ISAB Work-In-Progress Report:

Looking for Common Ground:

Comparison of Recent Reports Pertaining to Salmon Recovery in the Columbia River Basin

Independent Scientific Advisory Board
for the Northwest Power Planning Council
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Comparison of Recent Reports Pertaining to Salmon Recovery in the Columbia River Basin:

A. ISG – "*Return to the River*"

B. NRC – "*Upstream*"

C. USFS/BLM – "*An Assessment of Ecosystem Components in the Interior Columbia Basin and Draft Environmental Impact Statement*"

D. CRITFC – "*Wy-Kan-Ush-Mi Wa-Kish-Wit, Spirit of the Salmon*"

E. NMFS – "*Proposed Recovery Plan for Snake River Salmon*"

Background

Within the last several years a number of important documents related to salmon recovery in the Columbia River Basin have been produced, each purported to be based on sound science and each containing various conclusions and recommendations for changes in management practices. The Independent Scientific Advisory Board felt it would be useful to identify major points of agreement and disagreement among these reports and have therefore initiated this comparison. The project began in early 1997 and the original intent was to compare the findings of the Independent Scientific Group report "*Return to the River*" (ISG 1996), the National Research Council report "*Upstream*" (NRC 1996), and the draft report of the interagency task force on management of federal lands in the interior Columbia River Basin, which was subsequently issued as a report of the US Forest Service and Bureau of Land Management in mid-1997 (USFS/BLM 1997). Further discussions within the ISAB convinced us that the comparison should be expanded to include the National Marine Fisheries Service 1995 "*Proposed Recovery Plan for Snake River Salmon*" (NMFS 1995) and the Columbia River Inter-Tribal Fish Commission salmon recovery plan "*Wy-Kan-Ush-Mi Wa-Kish-Wit, Spirit of the Salmon*" (CRITFC 1995), as these two documents were being used to guide a number of important management decisions in the basin.

The ISAB realized that the specific focus of each report was somewhat different, depending upon particular management issues with which each was concerned. Nevertheless, we identified eight topics that were addressed in many of the documents: (1) conceptual foundation, or the basis for implementing strategies and tasks, (2) natural variation, (3) habitat, (4) artificial propagation, (5) hydroelectric operations, (6) salmon harvest, (7) institutions, and (8) monitoring and evaluation. No single report dealt in detail with all these topics and some topics were clearly beyond the mandate of the particular sponsoring organization or agency. But there was enough information to make comparison worthwhile.

Obviously, none of the reports was meant to be the final word on salmon recovery in the Columbia River Basin. Two of them (ISG and CRITFC) are currently in draft or pre-publication form and a third (NMFS) is a draft recovery plan under the Endangered Species Act. In the aggregate, however, these reports represent a tremendous regional investment in scientific thinking about a very difficult and complex natural resource management problem. Because there is neither complete certainty nor consensus about how to recover salmon in the Columbia Basin, the ISAB felt identification of areas of agreement or disagreement would help clarify what is currently known and highlight unknowns for further research and management attention.

This report contains two parts. Part I is a summary of the major points of scientific consensus and lack of consensus and is meant to be the ISAB's interpretation of the key conclusions of the five documents. Part II provides a more detailed summary of the major conclusions of each report with respect to the eight topics. Wherever possible, the original wording of each document has been retained in Part II. Complete citations for the reports are as follows. The acronyms in parentheses are used in the text to identify them.

Independent Scientific Group (**ISG**). 1996. Return to the river: restoration of salmonid fishes in the Columbia River ecosystem. ISG 96-6, Northwest Power Planning Council, Portland, Oregon. Prepublication copy 584 p.

National Research Council (**NRC**). 1996. Upstream: salmon and society in the Pacific Northwest. National Academy Press, Washington, D.C. 452 p.

United States Forest Service and Bureau of Land Management (**USFS/BLM**): Quigley, T. M., and S. J. Arbelbeide, technical editors. 1997. An assessment of ecosystem components in the interior Columbia basin and portions of the Klamath and Great Basins: volume 3. General Technical Report PNW-GTR-405, United States Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, Oregon, USA. Pages 1058-1713.

Columbia River Inter-Tribal Fish Commission (**CRITFC**, also **Tribal Plan**). 1995. Wy-Kan-Ush-Mi Wa Kish-Wit, Spirit of the salmon: the Columbia River anadromous fish restoration plan of the Nez Perce, Umatilla, Warm Springs, and Yakama Tribes. Volume 1. Columbia River Inter-Tribal Fish Commission, Portland, Oregon.

National Oceanic and Atmospheric Administration, National Marine Fisheries Service (**NMFS**). 1995. Proposed recovery plan for Snake River salmon. US Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Portland, Oregon.

Comparison

I. Conceptual Foundation

Consensus:

1. Reliance on ecosystem principles should form the basis for salmon recovery. Principles should be implemented through adaptive management. Although the documents vary in goals and approaches, all affirm that maintenance and restoration of ecosystem processes and conditions are necessary to achieve restoration goals in the Columbia River Basin.
   - The Columbia River salmon ecosystem includes the estuary and ocean.

- There is explicit or implicit recognition that human communities and socio-economic dimensions are components of the ecosystem.
- The importance of maintenance and restoration of habitat diversity and connectivity, and life history and genetic diversity, within an ecosystem context is emphasized.
- The Columbia River ecosystem cannot be returned to a pristine state, but it is possible to restore ecological processes that support naturally-reproducing populations at sustainable levels.

2. Solutions will not be quick, easy or inexpensive to implement. There is no "silver bullet" for restoration; salmon have declined as a result of the cumulative impacts of a multitude of human actions operating over many decades. Rebuilding salmon runs and other fish and wildlife resources will take a long time, will need coordination and improvement among all important issues, and will require strong and consistent political commitment.
   - Reports emphasize restoration of ecological functions and processes, although names given to the strategies differ. All, however, have self-sustaining salmon populations living in ecologically healthy watersheds as a major goal. To achieve this goal the following terms are used:

     A. *ISG* -- *Normative* ecosystem concept

     B. *NRC* -- *Rehabilitation* involving natural regenerative processes

     C. *USFS/BLM* -- Restore and maintain long-term *ecosystem health* and *ecological integrity*

     D. *CRITFC* -- *Gravel-to-gravel* management, including tributary, mainstem, estuary, and ocean environments
3. Changes in salmon management institutions and governance may be needed to implement ecosystem principles. Recovery of salmon runs will be facilitated by addressing all factors influencing abundance in an integrated way.
4. Obligations to protect the treaty rights of indigenous peoples must be honored.

Lack of Consensus:

1. Two of the reports (*NMFS* and *CRITFC*) treat conceptual foundation as the specific tactics for implementing strategies and goals, rather than defining a set of principles governing ecosystem function (as is attempted by the other documents). However, no major areas of fundamental disagreement exist. Differences arise in how the principles are to be implemented.
2. *NRC*, the *Tribal Plan* and *NMFS* distinguish actions needed to sustain long-term recovery and short -term actions needed to prevent further declines and extinction. For example, *NRC* recommends long-term recovery that relies on natural regenerative processes of ecosystems and short-term that would make use of selected human technologies. *NMFS* proposes explicit measures that will both prevent extinction and sustain long-term recovery.
3. The *Tribal Plan* differs somewhat from the other reports in that it directly addresses the cultural significance of salmon, which are seen as a foundation of culture, economy, and

religion to the Columbia Basin's native peoples: "The salmon was provided a perfect world in which to enjoy its existence. For thousands of years, the salmon unselfishly gave itself for the physical and spiritual sustenance of humans. The salmon's spirit has not changed; the human spirit has."

II. Natural Variation, Climate Change, and Ocean Productivity

Consensus:

1. Natural variability and diversity should be acknowledged. One-size-fits-all solutions are generally inappropriate whether applied to habitat, harvest, hydroelectric, or hatchery management. Planning and implementation should be tailored to local conditions. Natural variability contributes to a diversity of habitat types necessary for maintaining genetic variability.
2. Decadal cycles of ocean productivity have the potential to mask changes in the survival of salmon during freshwater phases of their life cycle, leading to erroneous interpretation of the performance of restoration efforts and increased losses of some stocks. Changes in marine survival need to be closely tracked and findings incorporated into management planning.
3. Protection of freshwater habitat is particularly important during periods of low ocean productivity. Likewise, salmon harvest rates should take changes in marine survival into account.

Lack of Consensus:

1. There were no major areas of disagreement, but reports generally ignored or were somewhat ambiguous with respect to the question of whether hatchery production should be scaled back during periods of low ocean productivity in order to minimize competition in the estuary or marine environments.

III. Habitat

Consensus:

1. Human activities (forestry, agriculture and grazing, hydropower, and development) have degraded, fragmented, and disconnected riverine and adjacent riparian habitats. Freshwater habitat degradation has contributed significantly to the decline of native fishes. Often, native fishes are abundant only in relatively small patches within watersheds and not well-connected to other patches.
2. Major long-term intervention will be required to restore spatial and temporal diversity of habitats and habitat connectivity. Interventions should be directed at multiple spatial and temporal scales including instream habitat, riparian features and processes, and at the watershed scale. Migratory corridors as well as spawning and rearing habitat need to be protected and restored.

3. Integrated ecosystem approaches to habitat rehabilitation will require action on both public and private lands, and among all types of land uses.
4. There was common recognition of ecosystem processes that need protection: riparian features and processes, large woody debris recruitment, water quality, natural sedimentation rates, floods and other natural disturbance regimes, adequate stream flows, upland (watershed) processes.
5. Core or reserve areas that currently maintain strong populations of salmon and trout are of particular ecological importance should be protected and reconnected with one another (i.e., with functionally intact migration corridors) to the extent possible.

Lack of consensus:

1. Overall, no areas of major disagreement existed. All reports acknowledged the importance of protecting the highest quality remaining habitat, restoring degraded habitats, and improving the connectivity between areas of good habitat quality. Differences probably will arise in implementation and emphasis. Some reports, notably the *Tribal Plan* and the *NMFS Snake River Salmon Recovery Plan*, emphasized the need to establish and enforce in-channel habitat standards; however, others such as the *NRC* and *USFS/BLM* reports emphasized restoring the full range of natural conditions.

IV. Artificial Propagation

Consensus:

1. Artificially produced salmon have largely replaced naturally-spawning populations over much of the Columbia River basin.
2. Artificial propagation can have a damaging effect on naturally-reproducing populations of salmon if the potential for genetic alteration, competition, predation, and disease introduction is not taken into account.
3. Non-native cold water and warm water species introductions (as well as some hatchery trout stocking programs) have contributed to the decline of native fishes.

Lack of consensus:

1. Reports were divided over the extent to which artificial propagation programs have contributed to the survival of naturally-reproducing populations, or to the support of tribal and non-tribal commercial and sport fisheries. The *Tribal Plan* and the *NMFS* Snake River report assert that hatcheries have been instrumental in supporting fishing and slowing the decline of some populations, while the *ISG* and *NRC* reports found relatively little evidence that artificial propagation has succeeded in achieving either conservation or harvest goals.
2. The reports were sharply divided over the issue of supplementation – using artificially propagated fish (with local broodstock where possible) to augment wild populations with the goal of building sustainable natural runs. The *Tribal Plan* advocated supplementation over

broad geographic areas as a major strategy to put fish back in the rivers. The risks of stock extinction, according to the *Tribal Plan*, outweighed some of the genetic concerns with supplementing scarce wild populations with hatchery-bred fish. Likewise, the *NMFS* Snake River report was supportive of existing supplementation programs, albeit with precautions against genetic introgression and other potentially harmful effects of hatchery fish introductions. The *ISG* and *NRC* reports, on the other hand, were skeptical of supplementation and recommended its use only in carefully controlled and monitored situations. The *NRC* report, for example, strongly argued against mining natural broodstock for supplementation programs. Both the *ISG* and *NRC* reports recommended the development of a basin-wide genetic conservation strategy that would provide a context for hatchery operations.

