comments, more detail on scoring methods are needed.

p. 35 – unlike the factors and threats, only one group was apparently involved in developing and reviewing the 20 percent survival improvement number. Is this correct? Are there any plans to discuss the 20 percent figure with the people who developed the threat scores, etc.?

The authors suggest "open technical, political, and social discussion could refine the targets until science substantiates them." Do the authors think this is a priority and if so how could this discussion be orchestrated?

p. 36 – 20 percent increase in survival is considered a plausible number. What would the total survival rate in the estuary be for ocean type and stream type if it were realized?

p. 42, Table 5.6 – were any economists involved in preparation of these costs (for example, hydrosystem operators with regard to costs of decreased hydrosystem revenues –footnote on page 45 regarding Management Action CRE-4)? The cost effectiveness of specific actions seems uncertain.

Chapter 6

p. 4 – Can any costs and benefits be given to research on key uncertainties (eg density-dependent effects and hatchery fish effects)?

p. 5- under Next Steps, it is stated "…recommended monitoring activities, including indicators, protocols, and estimated costs, will be presented in this estuary recovery module." Which recovery module is being referred to, i.e., is another one being prepared?

p. 5 re Next steps

Chapter 7

p.11 (and Executive Summary page 9): what is the evidence for degraded nearshore ecosystems?

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