

Sustainable Ecosystems Institute

Channel Improvement Questionnaire

S U M M A R Y

Panel Members participated: **Steven Bartell, Donald Boesch, Martin Cody, Lawrence Curtis, Thomas Dunne, Charles Goldman, Thomas Quinn**

Introduction and Brief Analysis

After four Scientific Panel meetings, SEI has compiled the questionnaire, which covered the disputed technical topics of the project. The general goal of the questionnaire was to obtain the Panel comments on scientific issues of physical modeling and the ecosystem conditions, risks and uncertainties evaluation, monitoring and adaptive management, as well as to guide the perspective agenda planning.

The survey is composed of the four main parts, 27 questions:
Part 1. General Questions,
Part 2. Questions related to Physical and Biological Processes,
Part 3. Questions related to Document 2,
Part 4. Questions related to Monitoring, Research and Management.

All seven Panel members responded to the survey, although not all Panelists were able to answer all questions. In addition, for questions answered participants did not always offer a further commentary.

In the first part of the questionnaire the Panelists were asked to characterize the knowledge basis for the “river channel – estuary” system, the threats of the proposed action to the local salmon population, and the indirect and cumulative impacts for *salmonid* species and their habitats. Five Panel Members indicated that the river channel-estuarine processes are “adequately understood” (*Question 1*) two Panelists characterized the knowledge basis as “poorly understood” referring to little perception of young salmon behavior, feeding and survival in the estuary. All reviewers either strongly agreed (4) or agreed with qualification (3) that wetlands and shallow water habitats could be affected by channel deepening, but appropriate design might reduce such impacts. In the future perspective (?) the sedimentation within the estuary, freshwater inflow and its regulation will be the key issues (*Question 2*). In terms of the indirect and cumulative impacts of the proposed action on salmon habitat (*Question 3*), the Panel gave varying opinions. Four participants agreed with comments that the project has the potential to contribute to overcome the long term to indirect and cumulative impacts for salmon and salmon habitats, but two Panelists disagreed, and one participant checked “no answer” option. Five Panel Members “strongly agreed” that SEI workshop process adequately addressed all main issues of concern (*Question 4*),

but two agreed with the qualification that there was a lack of information as well as studies of the subject (river estuary).

In the second part of the survey, Panelists agreed that the modeling used for the project appears structurally sound and represents the best available science (*Questions 5, 6*). However, four scientists referred to the results, expected from OGI model and running the physical model under low flow conditions. The overall consequences for salmon and its habitats (*Question 7*) were rated from negligible (2 Panelists) to minor (5 Panelists). However Panelists drew a varied response to the *question 8*. Five participants admitted that the biological consequences of the dredging are understood, and well understood, whereas two Panel members disagreed with clarification “It is the necessity of making predictions, or “best guesses”, from minimal understanding and limited data that generate the disagreement and uncertainties we have seen in this review process”. In the follow up comments five panelists out of six responded agreed with qualification that “some of the influences of the project physical factors are well understood, but others are not”. One participant found the follow up question difficult to answer. Six Panel members came to the conclusion that the amount of diverse habitat is one of the critical conditions of the salmon survivability (*Question 9*). In the follow up answers panel members provided comments on the significance of the shallow water habitats in the estuary and biological role of the river channel in salmon species life history. All six responded panelists qualified that their answers would remain the same. The approach of using the juvenile ocean-type *Chinook* salmon as model for evaluating the project’s effects has been debated among Panel members (*Question 10*). One panelist gave strongly positive answer, four agreed with qualification, but one participant disagreed, and one did not answer the question. On the subject of early-life-stage mortality, *Question 11*, five answers referred to the estuary, four to the ocean, three to upstream, four to downstream of dams. Two Panelists disagreed that the Corps has carefully sited dredge disposal to minimize impacts on salmon habitats, because “very little has been said on this important aspect of the study, almost as if it has been purposely omitted from out discussions” (*Question 12*). The panel opinion on the consequences for salmon of the larger ship wakes has divided almost equally (*Question 13*). Three Panelists admitted that this aspect would not be important in salmon survival and migration. Three other participants agreed with qualification on the “assessing the magnitude of potential changes due to larger wakes would require new work”.

In the third part of the questionnaire, Panelists evaluated the issues of uncertainty, potential risks and impact on salmon and its habitats, monitoring of physical and biological parameters, and topics, which were briefly discussed at the workshops. The Panel rated the perception of dredging volume, changes to suspended sediment and alteration of flow, salinity and changes in bathymetry from “adequately understood” to “well understood” with one “uncertain” response for bathymetry factor (*Question 14*). The opinions on redistribution of contaminants, contaminant exposure pathways, alterations of the food web and *salmonid* habitat were not unified in the same exercise. Several Panelists rated understanding of these answers as “uncertain” or “very uncertain”. In evaluating the potential risks of the same issues to salmon and its habitat (*Question 15*), panelists concluded that there was little risk for alteration of flow, salinity, ETM, suspended sediment changes and contaminant exposure pathways. However, the Panel was far from a consensus on the topics of changes in bathymetry, dredging volume, alteration of the food web and *salmonid* habitat. Nevertheless, most Panelists felt that changes to *salmonid* food habitat constitute moderate or high risks. Four Panelists responded that there would be no impact to listed species and their habitats (“agree with qualification”) while two Panel members disagreed with the statement (*Question 16*). All six panel members responded on the follow up questions qualified that no significant impact would be made on the listed species by the project activities. Three participants said that the issue of monitoring of physical and biological parameters was not adequately addressed in the panel process, but four Panel members agreed with qualification on

“What monitoring should be done that might identify project impacts in the early life of the project” (*Question 17*).

The fourth part of the survey raised topics related to monitoring, research and management. The scientific definitions of monitoring and adaptive management were given in according to advanced, contemporary research data and literature sources. Thus, effectiveness of monitoring and adaptive management were selected by all panelists as appropriate scientific response to issues of risk and uncertainty (*Question 19*). All of the Panel members agree that the monitoring program is required. The disagreement is based on the word "major" and the level of details (*Question 20*). As the aspects of high priority in potential monitoring panelists have chosen fish mortality in the estuary, fish abundance, residence, feeding and growth, prey assemblages and abundance, habitat changes in periphery and carrying out vegetation surveys in the estuary (*Question 21*). Fish ecology and habitat use in the estuary were highlighted as the main priority topics for the research (*Question 22*). Six Panel members selected Cathlamet Bay, areas near the salt wedge, and shallow-water areas for the measurements of proposed action consequences (*Question 23*). Five Panelists agreed that a scientifically credible monitoring that adequately measures the effects of dredging on salmon species should be conducted for at least five years, during and following completion of the channel improvement (*Question 24 and responses on the follow up questions*). One of the Panel members has remarked, “a five year span may seem minimal given the longevity of fish and slow reaction times to estuarine components”, also there is a reason to believe that “salient results must be forthcoming after five years”. All Panelists agreed that adaptive management should be used as an opportunity among methods dealing with uncertainty in scientific issues raised by the project (*Question 25*).

The complete review of the survey is given in the following summary with additional comments from the Panel and detailed analysis of all questions, including the feedback options between monitoring and management, mitigation and restoration concerns as well as the discussion topics for the final workshop recommended by the Panel members.

Part I. General Questions

1. Compared to other management issues that you have experienced (particularly on endangered species), how would you characterize the knowledge basis for the channel/estuary both ecological and specific processes?