3. The reports did not agree on the use of artificial propagation as a tool for supporting harvest. The *Tribal Plan* asserted that hatchery production was an appropriate means of providing salmon for in-river harvest. The *ISG* and *NRC* reports argued that artificial propagation was inappropriately used to support harvest and should instead be limited to genetic conservation goals.
4. The *Tribal Plan* claimed that the Evolutionarily Significant Unit (ESU) concept was improperly applied by *NMFS* to prevent the introduction of salmon from one watershed to another.
5. The *Tribal Plan* called for the development and testing of artificial propagation of Pacific lamprey. None of the other reports discussed the possibility of lamprey hatcheries. Management of non-salmonid species such as lamprey and sturgeon was addressed by the *Tribal Plan* but was not treated in detail in the other reports

V. Hydroelectric Development and Operations

Consensus:

All reports agreed that hydropower development in the Columbia and Snake River Basins has adversely affected salmonid populations, but there were relatively few areas of agreement about what should be done. The following section outlines the positions of each of the reports according to specific issues related to hydropower operations.

Flow augmentation

Lack of Consensus:

1. There was no clear consensus and considerable uncertainty regarding flow-survival relationships and the efficacy of flow augmentation.

   - *ISG*: A complex and variable relationship between flow and survival probably exists, but it has been simplified to a relationship centering on water velocity and travel times for juveniles in reservoirs. This simplified view provides and inadequate conceptual basis for restoration of a full range of life history types and stocks. The flow management strategy does not consider inherent variation in natural migratory behavior of a variety of life history types.

- *NRC*: It is doubtful, *a priori*, that declines in Snake River salmon have resulted from or are reversible by seasonal changes in flow regime alone.
- *NMFS*: There is a direct relationship between juvenile survival and flow. Although there is evidence of a relationship between flows and survival, it is difficult to determine the exact mechanism by which increased flows increase survival, and it is difficult to establish a particular level as being ideal. Changes in river management should be made to restore to some extent the "natural hydrographic conditions" under which listed salmon stocks evolved.
- *CRITFC*: Provide flow augmentation to achieve mean historical flows during juvenile migration periods.

2. Major uncertainties included:
   - The amount of flow need as to achieve a specific survival rates for all species and life history types is not well-established.
   - The mechanisms underlying effects of increased flows are complex and poorly understood.
   - The present flow management strategy does not take into account the complex migratory behaviors of juvenile salmonids.
   - The benefits of trying to duplicate in reservoirs the natural or historical hydrographic conditions that existed in a free-flowing river have not been assessed.

Transportation

Consensus:

1. There was consensus among the documents that transportation alone would not be sufficient to overcome the negative effects of habitat loss, etc., and would not halt the decline of Snake River salmon.

Lack of Consensus:

1. There was no clear consensus on the role of transportation and considerable uncertainty. Views on transportation ranged widely among the documents.
   - *ISG*: The report was skeptical of the efficacy of transportation. Transporting smolts could provide increases in survival for some life history types or stocks under certain conditions. Concerns were expressed about impacts on life history and stock diversity.
   - *NRC*: The report recommended continued barging as long as data indicated survival of transported smolts exceeded in-river migration. Research should evaluate effectiveness of transportation.
   - *CRITFC*: Transportation should be halted.
   - *NMFS*: The report asserted that available empirical data indicated transportation benefits Snake River spring/summer chinook and is likely to benefit Snake River sockeye and fall

chinook. Transportation of smolts is supported under most conditions. Research should be conducted to evaluate the effectiveness of transportation.

2. Major uncertainties included:
   - Impact on homing ability of adult salmon.
   - Effectiveness of transportation if evaluation is based on successful returns to a hatchery or successful reproduction on their natal spawning grounds, rather than adult returns to the point where tagged smolts were released.
   - Impacts on life history and stock diversity.

Drawdown of some mainstem Columbia and Snake River reservoirs to natural river levels or spillway crest

Consensus:

1. Most documents agreed that drawdowns of this nature would have large scale social and environmental impacts and that there are major uncertainties (biological, economic and social) associated with drawdowns to spillway crest or natural river level. The feasibility of drawdowns, including the ecological, economic and social costs and benefits, should be investigated.

Lack of Consensus:

1. The *Tribal Plan* calls for drawdown of John Day reservoir, the Lower Snake River reservoirs, and other reservoirs within the system to spillway crest or natural river level. The Snake River Salmon report contends that before drawdowns are considered, both the transportation option and methods to improve in-river migration conditions should be tested.

Structural and operational improvements at mainstem dams

Consensus:

1. All documents support efforts to modify structure and operation of hydropower projects to improve survival of downstream migrating juveniles and adults. There is general agreement on the need to proceed with a dissolved gas abatement program to reduce levels of supersaturation. The *NRC* and *ISG* reports call for better understanding of migratory characteristics of salmon in order that structural and operational improvements be oriented toward the natural migratory patterns of salmon.

Lack of Consensus:

1. Reports differ to some extent in the specific modifications of structure and operation that are recommended. The tribal plan emphasizes a need to increase turbine efficiency, extensive reliance on spill to achieve 90% fish passage efficiency (FPE), and expedited development of surface flow bypass systems. The *ISG* report concludes that turbine intake screens have increased fish guidance efficiency (FGE) but have not achieved the NPPC's goal of 90% FGE. The report also concludes that current bypass systems may selectively favor some life histories and stocks over others, and that success of bypass systems depends on consistency

of their design and operation with the natural migratory behavior of smolts. The *NRC* report made no specific recommendations for structural or operational changes in the dams themselves.

VI. Harvest

Consensus:

1. Reports generally agreed on the goal of harvest management. Harvest should allow for adequate adult escapement to maintain populations over time and the diversity of salmon stocks should not be compromised.
   - Harvest management regulations should be based on the productivity of individual stocks. Productive capacities of stocks are related to habitat conditions in watersheds, including habitat connectivity and the genetic and life history diversity of the stocks (*ISG* and *NRC*). To protect genetic diversity and allow for scientific uncertainty and inherent variability in the environment, sustainable escapements for each sub-basin should be established that are sufficient to restore metapopulation organization.
   - Harvest is only one of numerous sources of mortality and cannot be viewed as independent of other sources. When one source of mortality increases, other sources must decrease in order to keep populations from declining (zero-sum mortality: *ISG*). This is critical for harvest regulation in years of poor ocean or freshwater conditions.
   - Mixed stock fisheries in both fresh and salt water can lead to overharvest of less-productive populations and loss of stock diversity if not carefully regulated. This includes but is not limited to harvesting mixed stocks of strong hatchery and weak wild salmon populations. Mixed stock fishery management should be aimed at protecting stock and genetic diversity through improved stock identification and directed terminal fisheries.

Lack of Consensus:

1. The *ISG* and *NRC* reports tended to focus on general principles while the *CRITFC* and *NMFS* report recommendations were more specific. For example, *CRITFC* recommended full implementation of tribal treaty fishing rights and reductions in total mortality associated with harvest of chinook in the ocean. *NMFS* focused on ocean and in-river harvest management changes that would specifically protect and restore Snake River salmon (e.g., reductions in harvest capacity, development of alternative harvest methods, and commercial fishery buy-back program).

VII. Institutions

Consensus:

1. The reports agreed that current institutional arrangements are not succeeding in halting salmon declines and that new or altered arrangements are needed. Several of the reports blamed jurisdictional fragmentation and called for a streamlining of the Columbia Basin’s institutional framework. There was consensus on the need for adaptive management involving local knowledge and authority, having all groups with a legitimate interest at the

table, the need to honor treaty obligations, and better coordination among existing legal statutes, policies, and treaties.

Lack of Consensus:

1. Reports differed with respect to specific matters of institutional reform. The *ISG* and *USFS/BLM* reports did not make specific institutional or governance recommendations. The following are specific recommendations from the other documents:

   - The *NRC* report recommended management commissions be formed for each major sub-basin and that salmon recovery plans for each sub-basin be formulated. *NRC* also recommended a scientific advisory board to help inform policy decisions.
   - The *Tribal Plan* recommended implementation of an improved dispute resolution process that covered virtually all aspects of salmon management, including hydroelectric operations and land use policies. *CRITFC* also suggested that funding for the BPA Fish and Wildlife Program should be transferred in trust to the US Fish and Wildlife Service until a new governance structure could be formed consisting of the fisheries agencies (federal and state) and tribes. Both the *CRITFC* and *NMFS* reports recommended improved enforcement.
   - The *NMFS* report recommended formation of a Recovery Implementation Team, consisting of federal, state, and tribal policy leaders to improve coordination and teamwork among institutions having responsibility for Snake River salmon recovery. *NMFS* also agreed with *NRC* that a scientific review panel be set up to assist the implementation team.

VIII. Monitoring and Evaluation

Consensus:

1. A regional monitoring and evaluation program is necessary to appraise the status of populations and habitat, and assess the adequacy of management and restoration actions in achieving restoration goals.
2. The monitoring and evaluation program should have an ecosystem/watershed focus, deal with all stages in the life cycle of salmonids, and occur within an adaptive management framework.
3. The program should be designed and conducted cooperatively by agencies and tribes and should provide critical data, analyses, and integration to assess status and trends of ecosystem components, address monitoring objectives, test alternative hypotheses, and provide input to the adaptive management process.

Lack of Consensus:

1. No fundamental areas of disagreement existed. The documents differ in the level of detail and specificity of monitoring and evaluation approaches.

Conclusions

Determining areas of consensus among the five reports was complicated by the fact that the reports had different purposes or goals, were based on somewhat different conceptual foundations, and differed in regional scope and level of detail and specificity. *Upstream, Return to the River,* and *ICBEMP* focused primarily on general ecosystem principles related to salmon restoration at broad geographic scales. The Tribal plan, *Wy-Kan-Ush-Mi Wa Kish-Wit,* was regional in scope and detailed specific actions for restoration. The *Proposed Snake River Recovery Plan* was restricted to the Snake River basin and, like the *Tribal Plan*, proposed restoration actions more specific than *Upstream, Return to the River,* or *ICBEMP*. The reports often agreed on general principles but sometimes differed with regard to the specific actions needed to implement those principles.

There was substantial consensus in the areas of conceptual foundation, natural environmental variability, habitat, harvest, monitoring and evaluation, and the need for institutional reform. All reports agreed that ecosystem principles should guide restoration efforts and that these principles should be applied in an adaptive management framework. Although all the reports agreed that the Columbia River ecosystem cannot be returned to its pristine state, the reports also affirmed that maintenance and restoration of ecosystem processes and conditions would be necessary to achieve restoration goals. Salmon have declined as a result of the cumulative impacts of many human actions over many decades and consequently solutions will not be quick, easy, or inexpensive to implement, and will require significant changes in salmon management institutions and governance.

All reports concurred that natural variation in freshwater and ocean conditions was a significant factor affecting response of salmon populations to restoration actions. While natural variability contributes to a diversity of habitat types necessary for maintaining genetic and life history diversity, changes in ocean conditions can mask changes in freshwater survival resulting from restoration efforts. Changes in marine survival need to be tracked and harvest adjusted accordingly during periods of low marine survival.

There was strong consensus that human activities have degraded, fragmented, and disconnected riverine and adjacent riparian habitats and that this degradation has contributed to the decline of native fishes throughout the Columbia River basin. Habitat restoration will require long-term intervention directed at improving instream habitats, as well as riparian features and processes. At the watershed scale, coordinated action on both public and private lands, and among all types of land uses, will be necessary. Although all reports acknowledged the importance of protecting the highest quality remaining habitat, restoring degraded habitats, and improving connectivity between habitats, differences probably will arise in specific actions needed for habitat restoration.

All reports generally agreed that harvest management should allow for increasing escapements and protection of the diversity of salmon stocks through stock-specific harvest management. There were no fundamental areas of disagreement, but there were differences among the reports in specificity of recommendations for harvest management. Some of these concerned treaty obligations.

The reports agreed that current institutional arrangements were not succeeding in halting salmon declines and that new or altered arrangements would be needed. However, the reports differed in the kinds of institutional changes that should be made. All reports recognized the importance of a regional monitoring and evaluation program that could be conducted cooperatively among agencies and tribes to facilitate adaptive learning.

Lack of consensus was most evident in the areas of artificial production and hydropower operations. There was agreement among reports that artificially-produced salmon have largely replaced naturally-spawning populations over much of the Columbia Basin and that artificial production can have a damaging effect on naturally-produced salmon if the potential for genetic alteration, competition, predation, and disease introduction is not taken into account. The reports were divided over the extent to which artificial production programs have contributed to the survival of naturally-reproducing populations, or to the support of tribal and non-tribal fisheries. The reports also disagreed on the issue of supplementation and the use of artificial production as a tool for supporting harvest.

Perhaps the largest area of disagreement among the reports had to do with efficacy of management activities intended to mitigate the effects of the hydropower system. All reports agreed that hydropower development in the Columbia and Snake River basins had adversely affected salmonid populations and all supported modification of structure and operation of hydropower projects to improve survival of migrating juveniles and adults, but there was considerable disagreement over the specific modifications that were needed.

There was no clear consensus among the reports on the effects of flow augmentation, transportation, and drawdown of some mainstem dams to spillway crest or natural river level. There was considerable uncertainty regarding flow-survival relationships. These uncertainties included the amount of flow needed to achieve specific survival rates for all species and life history types, and the complex mechanism underlying effects of increased flows on survival. The present flow management strategy does not take into account the complex migratory behaviors of juvenile salmonids, and the benefits of trying to duplicate in reservoirs the natural or historical hydrographic conditions of a free-flowing river.

The reports agreed that transportation alone would not be sufficient to overcome the negative impacts of habitat loss and other human impacts, and would not halt the decline of Snake River salmon. The reports disagreed on the role of transportation in recovery efforts, the impact on homing ability of salmon, the effectiveness of transportation if evaluations were based on successful returns to a hatchery or successful reproduction on the natal spawning grounds rather than adult returns to the point where tagged smolts were released, and the impacts of transportation on life history and stock diversity. Most of the reports agreed that drawdown of some mainstem dams to spillway crests or to natural river levels would have large scale social and environmental impacts and that there were major biological and social uncertainties associated with this action.

Overall, the ISAB noted that topics involving extensive technological application, such as artificial production or hydropower operation, tended to be issues that engendered the greatest disagreement among the five reports. We believe it is not likely that a high level of consensus will be reached among the scientific community on these issues in the near future. On the other hand, consensus on other topics such as habitat protection and restoration seems much more achievable. This finding may have implications for programmatic decisions and project priorities.

PART II.

DETAILED COMPARISON OF KEY CONCLUSIONS OF COLUMBIA BASIN SALMON RECOVERY REPORTS

I. Conceptual Foundation

A. ISG Report – "Return to the River"

1. A conceptual foundation is a set of scientific principles and assumptions that can give direction to management and research activities, including restoration programs. A conceptual foundation determines what problems are identified, what information is collected and how it is interpreted, and as a result, establishes the range of appropriate solutions. Because it influences the interpretation of information, the conceptual foundation can determine success or failure of management and restoration plans.

2. The current (1994) Northwest Power Planning Council's Fish and Wildlife Program for restoration of salmon in the Columbia River basin does not contain an explicit conceptual foundation. However, it would be incorrect to conclude that a conceptual foundation is not *implicit* in the FWP. In fact, the FWP probably has been derived from more than one conceptual foundation. Each agency, institution, or interest group that proposed measures adopted by the Northwest Power Planning Council derived those measures from a conceptual foundation, sometimes from different conceptual foundations, some of which may be contradictory and possibly inconsistent with current knowledge. Because these conceptual foundations were not stated, the Northwest Power Planning Council, scientists, and the public cannot review or evaluate them.

3. The *normative ecosystem concept* is the cornerstone of the conceptual foundation for salmonid restoration proposed in *Return to the River.* The normative Columbia-Snake River ecosystem would be an ecosystem that provides functional biophysical features and processes that are essential to maintain diverse and productive salmonid populations. Normative is not historical, although the historical conditions that yielded high salmonid productivity can aid in establishing specific normative conditions. Restoration of Columbia River salmonids must address the entire natural and cultural ecosystem, which encompasses the continuum of freshwater, estuarine, and ocean habitats where salmonid fishes complete their life histories. Thus, a key condition for a normative ecosystem is a network of complex and interconnected habitats, which are created, altered, and maintained by natural physical processes in freshwater, the estuary, and the ocean. Genetic and life history diversity and metapopulation organization are ways salmonids adapt to these complex and connected habitats. These factors contribute to the ability of salmonids to cope with environmental variation in freshwater and marine environments.

4. The importance of a complex and dynamic continuum of habitats in the Columbia River is a central tenet of our conceptual foundation. Spatial connectivity of habitats has a riverine dimension that consists of a longitudinal continuum of runs, riffles, and pools, a riparian component composed of a lateral array of habitat extending from the main channel through side and flood channels to floodplains and the uplands of the valley wall, and a hyporheic dimension consisting of a latticework of underground habitats associated with the flow of river water through the alluvium (bed sediments) of the channel and floodplain. Temporally, these three components are continually being reconfigured by physical processes such as flooding. Floodplain (alluvial) reaches are especially important because habitat diversity and complexity are greatest in those locations. Alluvial reaches are likely to be nodes of production and biological diversity and they provide a complex habitat mosaic highly suitable for spawning, egg incubation, and juvenile rearing.

5. Availability of complex and connected habitats facilitates the expression of salmonid life history diversity. The richness of life history diversity in salmonid fishes is well-recognized. The complex, integrated set of phenotypic traits that comprise a salmonid's life history result from interaction of the genotype of an individual with its environments. Since physical habitat is a major component of the environment of salmonids, maintaining a rich diversity of genotypes and phenotypes depends on maintaining habitat diversity. Habitat degradation and loss of connectivity among habitats has suppressed expression of life history diversity and constrained salmonid production. For example, the decline of the ocean type life history of chinook salmon due to long-term, cumulative degradation of lower mainstem section of tributaries and inundation of mainstem reaches of the Columbia and Snake Rivers has been an important contributor to the overall decline of production of chinook salmon within the Columbia River basin. Enhancing normative conditions, reestablishing life history diversity, and increasing salmonid production requires restoration of habitat diversity and connectivity throughout the basin.

6. Metapopulations are spatially-structured groups of local populations linked by dispersal (straying). Metapopulation structure is likely in salmon because they display a high fidelity to their natal stream, which allows them to establish local spawning populations, and they have low, but variable levels of straying, offering the opportunity for recolonization of habitats where local extinction has occurred. Recent studies suggest that salmonid metapopulations resemble core-satellite metapopulations. Core populations are large, productive populations that are less susceptible to extinction than smaller satellite populations. Core populations serve as important sources of colonists that could reestablish satellite populations in habitats where extinctions have occurred. Thus, core populations can buffer metapopulations against environmental change and contribute to the resiliency of regional salmonid production. Spawning populations that could have functioned as core-like populations likely occurred historically in alluvial river reaches. The Hanford reach, which supports the last viable population of mainstem-spawning fall chinook in the Columbia Basin, currently may function as a critical core area.

7. Fragmentation and destruction of habitat can reduce life history diversity and disrupt metapopulation organization by extirpating vital core populations and isolating remaining populations. Chinook salmon in the Columbia basin above Bonneville Dam prior to extensive human development likely consisted of a complex mosaic of spring, summer, and fall races of salmon distributed among mainstem and headwater spawning areas. Inundation of alluvial habitats in the mainstem Columbia and Snake rivers following construction of dams and degradation of mainstem habitats in major subbasins have virtually eliminated productive mainstem spawning fall chinook stocks. Most summer and spring chinook which spawned in upper mainstem segments of subbasins and lower reaches of tributaries to subbasin mainstems have been extirpated. Aside from the Hanford Reach, natural production of chinook salmon is largely confined to relatively small, isolated populations of spring chinook in headwater streams where high quality habitat is still available

B. NRC Report – "Upstream"

1. As a framework in which to approach its deliberations, the committee chose to focus on *rehabilitation* – a pragmatic approach that relies on natural regenerative processes in the long term and the selected use of technology and human effort in the short term – rather than on attempts to restore the landscape to some pristine former state and rather than on a primary reliance on substitution, i.e., the use of technology and energy inputs, such as hatcheries, artificial transportation, and modification of stream channels. Rehabilitation would protect what remains in an ecosystem and encourage natural regenerative processes. The solutions will not be easy or inexpensive to implement; even a holding action to prevent further declines will require large commitments of time and money from many people in many segments of society in the Pacific Northwest. Therefore, broad-based societal decisions are needed to successfully provide a long-term future for natural salmon populations.

2. The long-term survival of salmon depends crucially on a diverse and rich store of genetic variation. Because of their homing behavior and the distribution of their populations and their riverine habitats, salmon populations are unusually susceptible to local extinctions and are dependent on diversity in their genetic makeup and population structure. Therefore, management must recognize and work with local breeding populations and their habitats. It is not enough to focus only on the abundance of salmon.

3. The social structures and institutions that have been operating in the Pacific Northwest have proved incapable of ensuring a long-term future for salmon, in large part because they do not

operate at the right time and space scales. Differences among watersheds mean that different approaches are likely to be appropriate and effective in different watersheds, even where the goals are the same. This means that institutions must be able to operate at the scale of watersheds; in addition, a coordinating function is needed to make sure that larger perspectives are considered.

C. USFS/BLM Report – "An Assessment of Ecosystem Components in the Interior Columbia Basin and Draft Environmental Impact Statement"

1. The purpose of the DEIS was to prepare a scientifically sound strategy for implementing ecosystem management, including long-term management of aquatic habitat, on lands administered by the US Forest Service and Bureau of Land Management. The Scientific Assessment was to support the development of the management plan by describing the ecological and socio-economic conditions, trends, processes, and functions of the basin. The principles and concepts to guide ecosystem management were as follows:

- **a)** **Ecosystems are dynamic, evolutionary, and resilient.** Change is inherent, which allows ecosystems to develop along many paths.
- **b)** **Ecosystems are viewed spatially and temporally within multiple organizational levels.** These levels can be organized within a hierarchy in which every level has discrete ecological functions but is also part of a larger whole, although terrestrial, aquatic, economic, and social systems may operate within different hierarchies.
- **c)** **Ecosystems have biophysical, economic, and social limits on their ability to withstand change and still maintain their integrity, diversity, and productivity.**
- **d)** **Ecosystem patterns and processes are not completely predictable although predictability varies over temporal and spatial organizational levels.** Monitoring and adaptive management can be helpful in dealing with uncertainty. Management policies need to be flexible enough to permit appropriate responses to unanticipated effects.

2. Seven alternatives were developed that represented varying combinations of emphasis on active and passive conservation (protection and maintenance of ecosystem conditions, health, and integrity). restoration (management designed to move ecosystems to desired conditions and processes), and production of goods and services. Two of those alternatives represented continuation of current management practices. Outcomes of each alternative were evaluated relative to the management goals**.**

3. The management goals were (1) to maintain and/or restore forest, rangeland, riparian, and aquatic health and productivity, (2) to maintain economic social, and cultural systems within the capabilities of the ecosystem, and (3) to meet federal trust responsibilities to American Indian tribes, (4) to help recover listed species, (5) to provide diverse recreational and educational opportunities. Key elements and concepts include**:**

- **a)** **Ecological integrity –** the degree to which all ecological components and their interactions are represented and functioning. Estimating integrity components in a relative sense across the basin aids in explaining current conditions and prioritizing future management. Thus, areas of high integrity would represent areas where ecological function and processes are better represented than areas rated as low integrity.
- **b)** **Ecosystem health –** a condition where the parts and functions of an ecosystem are sustained over time and where the system's capacity for self-repair is maintained, such that goals for uses, values, and services of the ecosystem are met.
- **c)** **Resilience –** the ability of a system to respond to disturbances, one of the properties that enables the system to persist in many different states or successional changes.
- **d)** **Restoration –**system-wide actions to modify an ecosystem to achieve a desired, healthy, and functioning condition.
- **e)** **Sustainability –** emphasizing and maintaining the underlying ecological processes that ensure

long-term productivity of goods, services, and values without impairing productivity of the land.

- **f)** **Viable population –** a population that is regarded as having the estimated numbers and distribution of reproductive individuals to ensure that its continued existence is well distributed in the project area.
- **g)** **Adaptive management** -- a continuing process of planning, implementation, monitoring, and evaluation to adjust management strategies to accomplish ecosystem management.
- **h)** **"Step-down"** – linking broad-scale, basinwide information and decisions to analysis and actions at finer scales. These include the mid-scale (e.g., a subbasin or group of subbasins), watersheds (e.g., watershed analysis), and site-specific projects.

D. CRITFC – "Wy-Kan-Ush-Mi Wa-Kish-Wit, Spirit of the Salmon"

1. In this plan, the tribal approach to salmon restoration is simply stated – put the fish back in the rivers. Yet making this happen has become increasingly difficult because of decades of poorly guided and deeply entrenched fish management policies. More than science and its limits, the problems almost always involve people and their institutions – whether government, business, or otherwise.