2 Poorly understood; 5 Adequately understood; - Well understood

Additional comment: a) Panel member referred to the "broad sense" and "narrow sense" of the issue. Meaning that if the issue is the minimizing of dredging impact on salmon, the answer is "Adequately understood". In the "broad sense" the answer would be "poorly understood", because of "so little seems to be known about the biology and distribution of the salmon".

b) “The available information concerning the physical characteristics of the estuary, salt water mixing, sediment characteristics in the proposed channel, distribution of contaminants, life history and ecology of the salmon stocks, and the estimated magnitude of current and proposed dredging operations provide a sufficiently comprehensive knowledge base compared to other management issues I have addressed. While additional data and modeling results would add to the information base, I doubt that the new information (unless there is some major surprise) would alter my impressions of the impacts of the proposed dredging”.

c) “No really new issues have emerged and some initially raised are now seen as relatively unimportant. Evaluation of the remaining issues can be improved by the OGI modeling being undertaken and comparisons with the WES model”.

- d) *“There is simply very little understanding of young salmon behavior, feeding, and survival in the Estuary of the Columbia River”.*
- e) *“Certain aspects, notably those related to the physical environment and likely effects of the operations, are well understood and comparatively simple compared to other kinds of human activities. However, the state of knowledge of salmon in the estuary is not adequate for the fine-scale kinds of judgments that the agencies want to make. That is, in order to detect the effects of this kind of activity on salmon we would have to have much better baseline information than we have”;*
- f) *“The ability to predict physical changes in the estuary appears fairly good. Understanding habitat use by out-migrating salmon is better for some stocks than others”;*
- g) *“The overall level of understanding of the system is rudimentary. Obviously, some aspects are fairly well known, but it seems that the most critical, those pertaining to a) salmon life histories, and b) the extent to which the different genetic entities are divergent in their use of the CR estuary and environs, are not at all understood in any level of detail”.*

2. In my opinion, salmon and salmon habitat in the estuary face greater threats from sources other than the proposed action.

4 Strongly agree; 3 Agree with qualification; - Disagree; - N/A

Additional comment a) *“The estuary has been altered in many ways, related to flow regulation, shoreline mismanagement, previous channel modification, and other features, and the salmon have been affected by a variety of well-known human and natural processes. I see this operation as comparatively minor in the context of these other changes and processes”.*

b) *“From what I have seen presented and heard discussed at the previous workshops, I would suggest that the salmon face far greater threats from the dominance of hatchery fish in the Columbia system and the continued human development within the watershed with subsequent associated impacts on salmon habitat, water quality, and food availability”.*

c) *“The cumulative threats of upstream habitat modifications, is certainly of more fundamental importance. With regard to habitat issues within the estuary itself, the principal other threats have do with modification of wetland and shallow-water habitats. These could be affected by channel deepening, but appropriate design could reduce such impacts. In the long run, the key issues seem to me to be freshwater inflow and its regulation and sedimentation within the estuary”.*

d) *“The loss of genetic selection in hatchery fish, the increasing tern predation from artificial islands, pollution from a variety of up stream sources and of course the central problem of loss of up stream spawning sites by the dams on the Columbia”;*

e) *“This assumes the physical modeling of Baptista is consistent with that of WES. The site-specific calibration in Baptista’s work is an important refinement in the overall modeling effort”.*

f) *“It is easy to name a multitude of threats to the endangered salmonids. Historically, these threats began a century ago and still continue. Given the dramatically altered nature of the system in Y2001, it is not easy to put into perspective the project and its potential effects. From a more distant view, it seems that the project can have but trivial net effect; on the other hand, and given the cumulative nature of past and ongoing challenges to the endangered species, it could be viewed as a step closer to thresholds from which recovery will be even more difficult”.*

3. In my opinion, the proposed action has the potential to contribute over the long-term to indirect and cumulative impacts for salmon and salmon habitat in general ecological sense.

- Strongly agree; 4 Agree with qualification; 2 Disagree; 1 N/A

- Additional comment: a)** *“There is always some potential, given a long enough time period for any minor effects to accumulate, but it’s doubtful that such indirect and cumulative effects could be discerned from the other more important threats to the endangered stocks”;*
- b)** *“The question is loaded. While there is a potential for almost any activities to contribute, the real issue is what is that potential. In my opinion, that potential is relatively small”;*
- c)** *“This is particularly true if contaminated sediments in upstream harbors are released into the Columbia river flow, or if release of the finer sediments in the estuary smother food supplies or reduce oxygen levels significantly. This depends upon how and when the dredging is done. Timing of the lower Columbia dredging could be crucial. I doubt that the dredging well above the estuary will be of much importance since the sandy channel material is so coarse that it will settle out rapidly from upstream dredging sites”;*
- d)** *“It has that potential. There are enough uncertainties about the estuarine ecology of salmonids, especially in the Columbia system, that almost any large activity has the potential to contribute to indirect and cumulative impacts. I would say that it may even be likely to contribute to them but in a comparatively minor way”;*
- e)** *“No presentations the various workshops provided any convincing evidence of a specific threat to salmon or salmon habitat”;*
- f)** *“Any change has the potential to contribute to cumulative impacts. The information available does not suggest the magnitude of change will not alter physical conditions in the estuary and/or river beyond the range of natural variation”;*
- g)** *“There is such a potential for the project to contribute to “cumulative and long-term, indirect” effects. However, the project has the potential to be only a minor player in the overall system. It is clearly one of many such potential contributors, most of which seem far more threatening and have been in place for half a century”.*

4. In my opinion, the SEI workshop process adequately addressed all major issues of concern, for the charge, we were set — that is, the effect of the proposed action on salmonids, particularly in the estuary?

5 Strongly agree; 2 Agree with qualification; - Disagree; - N/A

- Additional comment: a)** *“The major shock of our investigation of salmonids in the estuary was the lack of information and studies on the subject. Most of the research work has been done upstream. The political problem that I see the Corp of Engineers and the Port Authorities are facing is that the run is almost certain to continue to decline in the face of the almost insurmountable problem of the loss of up stream spawning sites to the dams and the inability of barging, or hatchery production to compensate for this and uncontrollable problems of high seas fishery losses and drought which will reduce the river flow this year and probably in the future”;*
- b)** *“It is always possible that we missed something but it seems to me that the obvious bases were touched and even some less-than-obvious ones too”;*
- c)** *“Some of the issue listed in Document 2 appear to have evaporated since the document was written, even though they were not addressed in the workshops. Examples are: reduce sand transport to the ocean”, increased SS changes bathymetry”, “deposition in spawning gravels”, “entrainment stranding”, “dredging window””.*
- d)** *“All major issues have been raised and addressed. This is not to say that the outcome of addressing the issues of concern is entirely satisfactory. Indeed, it appears that with the more pivotal issues, such as that of extent and quality of estuarine habitat, we are in a rather weak position to draw firm conclusions on potential project impacts”.*

I would like to see more discussion on the following issues at the final workshop:

- a) – “Available results of follow-on modeling regarding salinity changes and turbidity maximum,
- Future expectations of the numbers of hatchery fish relative to native stocks utilizing the estuary,
- Any changes in the FWS and NMFS decision models/process as a result of the workshops,
- Adaptive management and monitoring”;
- b) – “Monitoring designed for adaptive management,
- Rationale and approach to mitigation,
- Columbia estuary restoration strategy and contributions of federal and state agencies to it”;
- c) – “How the dredging in the estuary will be accomplished in terms of time and space and if attention will be given to avoiding the highest fish residence in the estuary.
- Are their heavy metals in estuary sediments that will be mobilized by the dredging ? We have pretty well accepted the idea that the channel sediments are relatively clean, but little sampling is reported for the more organically rich sediments of the lower estuary.
- Will off shore disposal of sediments be sufficiently “off shore to avoid smothering crab habitat”?
- Is there to be filling within the estuary that will reduce the area and depth of habitat? Are any new islands contemplated that will provide new populations of predatory terns? Can disposal sites be legitimately be separated from the overall discussion?
- Is upstream mitigation going to provide habitat for the salmon on side channels or flood diversion as it has so successfully worked in the Sacramento Yolo bypass?”
- d) – “ I feel that the fundamental problem is the weakness of basic biological data on salmon in the estuary. What is their spatial and temporal distribution, and how do habitat use patterns affect survival. The last part is especially important. Just documenting habitat use patterns will not be adequate. The extent to which estuaries are beneficial for salmon is more of an item of faith than science. They may indeed be beneficial but the evidence is amazingly thin. Therefore, I think that full discussion must be given to a research program that will shed light on this. Further detailed sampling and modeling of estuarine circulation, salinity and velocity will not be useful without biological information”;
- e) – “ What changes in habitat area do physical model predictions project?
- A balanced plan for assessment of current baseline physical conditions and assurance of timely analysis monitoring data if the project goes forward”;
- f) – “The more serious cause of concern is the interplay of factors that affect survival of (modified) juvenile salmon in the present-day modified estuary. It seems that vegetation, habitat quality, food bases and predation remain the important aspect, and further attempts to pinpoint potential project influences in these areas would be worthwhile. As I hold little hope for a useful contribution from the modeling currently underway, we have to get back to the natural history of the animals and their habitats. I do not think we have spent enough time on this, but at the same time, I realize that the critical information is sketchy at best. I should think that Tom Quinn would be in the best position to summarize this aspect of the scientific panel’s contribution (if any)”.

Part II. Questions Relating to Physical and Biological Processes

5. In my opinion, the modeling used for the project, whose purpose is to predict physical changes to the estuary (depth, velocity, salinity, etc.) as a result of the proposed action, appears structurally sound.

3 Strongly agree; 4 Agree with qualification; - Disagree; - N/A

Additional comment: a) *“Confidence would be enhanced by comparable results from the OGI model”;*

b) *“We have not yet seen the results of running the model under low flow conditions. A big point was made of the necessity of having the model rerun under low flow conditions. This (2001) is a year when low, low flows are predicted and these conditions may occur more frequently in the future”;*

c) *“I fully agree, with the qualification that this is not my area of expertise. I can think of no specific reason to doubt the soundness of the modeling for the purposes at hand”;*

d) *“The answer assumes that the modeling focus on the effects of the proposed project”;*

e) *“It makes sense to compare the results of two modeling efforts”;*

f) *“The model seems structurally sound. In that the components and linkages it encompasses are those, which we want to see represented. However, the way in which the physical processes transcribe to biological processes is critical, and here we will have little basis on which to “parameterize” the model. Its limitation in this respect must be recognized”.*

6. In my opinion, the modeling (meaning both models) used for the project represents the best available science on predicting the effects of the proposed action on salinity intrusion into the estuary.

2 Strongly agree; 4 Agree with qualification; - Disagree; 1 N/A

Additional comment: a) *“Again, conditional on successful completion of the OGI modeling”;*

b) *“I do not consider myself an expert on modeling, but almost all models have flaws or are not adequately tested for real predictability”;*

c) *“I do not feel qualified to judge if this is the best available science. It seems adequate and even impressive to me, however”;*

d) *“The standards for modeling of salinity intrusion into the estuary have evolved during the development and review of this project. The original Corps modeling was judged at the time by regulatory agencies to be adequate for assessment of the project’s impact, even though a more complex model could have been implemented if more data were collected on bathymetry, water levels, salinity and velocity structure. The judgment was made by all parties that the information was adequate - whether or not the science was “the best available”. A new round of modeling will involve a modern model, and higher resolution, current field data for calibration and for definition of boundary conditions. The model will probably predict local, higher resolution patterns than the original Corps model. But since at the June workshop no one in the audience or on the Panel was able to answer the question “If the predicted bottom salinity increases by 5% over 1 km at a chosen model flow, will that have a positive or a negative effect on salmon” the utility of the higher resolution predictions for the current decision remains to be defined. As for whether the latest modeling represents “the best available science”: it is conceivable that some more recent developments have taken place in modeling salinity intrusion and in assimilating field data in other parts of the world, but the proposed modeling seems quite adequate for the decision-making needs. It is certainly the “best available” locally on any useful time scale”;*

e) *“We have at our disposal the best available science. It remains startling that, with the enormous efforts that have been exerted in National marine/Fish and wildlife Services fisheries sciences, the database in the CR system is quite poor”.*

7. Based on the information presented, and given that the proposed action has some effect on various physical parameters (e.g., salinity intrusion, temperature, depth, and velocity), the overall consequences for salmon and salmon habitat are likely to be:

2 Negligible; 5 Minor; - Significant; - Major

Additional comment: a) *“Negligible requires some value judgment”;*

b) *“If adequate attention is given to points raised above on the timing of dredging and the disposal sites”;*

c) *“If we had more information on the salmon, we might view it differently. The effect would probably be on the “negligible” side or “minor” rather than the “significant” side but there is too much uncertainty for me to check “negligible””;*

d) *“Answer is based on likely effects on salmon habitat”;*

e) *“This is difficult to address without results from Baptista’s modeling”;*

f) *“Given the innate wide variations in salinity intrusion, temperature, depth and water velocity, I have to conclude that the project effects are likely to be, at most, minor”.*

8. In my opinion, the biological consequences of the physical effects stemming from the proposed action are well understood.

1 Strongly agree; 4 Agree with qualification; 2 Disagree; - N/A

Additional comment: a) *“There is always some small risk of a surprise response of the salmon to the proposed dredging. The results of the requested additional physical modeling might provide some useful insights. However, we seem to have gone through a comprehensive list of plausible physical issues; each one seems of minimal consequence to the listed stocks”;*

b) *“There is always the possibility that we have missed some serious impact on food chain dynamics in the estuary. This is particularly true because of the very limited studies of food web dynamics in the Columbia River Estuary”;*

c) *“The physical effects, in areas where juvenile salmon reside and migrate, are likely to be minor but the behavior and ecology of the fish is not well understood so the likely effects are also not well understood”;*

d) *“The physical effects on habitat are likely to be small, and no case has been presented. The proposed action can result in a significant deleterious effect on salmon. In this case, it is reasonable to say that it is well understood that the biological consequences should be small. This is not the same as saying salmon biology is well understood since many uncertainties remain about this topic”;*

e) *“Here I disagree. The consequences are certainly not well understood, though from what little we do understand, the biological consequences are unlikely to be large in the overall scheme of the CR system and estuary. It is the necessity of making predictions, or “best guesses”, from minimal understanding and limited data that generate the disagreement and uncertainties we have seen in this review process”;*

f) *Agree with qualification, “My only qualification is that almost all aspects of biology of these salmon were said by fish biologists at the workshops to be mysterious. I agree with the statement given to us in the sense that the physical effects of the project themselves are well understood, and there is no reason to believe that any of the physical factors that the fish biologists said are important to the salmon biology will be disturbed*