2. The plan emphasizes what the tribes have called "gravel to gravel management", that is, the tributary, mainstem, estuary and ocean ecosystems and habitats where anadromous fish live. The plan integrates this ecosystem, or gravel to gravel perspective, into an adaptive management framework. The plan recommends changes in current water, land and fish management needed to produce the required increases in survival, with an emphasis on an equitable sharing of the conservation burden. The actions in the plan are designed to measure whether or not survival levels are being achieved. Should the recommended measures not attain sufficient rates of survival, the plan calls for modifications and additional actions.

3. This plan establishes a foundation for the United States and its citizens to honor their treaty and trust obligations to the four tribes. If implemented, it would at least begin to meet the ceremonial, subsistence and commercial needs of tribal members and to return fish to many of the tribes' "usual and accustomed fishing places", as guaranteed in the 1855 treaties. What often sets tribal policy development apart from other decision-making is the tribal conviction that not all societal decisions can be properly weighed in terms of costs and economics. The costs of restoration must be at least equated with the value of restoration. That value includes the spirit of the salmon (Wy-Kan-Ush-Mi Wa-Kish-Wit). Tribal peoples can feel the yearning of salmon to serve its life purpose. There is no model that can factor in spirituality nor the ultimate value of living creatures.

E. NMFS – "Proposed Recovery Plan for Snake River Salmon -- 1995"

1. The strategy for this Plan is to implement, with careful monitoring and evaluation, those actions that are necessary for the immediate conservation and future recovery of the species, rather than to identify extended studies before any action is proposed. The basic approach is to address immediately all human-induced causes of mortality at each life stage of listed salmon, while at the same time conducting additional analysis and research to better understand where and how the greatest benefits can be gained.

2. The actions in this Plan are designed to take all reasonable measures that will, based on the best scientific information and judgment, avoid extinction, achieve rebuilding, and ensure sustained recovery of listed salmon. Actions should be implemented immediately to avoid extinction of Snake River salmon and prevent further degradation of Columbia Basin health and declines in numerous other species include:

- **a)** Improvements in downstream survival through increased flows and controlled spill in the Snake and Columbia Rivers.

b) Modifications to dams and their operations to bring about improvements in juvenile downstream passage survival and upstream adult survival.

c) Improvements in transportation.

d) Controlled propagation to preserve listed stocks until recovery actions can reverse their decline.

e) Improved hatchery practices (mitigation and fisheries enhancement programs) to protect natural populations.

f) Reductions in fall chinook harvest levels.

g) Protection and restoration of spawning and rearing habitat.

h) Testing of major system reconfiguration (surface bypass/collection, etc.) and planning for reservoir drawdowns.

i) Analyses and research to identify what factors limit our ability to restore productivity.

3. **The recovery strategy is adaptive, it places higher priority on actions that are most likely to provide the most immediate benefits, the greatest long-term benefits, and the best opportunity to identify those factors limiting recovery.** This strategy ensures that the recovery plan remains dynamic, allowing actions to be added, deleted, or refined following an adaptive management approach based on evolving scientific information and analysis.

II. Natural Variation, Climate Change, and Ocean Productivity

A. ISG Report – "Return to the River"

1. Global and regional processes in the ocean and atmosphere can regulate the productivity of local marine, estuarine, and freshwater habitats for salmon. Because salmon migrations are tied to major ocean circulation systems and, because the life cycles of salmon are shorter than the interdecadal periods of large-scale climatic change, abundance of salmon tracks large-scale shifts in climatic regime. Although managers cannot control the oceanic and atmospheric processes, natural variability must be understood to correctly interpret the response of salmon to management actions in the Columbia Basin.

2. Stocks with different life history traits and ocean migration patterns may be favored under (or differentially tolerant of) different combinations of climatic regime and local habitat characteristics. Such differences afford stability to salmon species over multiple scales of environmental variability. Together landscape modifications, construction of dams, overharvest in sport and commercial fisheries, and hatchery programs have simplified the geographic mosaic of conditions in the Columbia River Basin and reduced the variety of salmon life histories formerly associated with this mosaic. Such changes limit the capacity of salmon to adapt to periodic shifts in large-scale atmospheric and oceanographic conditions. The cumulative effects of human disturbance may not become apparent until severe climatic stresses trigger a dramatic response. Such interactions may be particularly severe in the Pacific Northwest where periods of reduced ocean survival of salmon and periods of stressful freshwater conditions (due to reduced precipitation, low stream flow, and increased stream temperatures) tend to co-occur. Although climatic factors may be a proximate factor in regional salmon decline, the ultimate causes may involve a longer history of change affecting the resilience of species and populations.

3. The dynamics of salmon metapopulations could change under different climatic regimes. Habitat fragmentation and loss of local stocks will likely magnify the effects of ocean productivity "troughs" by also increasing freshwater mortality, inhibiting recolonization of disturbed habitats, and slowing rates of population recovery. Thus, in concert with large-scale changes in climate, increases in the rates of local extinction and loss of stock diversity may lead to greater "synchrony" in the dynamics of salmon metapopulations and reduced metapopulation persistence. Regional patterns of salmon decline in the

Columbia Basin and throughout much of the Pacific Northwest are generally consistent with synchronization hypothesis.

4. Lack of long-term monitoring of ocean conditions and the factors influencing the survival of salmon during their first weeks or months at sea severely limit understanding of the specific causes of interdecadal fluctuations in salmon production. This understanding is needed if management programs are to adapt to natural variations to insure rebuilding of salmon populations in the Columbia Basin. To fully evaluate the interactions of hatchery and wild salmon, stock-specific distributions of Columbia Basin salmon in the ocean and the migratory patterns of hatchery and wild salmon need to be better understood. There is increasing evidence worldwide that ocean fisheries can destabilize marine food webs. Harvest management programs based on stock-recruitment relationships and monitoring of individual species do not provide adequate indicators of the effects of harvest on ocean food webs.

B. NRC Report – "Upstream"

1. Variations in ocean conditions powerfully influence salmon abundance. Salmon management must take the variability of ocean conditions into account. Because all human effects on salmon lead to reductions in the total production that the environment allows, management interventions are *more important* when the ocean environment reduces natural production than when ocean conditions are more favorable. In a situation of such uncontrollable external variation, it would make sense for fishing to take a *fixed and sustainable proportion* of the returning spawners rather than a fixed number, as long as the number of returning spawners exceeds a minimal safe threshold based on demographic and genetic considerations.

2. There is considerable regional variation in the physical, biological, social, cultural, and economic environments of salmon. No unified solution to the salmon problem, management strategy, research strategy, institutional arrangement, or governance structure can be expected to apply to the entire Pacific Northwest.

3. Any approach to improving the status of salmon populations must have regional components that, when possible, reflect the bioregions relevant to salmon biology and conservation. Preemptive recovery plans should include management and research strategies, institutional arrangements, and governance structures that are flexible and can be adjusted to fit regional variations.

C. USFS/BLM Report – "An Assessment of Ecosystem Components in the Interior Columbia Basin and Draft Environmental Impact Statement"

1. Habitat heterogeneity can be key to the expression and maintenance of biological diversity in terrestrial and aquatic environments. The maintenance of habitat complexity in the Columbia basin becomes critical if we are to conserve the natural diversity of aquatic biota in the face of disturbance. Although climatic and geological processes cannot be managed, human response to them can be planned, and in some cases, human disturbances might be modified to maintain desired habitat complexity in the context of natural disturbance regimes.

2. A single set of numeric riparian or instream management objectives fails to recognize the wide range of potential variability of those characteristics. They commonly lead to inflexible targets or thresholds that may be inappropriate for local conditions and to potential degradation of conditions in high quality watersheds where characteristics exceed those objectives. They can also shift the focus from the biophysical processes that are the drivers of riparian and instream conditions.

3. Cycles in marine productivity have the potential to mask the effects of degradation in freshwater habitats. A general downward trend in the condition of freshwater habitats is masked by long-term oscillations in ocean productivity. During periods of unfavorable ocean conditions, the consequences of degradation in freshwater habitats are most evident, and the risk of local extirpation is greatest. However, when periods of favorable ocean conditions are coupled with declining freshwater habitats, anadromous fish populations may appear to be stable or even increasing. Thus, favorable ocean conditions can lead to false beliefs of overall improvement in freshwater habitat quality. Similarly, haphazard restoration strategies may appear to be successful as population numbers increase, even though those increases are merely the fortuitous result of improving oceanic conditions. It is important to be aware of the larger context when assessing effects of management activities in a naturally fluctuating environment.

4. Long-term variations in ocean productivity also have a significant bearing on harvest and hatchery management. Harvest projections and limits are typically based on maximum sustained yield models that assume a constant environment. Because such models assume linear relationships between production and yield, they are particularly problematic in a changing environment or in one that is tending in a direction different from that in which the model was developed. Similarly, the survival and production of hatchery-reared fishes may vary significantly with oceanic conditions.

5. Although the amount of time that anadromous salmonids reside in freshwater habitat may be relatively short, condition of the habitat is critical, especially considering the natural fluctuations of conditions during their multi-year residence in the ocean. Freshwater habitats of high quality can ameliorate periods of poor ocean production, and it is becoming increasingly apparent that high quality freshwater habitat is not a luxury but a necessity to the survival of anadromous salmonids. Persistence of some depressed stocks of anadromous species will require high survival rates in areas influenced by management of federal lands in light of the high mortality rates that they experience in other habitats. The oscillating conditions of ocean productivity and decline of Pacific salmon and steelhead emphasize the need for monitoring and restoring habitat elements, such as spawning and rearing habitat throughout the Columbia Basin.

D. CRITFC – "Wy-Kan-Ush-Mi Wa-Kish-Wit, Spirit of the Salmon"

1. Changes in ocean productivity can be estimated from environmental monitoring data and salmon scale patterns, and these results can be used in an adaptive management process to guide compensating actions in freshwater portions of the salmon life cycle. Recommended actions include:

- **a)** Develop and refine an environmental index (or indices) of ocean productivity that is based on available information (e.g., ocean surface temperature, coastal upwelling, and weather patterns).
- **b)** Develop a biological index of ocean productivity that is based on variation in ocean growth patterns as recorded in salmon scales.
- **c)** Annually evaluate fluctuations in ocean survival of Columbia River salmon populations produced above Bonneville Dam. Identify and implement the magnitude of adjustment needed in activities affecting the freshwater environment to compensate for persistent periods of increased natural ocean mortality.

E. NMFS – "Proposed Recovery Plan for Snake River Salmon -- 1995"

The Snake River Salmon Recovery Plan did not reach any specific conclusions and recommendations with regard to natural variation, climate change, or ocean productivity.

III. Habitat

A. ISG Report – "Return to the River"

1. The normative ecosystem concept is the cornerstone of the conceptual foundation for salmonid restoration proposed in *Return to the River.* The normative Columbia-Snake River ecosystem would be an ecosystem that provides functional biophysical features and processes that are essential to maintain diverse and productive salmonid populations. Normative is not historical, although the historical conditions that yielded high salmonid productivity can aid in establishing specific normative conditions. A key condition for a normative ecosystem is a network of complex and interconnected habitats, which are created, altered, and maintained by natural physical processes in freshwater, the estuary, and the ocean. Genetic and life history diversity and metapopulation organization are ways salmonids adapt to these complex and connected habitat. These factors contribute to the ability of salmonids to cope with environmental variation in the freshwater and marine environment.

2. Habitat required for salmonid migration, spawning, incubation, and juvenile rearing has been severely degraded in the Columbia Basin by the cumulative effects of inundation and flow regulation by dams and diversions, forestry and agricultural practices and massive introduction of non-native biota. Habitat fragmentation and loss is extensive throughout the Basin except in those few areas where human activities are limited, particularly in roadless and wilderness areas in the upper portions of some sub-basins. Habitat degradation has reduced salmonid life history and stock diversity and salmonid abundance. Most alluvial floodplain reaches and associated habitats, historically providing large, productive spawning areas and essential, high-quality feeding and rearing habitats for maturing and migrating juveniles, have been destroyed by river inundation, substantially degraded by altered flows, or disconnected from the salmon ecosystem by dams that block migratory pathways. Habitat conservation and restoration has not been a priority in the Northwest Power Planning Council's Fish and Wildlife Program.

3. The presence of non-native fishes is a strong indicator of habitat degradation. Introduced fishes tend to be most successful in streams and rivers where natural habitat has been altered and native fishes depleted. Native salmonids remain healthy in less than 5% of the headwater streams of Columbia River tributaries, owing to genetic introgression and displacement by non-native species, both of which have been exacerbated by hatchery culturing, and changes in lake food webs as a result of stocking of mysid shrimp. Non-native fishes also are abundant in mainstem Columbia and Snake River reservoirs. Often, non-natives can be effectively suppressed in habitats that are maintained by natural flow and temperature regimes. All stocking of non-native biota should be stopped in areas used by or hydrologically connected to habitats required by resident and anadromous native species. Carefully evaluated mechanisms to reduce or eliminate the reproductive capacity and dispersal of non-native species should be implemented.

4. A well-distributed network of reserve watersheds and riverine habitat patches should be established. Reserves should be designated based on the current distribution of strong populations of native salmonids and should be protected from human disturbance in order to establish experimental natural baselines for evaluation of the effectiveness of management practices and to establish a biological hedge against possible failure of Best Management Practices to conserve and enhance aquatic habitat. Reserves should encompass areas in sub-basin watersheds as well as areas in the mainstem Columbia such as the Hanford Reach.

5. Freshwater habitat for all life stages of salmonids must be protected and restored with a focus on key alluvial river reaches and lakes. Habitat restoration must receive high priority and be approached in the normative ecosystem context. Life history and stock diversity and productivity of native salmonids cannot recover without restoring spatial (upstream-to-downstream, channel-to floodplain, and groundwater-to-floodplain) and temporal connectvity of the habitat mosaic. Restoration effort needs to focus on the tributaries, as well as the mainstem with priorities given to key alluvial reaches. Restoration activities should include incentives for watershed planning that emphasize riparian and upland land use activities that enhance stream and lake habitats, and re-regulation of flows to restore the spring high-water peak to revitalize the mosaic of habitats in riverine reaches and stabilize daily fluctuations in flow to allow food web development in shallow water habitats. Habitat restoration may be less effective at restoring native species where introduced non-native species are well-established.

B. NRC Report – "Upstream"

1. Freshwater habitats are critically important to salmon because they constitute the spawning grounds and nurseries in which the genetic makeup of a population is determined. Many human activities -- notably forestry, agriculture and grazing, hydropower, and commercial, residential and recreational development – have contributed to degradation of the riverine and adjacent riparian and near-river habitat and caused loss of habitat of spawning adults and young salmon, and loss of associated components of the ecosystem.

2. Increased protection should be provided to riverine-riparian ecosystems and to all biophysical watershed processes that support aquatic productivity. The importance of riparian zones to the maintenance of aquatic productivity cannot be overemphasized, yet insufficient protection has been given to these critical areas in the past. The width of riparian zones requiring protection from harmful human disturbances is usually not known with certainty, but all possible ecological functions should be considered when attempting to define riverine-riparian boundaries. Within the domain of interactions between aquatic and terrestrial environments that characterizes the riparian zone, some human activities may occur without major disruption; however, it is critical that the full range of ecological functions be explicitly protected, including all biotic and physical processes that mediate the exchange of energy, water, nutrients, and organic matter between streams and their watersheds. In many cases we are likely to find that the approximate width of the riparian zone in which these exchanges occur is substantially wider than the narrow border of vegetation often specified in current regulatory language.

3. Beyond the edge of the riparian zone it is important that hydrologic processes within watersheds not be altered by human activities to such an extent that patterns of water, sediment and organic matter inputs to streams continue to or exacerbate the degradation of aquatic habitat or riparian functions. Human activities resulting in habitat degradation include those that prevent important ecological processes from occurring (e.g., flooding and groundwater recharge) as well as those that alter the rates of other processes (e.g., accelerated erosion). Although land and water uses will continue to take place in most Pacific Northwest watersheds, recovery of productive salmon habitat will necessitate a concerted effort to restore the range of natural conditions in aquatic and riparian ecosystems. To facilitate this recovery the following recommendations are put forward:

- **a)** Forestry, agricultural, and grazing practices should allow riparian zones to maintain a full range of natural vegetative characteristics, i.e., those characteristics occurring in watersheds with natural disturbance regimes. Riparian zones must be wide enough to fulfill all functions necessary for maintaining aquatic productivity.

- **b)** Sediment from all land uses should be reduced to levels appropriate to the geological setting of a river basin. In practical terms the goal should be for human activities to cause no net increase in sediment over natural inputs. Likewise, water temperatures should reflect as closely as possible the normal regime of temperatures throughout the basin.

- **c)** Patterns of water runoff, including surface and subsurface drainage, should match in both quantity and quality the natural hydrologic pattern for the region to the greatest extent possible. Effects of consumptive water uses on both the timing and quantity of flow should be minimized. Water management technologies that promote the restoration of natural runoff and water quality should be strongly encouraged. This will mean implementation of methods to reduce the volume of waters used for irrigation, industrial, and urban uses.

- **d)** Toxic waste products from industrial, mining, agricultural, and urban activities should receive the highest possible treatment before being discharged into any body of water.

- **e)** Reclamation or enhancement activities should emphasize restoration of ecological processes and functions, not artificially-created habitat. Placement of permanent or semi-permanent habitat structures in streams should be discouraged unless it can be clearly demonstrated that no other alternative is available. Removal of existing structures should be undertaken whenever they appear to be impeding natural recovery.

f) Beneficial long-term effects of natural disturbances such as fire and flooding should be preserved or restored wherever possible. Lowland slough and estuarine habitat rehabilitation should receive high priority in coastal regions.

C. USFS/BLM Report – "An Assessment of Ecosystem Components in the Interior Columbia Basin and Draft Environmental Impact Statement"

1. Degradation and loss of freshwater habitats are a consistent and pervasive problem facing the aquatic faunas in the Basin. Continued declines of fisheries resources suggest that past management practices have been insufficient to reverse the trend. Broad-scale ecosystem approaches are needed to halt habitat degradation, to maintain existing high quality habitats, and to aid in the recovery of declining fish and aquatic invertebrate resources. Other important but often unappreciated natural processes, such as recharging underground aquifers and providing large woody debris to stream systems, would also be maintained. Water quality, recreation, drought resistance, and flood protection would be enhanced by improving watershed condition.

2. The composition, distribution, and status of fishes within the Basin are very different than they were historically. If current distributions of certain salmonid species are good indicators of aquatic ecosystem health, many systems remain only as remnants of what were larger, more complex, diverse and connected systems. Even with no further habitat loss the fragmentation and isolation may place remaining populations at risk. With the exception of the Central Idaho Mountains, Snake Headwaters, and perhaps the Northern Cascades, most of the important areas for key salmonids exist as patches of scattered subwatersheds. Many are not well connected or are restricted to much smaller areas than historically. Many of the important subwatersheds are associated with high elevation, steep, and more erosive landscapes. These may be more extreme or variable environments contributing to higher variability in the associated populations, and higher sensitivity to watershed disturbances. The patchwork of important watersheds also suggests that remaining populations of salmonids are not well distributed within the subbasins. The loss of spatial diversity in population structure and the full expression of life history pattern may lead to a loss of productivity and stability important to long-term persistence. Local extirpations may occur through random events even in high quality environments with no further habitat change, but in many cases the spatial and life history diversity necessary to mitigate the losses is no longer present.

3. Though much of the native ecosystem has been altered, core areas remain for rebuilding and maintaining functional native aquatic systems. The largest areas of contiguous or clustered watersheds supporting strong populations of key salmonids are associated with the major river subbasins found in the Central Idaho Mountains, the Snake River Headwaters, and the Northern Cascades. Important areas are also found in the Blue Mountains, Upper Clark Fork, and the Northern Glaciated Mountains, but are scattered or generally restricted to only portions of interior river subbasins.

4. Protection and maintenance of system integrity and functioning will require innovative approaches. Simple solutions such as setting aside small, scattered subwatersheds probably will not be adequate for the persistence of even current distributions and diversity. The problems are too complex and too pervasive. However, there are several actions which could be taken to maintain or restore the integrity of aquatic ecosystems:

a) **First, conservation of watersheds and habitats that support remaining areas of high intrinsic value or condition for aquatic species is critical**. These include areas supporting strongholds for one or multiple species, areas of high genetic integrity, fringe distributions, and areas that support narrowly distributed endemic or listed species.

b) **Second, reconnection and expansion of the mosaic of strongholds for widely distributed species such as native salmonids will enhance the integrity of larger systems**. For widely ranging fishes such as salmon, steelhead, and other migratory trouts, this includes protection of water quality and passage in migratory corridors as well as protection of spawning and rearing areas. Any conservation strategy focused on protecting or restoring habitat for a single species or life history form at the subwatershed scale will not provide for multiple species or complete communities.

5. Although the integrity of aquatic systems is most easily maintained in watersheds having little or no human influence, evidence suggests that many species persist in some intensively managed areas. Intensive land use did not necessarily eliminate all strong populations or areas of higher fish community integrity. There are many factors that contribute to the productivity of individual watersheds and systems of watersheds. Those watersheds that are intensively managed, yet support strong populations or areas of high integrity, should be among those of greatest concern.

D. CRITFC – "Wy-Kan-Ush-Mi Wa-Kish-Wit, Spirit of the Salmon"

1. In order to secure fish resource protection on private lands in conjunction with public land management, actively support ongoing watershed approaches and start new ones to implement subbasin planning in accordance with the FWP (Fish & Wildlife Program) and CRFMP (Columbia River Fish Management Plan) through a Columbia Basin watershed trust program. Establish a Columbia Basin Watershed Trust to encourage additional resources and provide facilitation services and technical support without diminishing local initiative.

2. Implement the following short term and long term habitat recovery measures, and include numeric survival goals for salmon life history stages:

Tributary Stream Flow

Short term: Halt any additional withdrawals of water from salmon subbasins; assure that no consumptive uses are occurring in excess of the amount permitted; meter groundwater and surface water withdrawals; halt any further impairment of wetlands; prevent additional soil compaction; prevent removal of riparian vegetation; prohibit activities that would contribute to the creation or maintenance of peak flows earlier or greater than those that would occur naturally

Long term: Establish instream flows designed to provide the full range of habitat conditions needed to provide harvestable salmon populations; mandate utilization of the most efficient irrigation methods; identify, through negotiation or adjudication, instream flow water rights reserved by tribes' treaties; implement actions to create wetlands, e.g., re-introduction of beavers; implement riparian recovery and soil de-compaction where it is not occurring naturally; if necessary initiate land management designed to return a watershed to a natural hydrologic regime

Watershed Restoration

Short term: Organize watershed-based associations to coordinate and implement watershed restoration actions; develop active restoration projects in the Grande Ronde, John Day, and Yakima subbasins; develop monitoring programs to document recovery trends

Long term: Develop active habitat restoration projects in additional watersheds as watershed-based associations are organized

Estuaries

Short term and long term: Protect remaining wetlands and intertidal areas in the estuary upon which anadromous fish are particularly dependent; undertake an immediate assessment of remaining and potential estuary habitat; protect existing estuarine habitat complexity; evaluate and condition additional proposals for hydroelectric and water withdrawal developments, navigation projects, and shoreline developments on the basis of their impact on estuarine ecology; identify and implement opportunities to reclaim former wetland areas by breaching existing dikes and levees; reestablish sustained peak flows which drive river and estuarine processes

Mainstem Habitat

Short term and long term: Implement a comprehensive review and monitoring program for water quality and substrate parameters; implement a biomonitoring program which includes (1) organochlorine compounds, heavy metals and radionuclides, (2) documents physiological abnormalities, (3) identifies hormone protein levels in fish blood as an indicator of organochlorine compounds, and (4) identifies sources of contaminants; all known permitted sources of persistent, bioaccumulative toxics affecting anadromous species should no longer be permitted; discharges of other contaminants must be reduced to meet water quality criteria fully protective of designated beneficial uses for anadromous fish

3. Establish in-channel habitat standards for surface fine sediment, cobble embeddedness, bank stability, and water temperature. Watershed or land management standards are recommended for sediment delivery, riparian reserves, grazing, roads, riparian grazing, and roadless reserves. Land management standards should be implemented regardless of the current habitat condition. Baseline conditions for in-channel habitat should be established for fine sediment at egg pocket depth, large woody debris, pool frequency and volume, residual pool volume, and stream shading. For these habitat conditions, no standards are imposed. However, these variables have great biological significance and degradation of these variables or lack of improvement from the current baseline in the context of general watershed rehabilitation for managed watersheds may constitute cause for concern and increased effort at restoration.