* In the Summary the follow up responses are given in the “Arial Narrow” font

in any recognizable way. Thus, there is no reason to believe that the biology of the salmon (remember that is all we were asked to comment on) will be disturbed in any recognizable way”.

g) Agree with qualification, “If the results from Baptista’s modeling agree with those from the WES modeling I am confident that the physical changes are not likely to be very large. If we accept the Bottom et al. opinion of suitable habitat for ocean type Chinook (and I do) the WES model does not suggest much habitat loss”.

h) Agree with qualification, “In addition to my earlier remarks, I would add that the potential changes in salinity intrusions, location of the turbidity maximum, water temperatures, dissolved oxygen concentrations, and bathymetry resulting from the proposed dredging in the estuary will be well within the historical patterns of variation in these parameters as experienced by the listed salmonid stocks. Perhaps there is a somewhat greater risk from physical alterations to the river farther upstream, where narrower channels might focus or amplify the physical effects associated with dredging. Again, from the evidence presented thus far, the impacts of dredging would seem to pose negligible risks compared to other historical alterations of the Columbia River System that have negatively impacted the salmonid stocks”.

i) “This is difficult to answer as stated. The biology of the fish is not well understood, with respect to details of habitat use and sources of mortality, so one could argue that the consequences of any action are therefore not well understood. However, the physical consequences of the project seem well understood and the connection to direct harm to salmon seems remote”.

j) Agree with qualification. “I agree that some of the influences of project physical factors are well understood, but others are not. In particular, the effects of water levels, flow regimes, salinity, temperature et al. on the distribution and quality of habitat in the estuarine area appear not at all well understood”.

k) Agree with qualification. “I think there is a reasonable basis for evaluating the potential direct impacts on salmon with regard to entrainment, turbidity, and remobilized contaminants. Indirect effects that may be related to changes in salinity, water flow, sedimentation, and resulting habitat changes are of course much harder to evaluate. In general, these indirect effects will probably be less than many other human impacts (dams, flow regulation, reduction of sediment inputs, spawning stream habitat degradation, etc.), but cannot be entirely dismissed at this point. The fact that these other human activities have such effects, as well as natural variation, will make these indirect effects difficult to evaluate”.

9. In my opinion, given the complexity of the estuary, one of the most scientifically significant issues to the survivability of salmon and long-term viability is the amount of diverse habitat in peripheral and side-channel areas.

4 Strongly agree; **2** Agree with qualification; **-** Disagree; **1** N/A;

Additional comment: a) “The most significant issues regarding the survivability and viability of salmon ESUs seem to be upstream habitat, barriers to migration, flow regulation, and climate change. The estuarine habitat issues are important, but probably less so than those”;

b) “It is not clear from the material presented at the workshop that habitat diversity itself necessarily translates into salmon survival because, if the Bottom et al. analysis is valid, some of the estuarine diversity is not suitable for salmon habitat. The great need is for increasing the amount of the right kind of habitat and food sources”;

c) “Ocean conditions may be more important determinant cohort success than those in the estuary. However, a stock cannot persist if fish cannot survive, and in some instances grow, in the estuary”;

d) “We are not concerned with main channel effects. I am confident that e.g., shipping and dredging activities will have little direct effect, but their ramifications to subtle effects in the peripheral estuarine habitats are not easily foreseen”.

Would your response change in the context of the entire project boundary?

e) *"Why do we care about whether the habitat is "scientifically significant"? Is it biological significant? And what is an "amount of diverse habitat"? At some level the amount of habitat is presumably significant to the production of salmon -- so long as other factors are not limiting their production somewhere in the river or ocean. Despite several presentations that misused the Kareiva group's 'Science' article, it was never proven that the estuary was critical -- we just accept that it is probably important. But at the first workshop, Dan Bottom indicated that most of the shallow water habitat in the estuary is currently not used by young salmon, and they didn't know why. However, I support the precautionary statement that conservation of the amount and diversity of shallow water habitat in the estuary is probably a good hedge that will favor salmon production in years when the other environmental factors favor high down-river salmon runs and when some marginal areas of the estuary can be re-connected to the estuary, as suggested by Simenstad and colleagues. Since the presenters were focused almost exclusively on the estuary (using the Kareiva et al paper as a basis for this focus) they presented almost nothing on the upriver reach. Even the new physical modeling was not targeted on that reach. So, it is a little late to be asking for detailed opinions on the river. Most of what we know about the river reach, therefore came a result of asides during follow-up questioning. However, I think I remember that we were told that the effect on water levels would be somewhat greater than in the estuary, but that since the sides of the channel are mainly steep, clay-rich or reinforced, the effect on shallow-water habitat would be difficult to recognize. Occasional reference was made to connections between channel water level at low flow and the connections of wetlands in the narrow floodplain, but again these matters were never portrayed convincingly. It is difficult for me to believe at this stage of the presentations that the fish biologists think that changes in flow at the channel margins are significant to fish which will be in the process of downstream migration. We were given even less information about the biological role of habitat and the residence time of fish in the channel than we were given about the estuary",*

f) *Agree with qualification, "All stages in salmon's life history are essential to survival of a stock. Different stocks use different habitats to varying degrees. As Bottom et al. point out, ocean type Chinook are especially dependent on side channel areas in the estuary. For any out-migrating salmon I assume low velocity habitat is essential for rearing, or at least resting. This applies to the entire project boundary. Changing the wording of this questions does not change my conclusion",*

g) *"My answer would change slightly in the context of re-defining the spatial extent beyond the estuary to include the entire project boundary. Given our incomplete understanding of how the different stocks utilize resources (e.g., habitat, food) as they move through the river system, it is certainly possible that some upstream peripheral and side channel areas might be significant to the different stocks. There might be justification for identifying and examining upstream locations where the impacts of dredging might be focused toward these peripheral areas because of the channel geometry, location and spatial extent of dredging, and frequency of dredging",*

h) *"What is meant by the "entire project boundary"? I agree that estuarine habitat needs and the consequences for salmon of estuarine disturbance are a very important knowledge gap but I do not agree that it is already evident that such disturbance is the cause for their decline in abundance",*

i) *"No, it would not. I believe that the potential effects of the project beyond the estuary, i.e. in the river channel and banks, are likely minor, and I would emphasize that the estuary is the main source of concern and should be the main focus of monitoring and any remedial work",*

j) *"No. Although the entire length of the project through the tidal river to Portland must be considered. Most of the concerns about critical salmon habitat that were raised focus on the brackish (the transition zone under the influence of some ocean salinity) portion of the estuary".*

10. Scientists from the different agencies have identified juvenile ocean-type Chinook as an appropriate surrogate for evaluating project effects on other species and stocks. This is based on the long residency time of this species throughout the project area. Is this a reasonable approach?

1 Strongly agree; **4** Agree with qualification; **1** Disagree; **1** N/A

Additional comment: a) *“Some attention should be given to life stages of the other salmonids and particularly the steelhead trout”;*

b) *“Species such as sockeye and yearling chinook are generally found in different areas and in different time periods so effects on sub-yearling chinook would not equate to effects on these other species and populations. Sub-yearling chinook might be a worst-case scenario but not a typical one”;*

c) *“Since this stock is especially dependent on the estuary for rearing, it may be most sensitive to change there and deserve priority. It is doubtful that habitat requirements reflect those of all or even most other stocks”;*

d) *“The logic of equating longer residency time with greater susceptibility to estuary changes seem sound. However, we were told of the wide diversity in salmonid ESU characteristics in terms of estuarine use, and a “chinook model” will have limited potential and extrapolation”.*

11. Some evidence was presented at the workshops suggesting that the early life-history stages of salmonids are key stages in determining population trends. On the evidence presented where do you think early-life mortality is concentrated (check as many as appropriate):

- 3 upstream of dams
- 4 downstream of dams
- 5 estuary
- 4 ocean
- 1 unable to decide

12. In my opinion, the Corps has carefully sited dredge disposal to minimize impacts to salmon and salmon habitat, including wetlands.

1 Strongly agree; 4 Agree with qualification; 2 Disagree; - N/A

Additional comment: a) *“We were not really given adequate information to make an independent judgment of this issue. However, judging by the lack of resistance by the agencies responsible for salmon, and it's lack of inclusion in Document 2, there does not appear to be a serious concern about the effects of disposal on salmon and salmon habitat. It was pointed out that there will be some wetland loss, but it was not demonstrated that the wetland loss was in places relevant to salmon habitat”;*

b) *“We only have general information on disposal”;*

c) *“Very little has been said by the Corp on this important aspect of the study. Almost as if it has been purposely omitted from our discussions”;*

d) *“I cannot fault proposed design of dredge spoil disposal”.*

13. In my opinion, the larger ship wakes from deeper draft ships, whose presence in the river and estuary will be made possible by channel deepening, may have consequences (either short or long term) for salmon and salmon habitat.

- Strongly agree; 3 Agree with qualification; 3 Disagree; 1 N/A

Additional comment: a) *“Not compared with the present situation. If the comparison were with the estuary without any ocean going vessel traffic my answer might be different”;*

- b) “The panel was not briefed on whether the larger ships would create larger wakes (or whether some control strategy would be found), and if the wakes are larger whether they would affect salmon habitat. It is not clear that this problem can be addressed simply by transferring from other rivers and lakes”;*
- c) “Assessing the magnitude of potential changes due to larger wakes would require new work”;*
- d) “So far, I have not seen or heard information on this important question”;*
- e) “I think this will not be a significant factor in salmonid movements or survival”.*

Part III. Questions Related to Document 2

A number of topics were outlined in NMFS documents expressing their concerns about the original Biological Assessment, and in the BO and FEIS. These were summarized and provided to you as 'document 2' during the panel process. Of the different issues listed in document 2, we focused attention on the issues listed in the first columns below. For each issue, check the appropriate box to indicate how you would characterize our state of knowledge of the linkage between the issue and biological responses on *salmonids* and *salmonid* habitat. Be sure to keep in mind that uncertainties are not the same as risks. It is possible, for example, for uncertainty on an issue to be low, while risks are high (e.g., if we are sure that a major impact will occur) or for uncertainty to be high, but risks low (e.g. if all possible outcomes entail low risks).

14. Uncertainty: Baptista’s results are expected in August. Once these become available, how would you rate our understanding and degree of uncertainty on the following topics considering both direct and indirect linkages to the project specifics?

	Very uncertain	Uncertain	Adequately understood	Well understood
Alteration of flow, salinity, ETM	-	-	6	1
Dredging volume	-	1	5	1
Changes to suspended sediment	-	-	6	1
Changes in bathymetry	-	1	5	1
Redistribution of contaminants	1	2	3	1
Contaminant exposure pathways	2	2	2	1
Alteration of the food web	3	2	2	-
Alteration of salmonid habitat	-	3	4	-

15. Risk: Now evaluate these same topics as potential risks to salmon and salmon habitat considering both direct and indirect linkages to the project specifics.

	High Risk	Moderate risk	Little risk	No risk

Alteration of flow, salinity, ETM	-	1	6	-
Dredging volume	-	2	3	2
Changes to suspended sediment	-	-	5	2
Changes in bathymetry	-	3	3	1
Redistribution of contaminants	-	2	3	2
Contaminant exposure pathways	-	2	5	-
Alteration of the food web	1	3	2	1
Alteration of salmonid habitat	3	2	2	-

16. In the original BA and FEIS the Corps concluded that there would be no impact to listed species and their habitats (including both direct and indirect effects) over the 50 year lifespan of the project. Do you agree with this assessment?

- Strongly agree; **4** Agree with qualification; **2** Disagree; **1** N/A

Additional comment: a) *“The state of scientific understanding does permit us to predict any change will have no impact”;*

b) *“If it would be said “little impact” I might have agreed, but “no impact” is neglecting the many uncertainties”;*

c) *“With the plethora of alterations and anthropogenic modification present in the system, there will be little or no chance that a project effect could be identified”.*

16a. In the original BA and FEIS the Corps concluded that there would be no significant impact to listed species and their critical habitats (including both direct and indirect effects) over the 50 year lifespan of the project. Do you agree with this assessment?

a) *Agree with qualification, “I would only qualify my agreement in the following way. No convincing presentation was made to the panel identifying any concrete reason for believing that the proposed project would increase the risk of damage to salmon or salmon habitat. Nor can I think of any reason for such an increase in risk”;*

b) *Agree with qualification, “I prefer to say it seems unlikely that the project will change physical conditions in critical habitat outside the range of natural variation. I assume the stocks evolved to persist within the range of natural variation”;*

c) *Agree with qualification, “Clearly, the modification to the question requires consideration of the meaning of “significance” in the context of the Endangered Species Act. In light of the evidence presented thus far, there seems to be little reason to strongly believe that measurable impacts will occur. Nevertheless, as a qualification, the considerable uncertainties inherent in this assessment suggest that a prudent course of action would be to conduct the project within an adaptive resource management framework”;*

d) *Agree with qualification, “The qualification is that the critical habitats are still poorly defined. The physical effects on them seem to be very slight, though”;*

e) *Agree with qualification, “I agree with qualification because there appears to be reason to think there will not be significant project effects on the listed species, but since the estuarine system is not well understood,*

and the effects of even minor perturbations might be important and even critical, there is reason for doubt, and therefore caution”.

f) Agree with qualification. “It does not appear to me that the withdrawal of the BO was prompted mainly by surprising new information. The Bottom et al. analysis basically brought together existing perspectives about the complexity and importance of habitat relationships. The Kareiva et al. analysis, while emphasizing the importance of estuarine and early ocean survival, did not document a risk related to channel deeping to a critical link. It seems to me that although these new perspectives heightened concerns, NMFS became less confident in their BO because of concerns about the monitoring and mitigation safeguards. That’s where attention should now focus”.

17. In your opinion has the panel process to date adequately addressed the issue of monitoring of physical and biological parameters?

- Strongly agree; **4** Agree with qualification; **3** Disagree; - N/A

Additional comment: a) “We have come to understand the nature of monitoring of previous (baseline) conditions in relation to the proposed project. However, to my recollection, we have not really addressed future monitoring needs in relation to management, adaptive or otherwise, of the proposed project”;

b) “No serious discussion of this yet”;

c) “The Panel has not yet considered monitoring”;

d) “Parameters to monitor were discussed, not sampling design”;

e) “The process was one of the best yet arranged to depolarize the combatants. Still lots of time was wasted by posturing, and there was a distinct lack of basic biological information on the life of salmon smolts passing through the estuary”;

f) “The issues have been raised and addressed, but we have really come to grips with what monitoring should be done that might identify project impacts in the early life of the project”.