E. NMFS – "Proposed Recovery Plan for Snake River Salmon -- 1995"

1. Land and water management actions, including water withdrawals, unscreened water diversions, stream channelization, road construction, timber harvest, livestock grazing, mining, and outdoor recreation have degraded important salmon spawning and rearing habitats in tributaries. Ultimately the recovery of anadromous fish species will depend principally upon ameliorating passage problems in the mainstem Snake and Columbia Rivers. Assuming these improvements are made and mainstem juvenile and adult survival rates are increased, adequate spawning and rearing areas in tributaries must be provided to ensure full recovery.

2. An ecosystem approach that emphasizes integrated Federal and non-federal land management is needed. Federal lands and Federal actions should bear, as much as possible, the burdens of recovering listed salmon species and their habitat. However, non-federal lands constitute approximately 35 percent of the Snake River salmon critical habitat. To achieve an ecosystem approach, all stakeholders in a subbasin or watershed are encouraged to participate in management partnerships.

3. Anadromous fish habitat is provided through ecosystem processes and functions. NMFS has defined Ecological Goals that relate to those ecological functions that support salmon. These goals include (1) Maintain and restore the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations, and communities are uniquely adapted, (2) Maintain and restore spatial and temporal connectivity within and between watersheds, (3) Maintain and restore the physical integrity of the aquatic systems, including shorelines, banks, and bottom configurations, (4) Maintain and restore timing, volume, and distribution of large woody debris recruitment by protecting trees in riparian habitat conservation areas, (5) Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems, (6) Maintain and restore the sediment regime under which aquatic systems evolved, (7) Maintain and restore instream flows sufficient to create and sustain riparian, aquatic, and wetland habitats, (8) Maintain and restore the timing, variability, and duration of floodplain inundation and water table elevation in meadows and wetlands, (9) Maintain and restore the species composition and structural diversity of plant communities in riparian areas and wetlands, and (10) Maintain and restore habitat to support well-distributed populations of native riparian-dependent plant and animal species.

4. To protect tributary ecosystem health, NMFS proposes a three-part approach: (1) Protect remaining high quality habitat by ceasing activities that would degrade ecosystem functions and

values that listed fish need, (2) restore degraded habitats, and (3) provide connectivity between high quality habitats. NMFS has proposed tasks to avoid extinction of Snake River salmon that include preserving remaining listed salmon populations by identifying and protecting important habitat and reducing loss of species at water withdrawal sites. The tasks NMFS has proposed to begin recovery include rebuilding listed salmon populations by restoring habitat, improving land management planing, providing adequate instream flows, and improving fish passage at barriers. NMFS has proposed tasks to sustain recovery that include reducing losses of listed species associated with poor water quality and reducing impacts on salmon from recreational activities.

IV. Artificial Propagation

A. ISG Report – "Return to the River"

1. Artificial production has been institutionalized in the Columbia River Basin. Today 80% of the salmon and steelhead in the basin were hatched and reared in hatcheries. From 1981-1991 expenditures on hatcheries accounted for 40% of the budget for salmon restoration. Fifty percent of the increase in salmon production of salmon from the NPPC's program is expected to come from artificial production. The historical assumption by management institutions was that artificial production could compensate for habitat destruction, which led to less emphasis on habitat protection and more emphasis on hatchery construction. More recently hatchery programs have been intended to augment declining natural production due in large part to habitat degradation throughout the basin and to maintain a supply of salmon for the fishing industry.

2. In the context of the entire history of the hatchery program and salmon management in the Columbia River basin, artificial production has failed to replace or mitigate lost natural production of salmonids due to habitat degradation. Since 1960, total releases from hatcheries have increased substantially but the number of adult salmon entering the river has not increased. Furthermore, hatchery-reared fish have become the dominant portion of the run.

3. Artificial production can have adverse effects on wild fish including increased mortality in mixed stock fisheries, genetic interactions that can cause reduced fitness of wild populations and loss of population genetic variability, spread of disease, and increased competition with wild fish.

4. The role of artificial production in salmon restoration has to be redefined. Hatcheries should have a more limited role in salmon production and restoration and should be integrated into strategies that focus on habitat restoration, reduction of human-induced mortality, and conservation of existing genetic and life history diversity in natural populations. Hatcheries could have a useful role as temporary refuges for dwindling populations while causes of natural mortality are alleviated or a temporary role in rebuilding depressed populations through supplementation.

5. Ideally supplementation should be viewed as a small scale and temporary strategy to boost natural production. New supplementation projects should follow the guidelines developed by the Regional Assessment of Supplementation Programs (RASP). Supplementation should be used in conjunction with, but not in place of, habitat restoration and modification of downstream mortality factors. Supplementation should be approached cautiously in an experimental framework that relies on careful design, rigorous evaluation, and incorporates adaptive management.

6. A comprehensive evaluation of hatchery programs in the Columbia River Basin has never been conducted. Such an evaluation should be undertaken and should address the following questions: 1) Do salmon and steelhead of hatchery origin contribute to the fisheries and/or escapement and is the economic value of that contribution greater than the cost to produce it? 2) Is the level of contribution consistent with the purpose or objective of the hatchery? For example if a hatchery is intended to replace natural production lost due to habitat degradation, this question asks did the hatchery, in fact, replace the lost production? 3) Do artificial produced fish add to existing natural production or do they replace it, i.e., does the hatchery operation generate a cost to natural production through mixed stock fisheries, domestication, and genetic introgression?

B. NRC Report – "Upstream"

1. The management of hatcheries has had adverse effects on natural salmon populations. Hatcheries can be useful as part of an integrated, comprehensive approach to restoring sustainable runs of salmon, but by themselves they are not an effective technical solution to the salmon problem. Hatcheries are not a proven technology for achieving sustained increases in adult production. Indeed, their use often has contributed to damage of wild runs. In many areas, there is reason to question whether hatcheries can sustain long-term yield because they can lead to loss of population and genetic diversity. It is unlikely that hatcheries can make up for declines in abundance caused by fishing, habitat loss, etc., over the long term. Hatcheries might be useful as short-term aids to a population in immediate trouble while long-term, sustainable solutions are being developed. Such a new mission for hatcheries – as a temporary aid in rehabilitating natural populations – could be important in reversing past damage from hatcheries as well as from other causes.

2. The intent of hatchery operations should be changed from that of making up for losses of juvenile fish production and for increasing catches of adults. They should be viewed instead as part of a bioregional plan for protecting or rebuilding salmon populations and should be used only when they will not cause harm to natural populations. Hatcheries should be considered an experimental treatment in an integrated, regional rebuilding program and they should be evaluated accordingly. Great care should be taken to minimize their known and potential adverse effects on genetic structure of metapopulations and on the ecological capacities of streams and the ocean. Special care needs to be taken to avoid transplanting hatchery fish to regions in which naturally spawning fish are genetically different. The aim of hatcheries should be to assist recovery and opportunity for genetic expression of wild populations, not to maximize catch in the near term. Only when it is clear that hatchery production does not harm wild fish should the use of hatcheries be considered for augmenting catches. Hatcheries should be audited rigorously. Any hatchery that "mines" broodstock from mixed wild and natural escapements should be a candidate for immediate closure. It is useful for all hatchery fish to be identifiable. Marking hatchery fish externally is particularly important when fishers and managers need to distinguish between hatchery and wild fish.

3. Current hatchery practices do not operate within a coherent strategy based on the genetic structure of salmon populations. A number of hatcheries operate without appropriate genetic guidance from an explicit conservation policy. Consistency and coordination of practices across hatcheries that affect the same or interacting demes and metapopulations is generally lacking.

4. Hatcheries should be dismantled, revised, or reprogrammed if they interfere with a comprehensive rehabilitation strategy designed to rebuild natural populations of anadromous salmon sustainably. Hatcheries should be tested for their ability to rehabilitate populations whose natural regenerative potential is constrained severely by both short- and long-term limitations on rehabilitation of freshwater habitats. Hatcheries should be excluded or phased out from regions where the prognosis for freshwater habitat rehabilitation is much higher.

5. Decision-making about uses of hatcheries should occur within the larger context of the region where the watersheds are located and should include a focus on the whole watershed, rather than only on the fish. Coordination should be improved among all hatcheries – release timing, scale of releases, operating practices, and monitoring and evaluation of individual and cumulative hatchery effects, including a coastwide database and wild fish proportions and numbers. Hatcheries should be part of an experimental treatment within an adaptively managed program in some regions but not in others.

6. All hatchery programs should adopt a genetic conservation goal of maintaining genetic diversity among and within both hatchery and naturally spawning populations. Hatchery practices that affect straying – genetic interaction between local wild fish and hatchery-produced fish – should be closely examined for consistency with regional efforts.

C. USFS/BLM Report – "An Assessment of Ecosystem Components in the Interior Columbia Basin and Draft Environmental Impact Statement"

1. **Hatchery programs and introductions of non-native species have adversely affected native fishes.** The Assessment suggested that land management agencies could work with state fishery management agencies to reduce or eliminate stocking of non-native and hatchery-reared fish in areas capable of supporting self-sustaining native species.

D. CRITFC – "Wy-Kan-Ush-Mi Wa-Kish-Wit, Spirit of the Salmon"

1. The tribal goal to put fish back in the rivers means literally putting the fish back. Rather than continuing current hatchery rearing and release methods, the plan outlines the use of propagation strategies to reestablish naturally spawning salmon runs. With so many Columbia basin stocks at such low numbers, supplementation, which is what the tribes call their propagation proposals, is now an indispensable part of any restoration plan. While accounting for genetic concerns, the tribal plan asserts that increasing likelihood of species extinction is in fact the far greater genetic risk.

2. The tribal approach to using artificial propagation for supplementation and reintroduction is based on scientific principles and practicality and addresses genetic concerns by applying specific protocols for spawning, rearing, release and disease prevention. Fish utilized in supplementation and reintroduction efforts will be selected to best match the natural population of the stream in question. In the case of supplementation, the current population of the stream will serve as the source of fish for use in enhancement efforts, if possible. The intention of tribal supplementation proposals is to increase the abundance of naturally reproducing populations through outplanting while keeping genetic risk at acceptable levels.

3. The NMFS ESU policy, as applied to fragmented, isolated populations would separate those same populations from basin populations in adjoining subbasins and hatcheries that could render assistance. Thus, the ESU policy is at odds with the plans and programs of CRFMP, FERC and FWP which rely upon specific watershed programs that utilize habitat protection and artificial propagation techniques for restoration. The basis of the ESU is a genetics theory arguing that a salmon population's fitness is reduced by the inflow of genes from hatchery bred salmon populations, even when the broodstock for the populations comes from the same or adjoining populations. A recent report of the National Research Council (Science and the Endangered Species Act) supports tribal analysis of the ESU indicating that ESA policies should not stress reproductive isolation as an indicator of population distinctiveness or as a limitation on recovery.

4. Transfer the Klickitat hatchery to the Yakama Indian Nation, the Kooskia, Clearwater and Dworshak hatcheries to the Nez Perce Tribe, and the Lookingglass and Umatilla hatcheries to the Umatilla Tribes under authority of the Indian Self-Determination Act. Provide operation and maintenance funds for hatchery operation and for the transfer of other hatcheries as needed. Fund and implement Fish and Wildlife measures to construct tribal production facilities. Redirect Mitchell Act propagation facility capacity and implement mitigation for John Day Dam. For over fifty years, basin hatchery policy has discriminated against tribal fisheries and has resulted in the loss of upriver naturally-spawning populations because of fishery effects and the taking of broodstock. Because tribes retain the exclusive right to take fish on their reservations and because the hatcheries listed are located within the boundaries of their reservations or ceded areas and serve the purpose of protecting treaty fishery resources, tribes are entitled to a transfer of hatchery properties along with the operation and maintenance funding to maintain them. However, recovery activities proposed by the tribes will require hatchery capacity beyond that proposed for transfer. Therefore, funding of new tribal facilities required under the Fish and Wildlife Program as well as the reprogramming of the Mitchell Act and implementation of John Day mitigation are also necessary measures for restoration.

5. Develop and implement artificial propagation and/or transplantation programs where suitable habitat exists and fewer lamprey are present than rearing habitat can support. Increase the scale

of successful artificial propagation and transplantation techniques to supplement natural lamprey production. Numbers of lamprey adults now returning past Bonneville and other federal projects are orders of magnitude lower than the numbers recorded during the last regular counting season (1969). The decrease in Columbia River Basin lamprey populations above Bonneville Dam is due in part to the loss of juveniles killed or injured from contact with submerged screening devices, predation by exotic and native fishes, and delays in reaching the estuary. Upstream migrating adults are delayed or killed at hydroelectric dams an a result of velocity barriers, picket spacing problems, fallback through turbines, and entrapment under diffuser grates.