18. At the SEI workshops, we briefly discussed some of the document 2 topics from the workshops either because they were outside our scope (focus on endangered salmonids, primarily in the estuary), or the group did not see a way for them to affect salmonids, or because the topics were now thought to be of lower priority. Do you still agree with this assessment? The topics were:

	Strongly agree	Agree with qualification	Disagree	N/A
Reduced ability to transport sand to the ocean	5	2	-	-
Deposition in spawning gravels (no spawning thought to occur).	5	1	1	-
Reduced ability of the estuary to function as a conduit for fish to the ocean	5	2	-	-
Behavioral/sub-lethal effects of increased turbidity	5	2	-	-
Adult salmonid migration routes	6	1	-	-
Entrainment	6	1	-	-
Stranding	5	2	-	-
Dredging window	5	-	1	1

Additional comment: a) “I checked the boxes according to whether I agree or disagree with the statement that the matter is unlikely to have negative consequences for salmon. I do not know what the “dredging window” issue specifically means. I checked some issues “with qualification” because there seems to be some uncertainty about the basic ecology so estimating effects is also uncertain”;

b) “Although I agree that each of these activities can be made useful, they are often employed so loosely that they are ineffective. There still needs to be much pragmatic discussion about each activity could be useful for the narrow project management and broader estuary management purposes that have been referred to in these workshops”;

c) “I found this set hard to assess. I felt that upstream effects were too lightly treated where a change in water level by deepening the channel could be important and side channel conditions were not really considered”;

d) “Might chum salmon spawning could be altered by disposal?”;

e) “The question of estuarine function in salmonid life, and the degree to which it might be impaired by the project, is something we have retained on the table, and it remains, I think, in the center of our discussions, and a source of many of the uncertainties inherent in the project and its consequences”.

Part IV. Questions Related to Monitoring, Research and management

Some definitions of terms as used in the scientific literature:

Monitoring as used in applied situations can involve several different components.

Compliance monitoring essentially determines whether the actions proposed (e.g. dredging, buying mitigation lands) were in fact carried out – this is essentially irrelevant to our concerns here. *Effectiveness* monitoring typically determines whether the expected impacts or improvements occurred. A subset of such monitoring may be tied to trigger points that cause changes in management (e.g. increased impacts lead to changes in dredging).

Investigations (or validation monitoring), which test the basic assumptions used in predicting impacts, may be regarded as a third component of monitoring, although it can also be argued that this is more appropriately viewed as research. *Research* (as distinguished from monitoring) may be thought of as explorations of issues that are not closely linked to project assumptions or effects.

Adaptive management involves an explicit feedback between monitoring and management. In some cases projected monitoring results can be linked to resultant changes in management that can be agreed in advance. For instance if there is reduced sediment deposition in peripheral channels, it may be possible to alter the site of dredged material disposal to compensate. Adaptive management allows for uncertainties in project outcome by building in sufficient options to compensate for all expected outcomes. Under some definitions, adaptive management also incorporates an investigative component (see above) that tests the basic assumptions of the proposed action, where these assumptions are not fully sure. Kai Lee (2000 and references therein) provides a discussion of the differing uses of the term.

19. In my opinion, appropriate (scientific) response(s) to issues of risk and uncertainty, including direct and indirect impacts are (check/tick):

Effectiveness monitoring 7

Investigations of base assumptions 6

Research 5

Adaptive management 7

Additional comment: a) “The appropriate scientific responses to issues of risk and uncertainty would judiciously use all of these possible methods to further characterize risk and hopefully reduce uncertainty. However, a management response might emphasize effectiveness monitoring

within an adaptive management framework, with investigation of base assumptions and research conducted on limited and specifically targeted basis”;

b) ““Yes” to the research, but only in the context of elucidating potential project impacts”.

Effectiveness Monitoring

20. In my opinion, the levels of uncertainty and risks from predicted impacts to habitat are so low that a major monitoring program is unwarranted.

- Strongly agree; 3 Agree with qualification; 4 Disagree; - N/A

Additional comment: a) “It’s obvious that a monitoring program is required, but it should be focused on key environmental responses”;

b) “Depends on the definition of “a major monitoring program”... an effectiveness monitoring program of sufficient spatial-temporal resolution and predetermined statistical power ought to suffice. Not every conceivable environmental factor needs to be exhaustively monitored”;

c) “The status of salmon is so dismal that the risk must be evaluated. How large a program is warranted needs to be determined”;

d) “For the first time a serious estuary food web and salmonid study should be integrated. Further, trial dredging in the estuary should be done in close coordination with the above”;

e) “There is an obvious need to assuage the concerns of those stakeholders for whom only empiricism is acceptable in environmental management. There is still a need for thorough discussion of what kind and how much monitoring is appropriate for the two major goals referred to the above (question 19)”;

f) “Undertaking the project is not risk free. We do not understand the system well enough to assume predictions are accurate”;

g) “The level of uncertainty in potential effects on estuarine habitat is high; this warrants a monitoring program for estuarine habitat, but it need not be termed “major””.

21. In terms of potential impacts of the proposed action on salmonids and salmonid habitat, please prioritize the following issues as potential monitoring issues. Factors that you might wish to consider in your decisions could include: relationship of issue to salmonid conservation; ability of monitoring program to detect change; ability of monitoring program to distinguish project impacts; ability of monitoring program to feed back to potential management modifications; testing of assumptions set out during the works hop process; contribution to new knowledge; cost effectiveness.

	Low priority	Medium priority	High priority	N/A
Salinity	1	3	2	1
Temperature	4	1	1	1
Bathymetry	1	4	1	1
Turbidity	-	5	1	1
Suspended sediments	3	2	1	1
Toxic contaminants in dredge sediment	3	1	2	1
Toxic contaminants in estuary	2	2	1	1

Toxic contaminants in fish	3	2	1	1
Fish mortality in the estuary	1	1	4	1
Fish abundance and residence	-	2	4	1
Fish feeding and growth	1	1	4	1
Trends in hatchery: wild fish	1	1	3	2
Prey assemblages and abundance	-	2	4	1
Vegetation surveys in estuary	1	1	4	1
Habitat changes in periphery	-	1	5	1
Other habitat changes	1	3	-	3
Effects of dredging on adult salmon migration	5	1	-	1

Additional comments: a) *“Physical measurements are necessary to validate modeling used for prediction of habitat changes. Actual assessment should address habitat loss, one of the major concerns for salmon. Food web transfer of toxic chemicals was a second major concern. Direct assessment of this potential problem is advisable”;*

b) *“The physical changes (temperature, salinity, etc.) are likely to be slight and not strongly linked to fish populations. Toxics are important but I did not see a link to the project so they would be worth studying but are not well connected to this project. The major needs are in basic fish ecology and habitat, including ways in which the project may affect shoreline vegetation, prey and fish distribution. This information is not uniquely needed for this project and indeed should have been better documented already. Trends in hatchery-wild salmon populations are important but not related to this project. Adult migration is important but not as much as juvenile salmon ecology, and might be harder to determine”;*

c) *“Given our previous discussions that emphasized the potential for increased mortality or decreased growth for early life stages of salmon, it would seem that a monitoring program, particularly an effectiveness monitoring program, would dedicate resources to these impacts. Collecting information that might help relate any diminished salmon early life stage success to the project would seem to be next in importance. Collection of data and information that would explain any further degradation of the listed stocks in relation to non-project issues would seem to be of lesser importance”;*

d) *“It would be useless, and perhaps diversionary, to prioritize these monitoring issues in such a casual manner without basing the decisions on the newly developed conceptual model, and without a plan for how resulting data would be analyzed. Some of the items listed, such as “effects dredging on salmon migration are not so much “potential monitoring issues”, but are entire complexes of biological issues that have not even been discussed in these workshops”;*

e) *“I would design a modest monitoring program that would address not physical factors as these might have minor and indirect effects only, but concentrate on the major biological variables, of which habitat, habitat quality, and its potential to grow and sustain juvenile salmonids, is the predominant”.*

Research

22. In terms of potential impacts of the proposed action on salmonids and salmonid habitat, please prioritize the following issues as potential research issues, and the potential value of new information to understanding both salmonids and the estuarine environment. The overall intent here is to identify research topics that might allow better decisions to be made in the future.

	Low priority	Medium priority	High priority	N/A
Physical factors in estuary	-	2	3	2
Source of toxic contaminants in estuary	2	3	1	1
Pathways of contaminants entering salmonids	1	3	2	1
Fish ecology in the estuary	-	1	5	1
Habitat use in the estuary	-	-	6	1
Identity of fish (genetic stock) in estuary	1	5	-	1
Food webs in estuary	-	3	3	1
Radio-isotope and other studies of diet	2	2	2	1
Adult salmon migration	4	1	1	1
Dissolved Oxygen	6	-	-	1

Please explain your choices: a) *“It is not clear how fish ecology, food webs, and diet differ. They are all important, as is basic migration route and habitat use issues for juveniles and adult”;*

b) *“The greatest degree of uncertainty associated with the present assessment appears to be associated with the relative lack of understanding on how the early life stages of salmonids actually use the estuary. Thus, it would seem prudent to identify research in these areas as being of the highest priority. Research that further elaborates feeding behavior and estuarine food webs is of lesser importance, but should be performed if resources were available. The contaminant issues appear of minimal importance in relation to the proposed dredging and contaminant research would seem to be of low priority (although the general issue of contaminants in salmonids might be worth monitoring, but not in relation to the dredging)”;*

c) *“Though it is easy to support more research, especially in an estuary that is so poorly known from a scientific viewpoint, but the list of research topics (such as “fish ecology in the estuary”) is too ill-defined for useful prioritization in this form and without reference to the conceptual model, degree of directedness of the research, and plans for assimilating research results into environmental management. For example, many, if not most of the research issues could not be implemented on the time scale of the proposed dredging project and its recognizable aftermath”;*

d) *“I’ve listed as potential research areas those for which the current data base seems poorest, and those which have the greatest potential for enhancing understanding of the CR system and thence project impacts”.*

23. In my opinion, monitoring efforts that would best measure the consequences of the proposed action on salmon and salmon habitat should occur at (check as many as you think apply):

- 2 Select areas around Jones Beach
- 6 Select areas in Cathlamet Bay
- 6 Select areas near the salt wedge
- 3 Select areas near River Mile 40, where the river narrows considerably
- 2 Select areas at the mouth of the Columbia
- 2 Select areas at the confluence of the Columbia and Willamette rivers
- 6 Select shallow-water areas
- 2 Select side channels
- 3 Select areas along the estuarine portion of the channel
- Other areas

Additional comment: a) *“Pre, during and post dredging should be built in to the monitoring program. But monitoring without adequate evaluation would be a waste of public money. That has been the problem with a lot of monitoring programs. Lots of data collection and very little attempt to interpret and apply it to adaptive management”;*

b) *“Obviously, a sampling program needs to be stratified in some way to evaluate presence, diet, etc. over the range of habitats. Jones Beach would seem to be a good site for linkage with previous sampling. I am not sure how the “estuarine portion” differs from the “salt wedge”, and the mouth of the river may be too daunting for useful surveys”;*

c) *“Basically, I would concentrate both monitoring and research (if any) on areas/habitats that have the greatest potential to impact salmonid growth and survival”.*

24. In my opinion, a scientifically credible monitoring effort that adequately measures the effects of the proposed action on salmon and salmon habitat should be conducted for at least:

- One year, during and following completion of the channel deepening.
- 5 Five years, during and following completion of the channel deepening.
- 1 Ten years, during and following completion of the channel deepening.
- Twenty years, during and following completion of the channel deepening.
- 1 The entire lifetime of the project (50 years).

Additional comment: a) *“Continuous monitoring is probably not warranted but a program of periodic monitoring might be more cost-effective, with an interval in between periods of sampling”;*

b) *“If the monitoring effort is developed and conducted within a framework of adaptive management, then the monitoring (and managing) should occur at least over the duration of the proposed project. However, if “effectiveness monitoring” will be the emphasis, then perhaps 10 years during and 10 years after the project might be sufficient to discern any project impacts from the other factors that influence the population dynamics of the listed salmonids”;*

c) *“A five year span may seem minimal given the longevity of fish and slow reaction times to estuarine components, but I believe that salient results must be forthcoming after five years. If, thereafter, merit is seen in further data collection, I would be all in favor of continued work that will further sharpen the data base, processes, and pathways within the system”.*

24 a. "You said xxx years, what did you mean by that?"

- a) "I don't understand this follow-up question. "What did I mean by FIVE years"? I meant five years. If you are asking why did I choose five years, it was because I believe that in one year it will not be possible to test the hypothesis that there is no effect --- the year would be too confounded by environmental fluctuation. It will take five years to obtain a satisfactory confidence level. On longer time scales any effect of the dredging project will disappear under the changes caused by other events, almost all natural. However, let's not forget that no one has yet proposed WHAT the monitoring effort would consist of. What would be measured, and more importantly --- how would the data be analyzed?",
- b) "Five years. Given annual variation, especially in flow, it is important to monitor over a number of years. Five years of monitoring would provide baseline data over enough time to include a reasonable amount of annual variation",
- c) "Again, if the purpose of the monitoring is to provide meaningful input into an adaptive management framework, it seems only logical that the framework (hence the monitoring) would be conducted for at least the project lifetime. The exact nature and scope of the monitoring might reasonably change during this period (e.g., remove some factors, add others, revise sampling protocols) to reflect the adaptive aspect of an integrated monitoring-management program. Alternatively, if effectiveness monitoring is the selected plan, then monitoring should be designed in relation to the relevant ecological scales of the salmonids and the environmental parameters potentially impacted by the project. The year-to-year variability in fish stocks is well known and occasional strong year classes can exert a strong influence on subsequent population dynamics for a number of years determined mainly by the life span of the species of concern. Therefore, a useful monitoring plan should be of sufficient duration (and statistical power) to discern the potential impacts of dredging from other sources of variation in highly variable populations of salmonids in the Columbia River System. Effective monitoring of dredging impacts on physical and chemical parameters might be designed around shorter time periods in relation to the characteristic spatial/temporal scales of the particular parameter (e.g., salinity, turbidity maximum, dissolved oxygen). However, given the focus on the listed stocks, the ecological scales relevant to these fishes would presumably be of paramount importance in designing an effective monitoring plan",
- d) "Any monitoring should be over at least a five-year period, as I said previously. Then, after such a period, further monitoring (if any) should be assessed from the results of these first five years. Given the longevity of the fish, and especially of the vegetation, it seems that five years is minimal, and that further monitoring beyond this time period will be required to more accurately see what changes are taking place within the estuary",
- e) "I responded 5 years. My thought was that a 5-year monitoring program be designed and executed. It should provide an adequate basis for evaluation the impacts that occur during and, in the near term, after the project (e.g. salinity changes evaluated by coupled observations and predictions). It will also provide a better basis for honing any remaining questions and subsequent approaches. Changes in tidal flats and wetlands will take longer to be manifest. These and other remaining questions may require monitoring past the 5-year program. The scope and direction of the longer term monitoring should be determined after year 4".