E. NMFS – "Proposed Recovery Plan for Snake River Salmon -- 1995"

1. Effects from intensive hatchery production (such as supporting harvest rates in excess of what the natural populations can withstand, using natural fish for hatchery broodstock, and causing introgression into natural gene pools) have also contributed to the continued decline of some natural salmon populations. Artificial propagation in the Columbia River Basin has successfully contributed to ocean and inriver commercial, sport, and tribal fisheries. In some cases, hatchery production has slowed the decline of natural salmon populations or helped preserve them. However, ecological interactions between hatchery and natural fish such as competition, predation, displacement, and disease transfer need to be minimized.

2. The Plan proposes to conserve remaining Snake River salmon gene pools through captive breeding, supplementation, and gene bank programs. NMFS supports the supplementation programs underway and intends to work with the fisheries agencies and tribes to support propagation efforts needed to conserve Snake River salmon. The Plan also proposes to protect listed species from excessive genetic introgression, minimize impacts on listed salmon resulting from interactions between Columbia River Basin hatchery salmon and natural salmon, improve the quality of fish released from hatcheries, reduce predation and competition interactions between listed salmon and steelhead and hatchery trout, restore listed chinook by reintroducing them to historic habitat, and conduct research for the purpose of optimizing production and conserving natural populations.

V. Hydroelectric Development and Operations

A. ISG Report – "Return to the River"

1. Construction and operation of hydropower projects has contributed to the decline of native salmonids in the Columbia and Snake River basins. Hydropower dams have blocked passage of salmon into a significant portion of their historical range in the Columbia and Snake River basins. The mortality of downstream migrating juvenile salmon has increased as a result of passage through turbines or bypass systems, and from predation by native and non-native fishes in reservoirs. Dams have severed the connectivity between the river channel, groundwater sources, and the floodplain and have reduced habitat diversity. Water flows, temperatures and food webs have been altered, which could affect growth and survival of downstream migrants and likely slowed migration rates. Reservoirs have inundated productive alluvial floodplain reaches, extirpating mainstem spawning populations of fall chinook and eliminating high quality feeding and resting habitats for downstream migrants. Operation of dams for hydropower production has altered habitats and food webs in riverine reaches below dams by reducing flood peaks, increasing variability in daily discharges, altering seasonality of temperature, and impeding transport of sediments that create and reconstruct stream habitats. The result has been substantial loss of biodiversity of native species and an increase in diversity and abundance of non-native species.

2. The current approach to managing water flows and habitats in the mainstem Columbia and Snake Rivers to aid juvenile salmon migration does not recognize the complex behavioral and ecological components of migration. The current view of juvenile migration is that the mainstem

Columbia and Snake Rivers function primarily as corridors used by downstream migrating salmon for travel to the ocean. Current restoration efforts focus on moving juvenile salmonids through the reservoir system as rapidly as possible to minimize exposure to the multiple sources of mortality in reservoirs. The proposed ways of increasing migration rate through the river corridor include altering flows through the reservoirs in spring with reservoir drawdowns or increased spring flows. However, juvenile salmon emigration through the river system is not a passive riding of currents straight to the sea but rather is a spiral of alternating active movement with the current and use of mainstem habitats for resting and feeding. Both yearling (e.g., spring chinook and steelhead) and underyearling (e.g., fall chinook) migrants spiral through the system but underyearlings tend to spend more time resting and feeding than yearlings. This type of migratory behavior implies that high quality mainstem habitats for resting and feeding are necessary for successful downstream migration.

3. A simple, direct relationship between flow and survival adequate for defining flow requirements to maintain and restore stock and life history diversity has yet to be demonstrated. There are many avenues by which volume of river flow could affect salmonid survival in addition to moving them faster through the mainstem reservoirs. These avenues include increased spill of water at dams (facilitating passage through dams), reduced summer temperatures, flooding of riparian zones (with stimulation of food production), reduced predator efficiency in high velocities and water volumes (less predation mortality), and the aggregate energy budget of migrating fish (better growth and survival). A complex and variable relationship between flow and survival probably exists, but it has been simplified to a relationship centering on water velocity and travel times for juveniles in reservoirs. This simplified view provides an inadequate conceptual basis for restoration of a full range of life history types and stocks. Currently proposed approaches for managing river flows could lead to the loss of stock and life history diversity. A water flow management strategy that consistently attempts to move fish as rapidly as possible through the river system does not consider inherent variation in the natural migratory behavior of a variety of life history types. This kind of flow management strategy could favor fish stocks with one migratory behavior or habitat use (e.g., yearling migrants) to the detriment of others (e.g., underyearling migrants). In the normative river concept, the most favorable flow strategy for a diverse assemblage of salmonids could be one that varies, favoring some stocks at one time and other stocks at another. Such a flow management strategy should be coupled with restoration of high quality feeding and rearing habitats in mainstem areas.

4. Impoundment of the mainstem Columbia and Snake Rivers has altered food webs and inundated feeding and rearing habitats of juvenile salmonids. All life history types of juvenile salmon feed to some degree during their downstream migration. In a riverine environment they are adapted to feed upon aquatic insects and terrestrial insects that fall into the water. These critical food web components are not abundant in mainstem reservoirs and are substantially reduced in riverine segments where flow is regulated by dams. In the impounded portions of the mainstem Columbia and Snake, food webs characteristic of lakes and the lower Columbia River estuary have developed. Many of the taxa composing these altered food webs are either of poorer nutritional quality than riverine taxa or are not eaten by juvenile salmonids. This shift in food web composition could compromise the nutritional state of juveniles and affect survival during migration and in the estuary and ocean. Research evaluating the importance of food production to successful juvenile rearing and outmigration should be conducted.

5. Drawdown of selected Snake and Columbia River reservoirs to restore inundated alluvial river reaches that were historical salmon producing areas is consistent with the normative ecosystem concept: the biological and social costs and benefits of drawdown to natural river levels should be evaluated. Some alluvial river reaches in the mainstem Columbia and Snake Rivers supported productive spawning populations of fall chinook salmon and likely served as important feeding and resting areas for downstream migrating juveniles. Most of these spawning areas have been inundated by mainstem reservoirs. The Hanford Reach in the Columbia River is one of the few river reaches that provides relatively high quality riverine habitat and is the only mainstem area of the Columbia and Snake that continues to consistently produce fall chinook salmon. Available evidence also suggests that the section of river presently inundated by the reservoir behind John Day dam also once supported a productive spawning population of fall chinook.

6. Transportation of juvenile salmon and steelhead in barges and trucks could selectively favor certain life history types over others. Although transportation could provide increases in survival for some life history types or stocks, measured as adult returns to the point where tagged smolts were released, it has not been shown to be appropriate for all life history types and stocks. All life history types and stocks of downstream migrating salmonids are not equally likely to be transported. Fish are collected in turbine intake bypass systems at dams and placed in trucks or barges. The efficiency of collection in the bypass systems varies with species and life history type, and depends upon the physiological state of migrating fish, time of year, and other factors. Thus the collection and transportation operation may selectively favor certain life history types or stocks over others, further eroding salmonid biodiversity. Furthermore there are serious concerns about whether transportation impairs the homing ability of adult salmon. Assessment of the efficacy of transportation should be based on successful reproduction of adult fish on their natal spawning grounds, not simply in terms of adult returns to the point of release of tagged juveniles. Transportation alone does not appear sufficient to overcome the current negative effects on salmon of cumulative habitat loss, hydropower operations, and other sources of mortality, and probably will not halt the decline of endangered salmon in the Snake River.

7. The success of turbine intake bypass systems depends upon consistency of their design and operation with the natural migratory behavior of juvenile salmonids. Spill is effective in reducing mortality of juveniles passing mainstem dams: however, high water volume spill at some dams can cause gas supersaturation at levels thought to be lethal to juveniles. Turbine intake screens have improved fish guidance efficiency (FGE; the proportion of juvenile salmon entering the turbine intakes that are diverted into the bypass system) but have not achieved the NPPC's goal of 90% FGE for all life history types of salmon. Despite improvement in FGE over the last 20 years, corresponding improvements in the return rates of most wild adult salmon populations have not occurred. Either survival in passing dams was not improved or the improvement was masked by changes in survival elsewhere in the ecosystem. Furthermore, bypass systems, as they are currently operated, may selectively favor some life history types or stocks over others. Surface spill and surface bypass, which are more consistent with the natural migratory behavior of juvenile fish, are the most promising methods of achieving bypass goals.

B. NRC Report – "Upstream"

1. Although as many as 90% of young salmon might survive passage over, around, and through any individual major hydropower project on the Columbia-Snake River mainstem, the cumulative reduction in survival caused by passing many projects has adversely affected salmon populations. Partly because salmon do not have rights to water, allocations of water rights usually has not included considerations of their long-term survival.

2. Improve salmon survival rates associated with passing hydropower projects in the Columbia and Snake rivers by:

- **a)** Determine existing reach survival by project and project components. Upon completion of studies, initiate measures to improve survival prioritized by the greatest gains obtainable.
- **b)** Secure water from water-consumers as need is demonstrated by subsidizing water conservation by buyout of water rights and improved reservoir system operation.
- **c)** Continue downriver transportation of smolts by barge in the Columbia and Snake rivers as long as data indicate that survival in barge transport exceeds that of inriver migration. It is critical that barging be done with experimental controls so that information can continue to accumulate, i.e., enough smolts should continue inriver migration to assess the effectiveness of barge transportation.
- **d)** Improve information on the migratory characteristics of salmon in the Columbia-Snake river system. Facilities that detect tagged fish should be set up on all bypasses so that adult returns can be evaluated to compare survival of fish that migrate via bypass, barge transport, and turbine and spill, and so that reach-specific information can be obtained on tagged smolts. Spawning

ground surveys should be greatly expanded to evaluate homing efficacy in transported and non-transported fish.

3. The many dams on the Columbia River and its tributaries cumulatively have had large effects on salmon survival. Therefore, the addition of any new major dams in undammed reaches of large rivers in the region (e.g., the Hanford Reach of the Columbia River) would make the situation worse; existing dams should have adequate fish passage facilities where feasible and appropriate before being relicensed.

4. Because there has not been a major seasonal shift in the annual Snake River hydrograph, it is doubtful, *a priori*, that the declines in Snake River salmon populations have resulted from or are reversible by seasonal changes in flow regime alone. Even if flow changes could be helpful in a rehabilitation effort, they are likely to be insufficient without changes in other human interventions in the salmon life cycle and habitat.

5. Because the Snake River system stores and then diverts substantial quantities of water for consumptive uses, and the volume of water flowing through the system has therefore decreased, beneficial changes in flow regime for salmon can in principle be obtained in a controlled fashion by reallocating human uses of water, including agricultural uses. Whether those changes can be made at lower total social cost than large-scale engineering changes, such as drawdown, would need to be analyzed on a case-by-case basis.

6. Transportation of smolts to bypass middle Columbia dams might prove better than inriver migration as more data become available on bypass and collection in that region. Because of the stress, injury, post-bypass losses, and delayed arrival of smolts at the ocean resulting from decreased water velocities in reservoirs, the most appropriate use of bypass facilities at most dams might be to collect fish for transportation. Avoidance of mortality at downstream hydropower dams and in reservoirs is an attractive concept. The concept might become even more attractive as means develop to improve survival through release point protocols. Any experiments with transportation should follow strict guidelines for evaluation.

7. Transport of middle Columbia summer migrants should be investigated. At McNary Dam, upstream from three hydropower projects, transportation of subyearling migrants yielded transport:benefit ratios (observed survivals to adulthood of transported smolts to observed survivals of inriver migrants) of over 3.0:1 in tests in the 1980s.

C. USFS/BLM Report – "An Assessment of Ecosystem Components in the Interior Columbia Basin and Draft Environmental Impact Statement"

The USFS/BLM report stated that a comprehensive approach to address all mortality factors was needed but did not offer any specific conclusions or recommendations on hydroelectric development and operations.