Adaptive management

25. Adaptive management is often advanced as one method of dealing with uncertainty in outcomes. Do you see opportunities or advantages to this approach for the scientific issues raised over the proposed project?

1 Strongly agree; **6** Agree with qualification; - Disagree; - N/A

Additional comment: a) " "Adaptive management", like "monitoring" and "research" is a term that rolls easily off the tongue, but it's useful implementation will require careful planning, beginning with clarification of hypotheses. This has not yet been done in the workshops";

b) "One must agree in advance how the results from monitoring will be folded into the decision process. Otherwise, monitoring and operations are isolated from each other";

- c) *“It will be hard to use adaptive management in periodic “go-no go” decisions, but it could be useful in altering design and in mitigating any impacts”;*
- d) *“The success of adaptive management really depends on the ability to collectively define a “desired system state” and view the dredging as a large-scale perturbation or experiment on the system. The success of this approach further depends on the ability to establish feedback mechanisms (see below) that can be used to drive the system toward the desired state, given the nature of the perturbation (i.e., dredging in this case)”;*
- e) *“I see relatively little chance that, within the first few years of the project, definitive data will be forthcoming that suggest “project effect A has the following and specific negative consequences on salmonid survival or growth factor B.” Nevertheless, I strongly support adaptive management in principle; should there be reasonable cause to link a negative impact to the project, then the project should indeed be modified or halted pending further assessment or mitigation”.*

26. Can you identify any feedback options between monitoring and management? Two that have been discussed by the management group are:

- 1. Monitoring sediment deposition in the shallow water areas, and increasing in-water disposal to compensate for any losses.**
- 2. Monitoring sediment quality for toxic contaminants, and removing such materials to secure disposal sites.**

What other feedback options, related to the effects of channel deepening, come to mind?

- a) *“Loss of emergent vascular plants due to increased salinity intrusion was identified as a significant potential problem. If loss occurs near the upper salinity intrusion boundary it would be good to create new habitat upstream. If toxic chemical accumulation increases in salmon or their food, it may be wise to reduce upstream sources”;*
- b) *“It would be surprising, if over the short term of the project and any recognizable aftermath, it is possible to define a “loss” in sediment deposition in shallow-water areas. The base-line is unknown, as is its pre-project variability. However, as the basis for long-term monitoring of estuarine ecology it would be useful to begin measuring sediment deposition, or at least depth variations, and the biological quality of the substrate at a sufficient number of sites for thorough scientific analysis. Monitoring of sediment quality for toxic contaminants would be a prudent measure in any area where the substrate is disturbed. However, care should be taken to archive the results and to interpret them so that uncertainty is reduced in management of the estuary in the long term. It would also, be, useful to monitor turbidity and suspended sediment characteristics around each dredging project to ensure quality control of the engineer practice and to gather information that could be used to refine understanding of sedimentary processes in the estuary. Unforeseen effects on sediment diffusion, for example, might trigger alteration of the timing or operation of the dredging”;*
- c) *“Checking body load of contaminants in estuary fish before dredging starts so that any build up can be detected during the monitoring program and sites of contaminants can be detected and alternately disposed of or avoided. GIS views of existing habitat are important to detect losses. Some surveys of side channel effects such as we have on the Sacramento River are essential. This could be an effective mitigation if it has the same positive effect on survival that the Yolo bypass has on the King Salmon down stream smolt seaward migration in the Sacramento river”;*
- d) *“How far are you willing to go if monitoring shows that the physical circulation models are totally wrong? This is very unlikely but possible. If salinity profiles change greatly, will this be good or bad for salmon? I am not sure. The fish need complex and diverse edge habitats, undiked marshes and rivers, and high spring flows of water. Assessment of their use of shoreline habitats is important in a general way but it is not certain how the information would be used to*

modify the operation (unless the effects were so ghastly that cessation was needed). Perhaps seasonal windows of operation might be modified depending on use patterns”;

e) “Monitoring the effects of dredging on the distribution and abundance of salmonids that inhabit areas near the navigation channel. Possibly alter timing and location of dredging in relation to spatial-temporal patterns of habitat use by the salmonids”;

f) “I would suggest direct monitoring of extent, distribution, composition and “quality” of the vegetation that constitutes the estuarine habitats critical to salmonid survival and growth. What might be the effect of a few cm change in bathymetry? Will shallow-water habitat simply shift in spatial position but retain essential elements, prey base, cover etc? Will minute changes in salinity, and its variation over space and time, have any substantial effects on salmonid prey, feeding rates, etc? I think we have to address directly the ultimate recipients of potential effects, namely the endangered ESU’s, their food and predators”.

Mitigation and Restoration

27. Currently, the project is slated to restore 1,250-1,550 acres of wildlife habitat at Shillapoo Lake (near Vancouver, WA), improve tide gates on 38 miles of spawning streams in the Lower Columbia River, and enhance circulation for migrating salmonids in certain shallow-water areas. Mitigation focuses on developing or restoring 736 acres of wetland and riparian habitat to mitigate for the loss of 20 acres of wetlands, 67 acres of riparian habitat, and 200 acres of wildlife habitat on farmland due to dredge disposal. In your opinion, are these mitigation and restoration efforts comparable in size to the potential losses of salmonids and salmonid habitat as a result of the channel deepening project?

a) “A credible answer would require some quantitative assessment of the anticipated impacts of the project on salmonids (if there are any) and an estimate of what increases in habitat, habitat quality, and food availability afforded by the proposed mitigation would be necessary to offset the projected impacts. Without some even cursory analyses, any opinion regarding the proposed mitigation would be simply an uninformed guess”;

b) “Probably so, when narrowly viewed, but habitat enhancement should be viewed in broader terms than mitigation. To the degree to which the Corps is our governor’s construction firm, with the capacity to physically alter the estuarine ecosystem because of channel deepening or other means, it should look at any project that changes the architecture of the system from the following perspective: How can we design this in a way that rehabilitates important habitat. That is, these activities should not only be expected to be compatible with restoration goals, they should be designed to contribute to them”;

c) “No details were presented on these projects. Without knowing a good deal more about the specific projects it is hard to know what they will accomplish, though in general they seem very worthwhile. Simple arithmetic suggests that this is a good deal but losses and benefits are not always equivalent on an acre per acre basis. It is difficult to determine the magnitude of the losses that might result from the project so it is even harder to determine if the mitigation is going to be adequate”;

d) “This is a particularly hard question to answer since it depends upon a host of unknowns in terms of the impact of the dredging. It would be good to see some serious side channel work considered. The mitigation is reasonable based on the assumptions of little or no impact of the project, but since the information base is so shallow for the estuary the mitigation might turn out to be very inadequate for salmon smolt losses that might be sustained in the estuary”;

e) “It is difficult to assess adequacy of mitigation until one knows the potential habitat loss. If the habitat gained is high quality it may provide substantial benefit to salmon”;

f) “The workshops have not discussed mitigation and restoration, and have not identified the “size” of potential losses of salmonids and salmonid habitat as a result of the project”;

g) “These are useful endeavors that I would support. I see a lack of equivalency, however, between these mitigation efforts and whatever “potential losses” are mitigated for, simply because the latter part of the equation is so poorly understood. I would think that resources invested in monitoring and research would be a surer way to understand, anticipate, and then counter, potential project damage to salmonid stocks”.