D. CRITFC – "Wy-Kan-Ush-Mi Wa-Kish-Wit, Spirit of the Salmon"

1. Implement a program of short term and long term juvenile passage measures at federal and nonfederal dams on the mainstem Snake and Columbia rivers and establish numeric survival targets for fish passage performance:

Short term

Water flow: Implement instream flow measures in the Snake and Columbia rivers according to targets established by the Firm Energy Load Carrying Capability (FELCC) declarations. Provide Snake River flow augmentation volumes managed at the direction of the Columbia River treaty tribes and federal fishery agencies.

Turbines: Avoid operating turbines outside of 1% of peak efficiency. Completely avoid excursions during peak migration periods, particularly at projects which are experiencing large juvenile and adult migrations. Implement powerhouse optimization programs to improve turbine operating efficiencies at all dams.

Spill: Implement a program of controlled spill to achieve an 80% fish passage efficiency (fish passing by non-turbine routes), while managing spill so that dissolved gas concentrations do not exceed 120-125% daily average total gas pressure.

Predator control: Continue evaluation of intensive removal of predaceous bigmouth minnow. Implement evaluation of control programs for other predators including seagulls, bass, and walleyes.

Transportation: Halt mass transport barging and trucking of juvenile anadromous salmonids from Snake and Columbia River dams.

Structural measures: Draw down John Day, Lower Granite, Little Goose, Lower Monumental, and Ice Harbor dams. Expedite prototype development of surface flow bypass systems at Bonneville, John Day, The Dalles, Ice Harbor, Rocky reach, Priest, and Wanapum dams. Install fliplips at John Day, Ice Harbor, Wanapum, and Rocky Reach dams as soon as possible.

Long term

Spill: Modify the controlled spill program to achieve at least a 90% fish passage efficiency.

Flow augmentation: Implement system operations to achieve mean historical flows during juvenile salmon migration periods. Historical flows in this context mean those flows that would have existed prior to water resources development.

Drawdown: Permanently draw down John Day dam and the four lower Snake River dams either to spillway crest or to natural river level. Implement drawdown at Wanapum and Rocky Reach dams and take any actions necessary to restore salmon passage through the Hells Canyon complex.

Turbines: Retrofit turbines with more efficient turbine designs and automated operating procedures to decrease fish mortality.

2. The construction and operation of mainstem hydroelectric projects has impaired adult salmon migrations in the Columbia River basin. Mainstem temperatures are detrimental to adult migrants. Adult fishways are not operated for maximum effectiveness. The majority of adult salmon counted at dams by real-time human observations are prone to errors. The following measures are proposed:

Temperature: Provide additional Dworshak reservoir storage water for use during July-September to provide cool water for flow augmentation.

Fishways: Correct operations of adult fishways. Evaluate and implement new ladder designs. Identify and implement structural remedies to reduce the incidence of adult shad in fishways. Implement hydraulic evaluations of all fishways.

Fish counts: Employ more accurate and precise counting methods, such as video counting, as well as 24-hour counting at each dam and selected tributaries during the entire upstream migration of listed species.

E. NMFS – "Proposed Recovery Plan for Snake River Salmon -- 1995"

1. Reduce the loss of juvenile fish through flow augmentation and improved water management. NMFS concluded that the rate at which smolts migrate has been shown to increase with increasing flows. Slow passage through reservoirs increases exposure of migrating salmonids to multiple mortality factors. Although there is evidence of a relationship between flows and survival, it is difficult to determine the exact mechanism by which increased flows increase survival, and it is difficult to establish a particular level as being ideal or necessary. NMFS believes that changes in river management should be made, within the constraints of available water, to increase flows in reservoirs during the spring and summer salmon migration, restoring to some extent the natural hydrographic conditions under which listed salmon stocks evolved.

2. Reduce loss of downstream migrating juvenile fish through increased spill at mainstem dams. NMFS concludes that the safest routes of passage are over the spillways and through the bypass systems. Although spill has generally been shown to be the safest route for passing dams, it also poses risks to anadromous fish because it can result in elevated levels of total dissolved gases in their bloodstream. To achieve a fish passage efficiency of 80%, NMFS recommends that the COE should spill at all projects during the spring/summer migration period, except under low flow conditions, and at all non-collector projects during the fall chinook migration. Acceptable upper limits for gas supersaturation levels should be established to reduce the risk of gas bubble disease in juvenile and adult salmonids, and structural modifications at dams should be used to develop and implement a gas abatement program.

3. Reduce loss of juvenile fish through structural and operational improvements of bypass facilities and dams. The COE should maintain fish facilities within criteria identified in the COE Fish Passage Plan. In addition, the COE should continue installation of extended length screens at selected dams, relocate the permanent downstream migrant outfalls at Bonneville Dam, and investigate the application of surface collection technology at lower Snake River and Columbia projects.

4. Reduce juvenile fish losses through improved transportation. NMFS' view has been that available empirical data indicate that transportation benefits Snake River spring/summer chinook and is likely to benefit Snake River sockeye and fall chinook. Accordingly, NMFS has supported transportation of Snake River salmonids under most conditions. However, NMFS acknowledges that transportation alone is not likely to be the solution to rebuilding listed salmon populations. In the short term, NMFS views transportation as a tool to reduce or stabilize the decline of listed Snake River salmon. NMFS recommends development and implementation of transportation criteria that maximize benefits for fish, and transportation of all fish collected at the lower Snake River collection projects unless the transportation operations are out of criteria. NMFS also recommends implementation of operational improvements to maximize survival of transported migrants, and assessment of the residual (sublethal) effects of transport on chinook and sockeye smolts. The effectiveness of the transportation program should be evaluated by conducting research to compare the survival of all fish migrating under improved inriver conditions (e.g., additional flow augmentation and spill at all projects when flows are adequate) to the survival of salmon smolts being transported by barge from Lower Granite Dam.

5. Continued study of drawdown of the John Day pool and the Snake River reservoirs to spillway crest. Drawdowns to natural riverbed have been suggested as a method for decreasing smolt travel time and eliminating lethal reservoir conditions and dam passage mortalities. The proposition that natural river drawdown has the greatest likelihood of recovering stocks is supported by some life cycle models but not others, depending on assumptions about the level of mortality in the migration corridor and in the ocean, and improvements in survival from transportation. NMFS recommends investigation of the feasibility of operating John Day pool near spillway crest and long-term drawdown of Snake River reservoirs. NMFS is concerned about whether the potential benefits of either spillway crest or natural river drawdowns are sufficient to improving survival to the point where it can contribute to the recovery of listed stocks, or even that such an improvement will be greater than survivals obtainable by transportation. Thus NMFS concludes it is reasonable to first test both the transportation option and methods to improve inriver migration conditions.

6. Reduce the losses of adult fish by improving structural and operational passage at dams. NMFS concludes that the cumulative loss of adults passing up the Columbia and Snake Rivers through the mainstem dams can be substantial. Death can be caused by delayed migration, fallback through turbines, illegal harvest, and delayed mortality from marine mammal predation, gillnet interactions, and disease. Apparent adult loss between dams also may be due to factors other than adult mortality such as counting errors, straying, etc. NMFS recommends incorporating dam and bypass operating criteria to minimize negative effects on fish, implementation of facility modifications to improve the survival of migrating fish, and conducting related monitoring, evaluation, and research to improve adult passage.

7. Reduce listed species loss at water withdrawal sites. Unscreened and improperly screened gravity and pump water intakes pose a significant mortality threat to resident and migrating juvenile fishes. NMFS recommends that all COE-permitted gravity and pump water intakes be required to have operational screens that meet NMFS criteria.

8. Control predation by squawfish, birds, marine mammals, and non-native fishes. Measures are also proposed to reduce American shad populations in the Columbia River because they both prey on and compete with juvenile salmon. NMFS recommends research to determine the extent of predation problems and evaluate predator control measures.

9. Reduce the loss of listed fish resulting from elimination or disruption of shallow water habitat. Shallow water areas provide important rearing habitat for juvenile salmonids. Alteration of shallow water habitats resulting from activities, including construction, erosion control, flood control, channel dredging, and gravel and sand mining, can be substantial. The cumulative effects of these actions on fish productivity should be identified and considered prior to allowing an action to proceed.

10. Reduce loss of listed species associated with poor water quality. The EPA should evaluate water quality in the mainstem and estuary habitats develop or modify control mechanisms for protecting listed Snake river salmon.

VI. Harvest

A. ISG Report – "Return to the River"

1. Intense unregulated and poorly regulated harvest by fisheries, coupled with extensive degradation of habitat and construction of dams, has contributed to the decline of Columbia River basin salmon over the last 100 years. Inappropriate harvest in fisheries impacts salmon by reducing abundance and eliminating local spawning populations (demes) that are adapted to the diverse habitats within the basin, thereby limiting overall production by decreasing life history or phenotypic diversity.

2. Long-term conservation of salmon will require both habitat protection and restoration, and conservative harvest management. Restrictions on harvest alone are not sufficient to recover declining salmon populations. Salmon exploitation rates appropriate to conservation are ultimately dependent on the productive capacity of the habitats of individual spawning populations. All Columbia River stocks, with the possible exception of Hanford fall chinook, are currently at such low levels that ocean harvest on these stocks will have to be low or non-existent to allow habitat restoration to contribute effectively to rebuilding of the stocks.

3. Sustained yield management of local salmon populations (demes) needs to be based on numerical spawning escapement goals at the watershed level. Directed (intentional) and incidental (unintentional) harvest of Columbia River salmon has occurred in the absence of knowledge of harvest impacts on abundances and viabilities of most individual native spawning stocks in watersheds. Harvest management should take into account the role of habitat in watersheds in determining salmon productivity. Effective management strategies should provide for salmon spawning escapements to individual tributaries, and accurately measure the attainment of escapement goals through comprehensive monitoring programs. Harvest management of Columbia River chinook populations remains ineffective because the two principal harvest control organizations do not provide harvest regulations that explicitly provide for salmon spawning escapements to individual tributaries.

4. Fishing mortalities need to decrease as distance from the spawning grounds increase. This concept is especially critical where distant mixed stock fisheries harvest populations from degraded habitat. Accurate stock identification is less likely the farther that harvest occurs from the spawning grounds.

5. The concept of zero-sum mortality allocation should be followed. This concept holds that when one source of mortality increases, other sources of mortality must decrease in order to keep populations abundances from declining. Zero-sum mortality allocation is particularly critical in years of poor ocean or freshwater conditions. Accounting for all sources of mortality throughout the life cycle is critical to effective management so that managers will understand the full range of options available to them when trying to implement conservation measures.

6. Mixed stock fishery management should be aimed at protecting stock and genetic diversity and should make use of information about migratory pathways, migratory timing of different populations, and other differences among salmon populations to determine the impact of fishing on individual stocks. Fisheries that harvest a mix of geographically diverse stocks at the same time (mixed stock fisheries) not only can extirpate the most vulnerable of these stocks but also could synchronize the dynamics of remaining stocks, which could compromise metapopulation integrity.

B. NRC Report – "Upstream"

1. Not enough fish are being allowed to return to spawn. Unless enough fish are able to spawn, there will not be enough fish produced to compensate for all the sources of mortality imposed by human activities and to provide sustainable runs of wild salmon. Therefore, a goal of management should be to increase the size and maintain the diversity of spawning populations and to re-establish ecosystem processes.

2. Escapements should be increased. A shift must be made from focusing on catch to focusing on escapement. Increasing the number of adults that return to spawn will enhance opportunities for evolution of genetic diversity through colonization, straying, and competition, and will bolster nutrient input to streams. Management should set new goals of minimum sustainable escapement (MSE), allowing escapements to vary above the MSE, as opposed to managing for one fixed escapement.

3. Long-term survival and production of natural salmon runs depend on maintenance of genetic diversity and metapopulations. Fishery management should explicitly recognize the need to conserve and expand genetic diversity via natural increases in population sizes. A holistic approach should be taken that recognizes the interdependence of genetics, habitat, and salmon production, and it must account for the uncertainty in scientific knowledge and the inherent variability of biotic and abiotic environmental factors. This is accomplished by never allowing numbers of salmon to decline below the minimum sustainable escapement and by filling out the dendritic structure of salmon metapopulations in a river basin. When escapements *exceed* the MSE, extra fish should be allocated between escapement and catch. It will often not be possible to maintain all the diverse habitats dictated by the full dendritic structure of the watershed. Land-use planners and managers must be vigilant in preserving as much of the structure as possible (i.e., allowing for connectedness of spawning populations) and then developing approaches for rehabilitating other parts of it.

4. Past practices of harvest management have not treated strong and depleted populations differently enough, and – more important – harvest management has not been sufficiently based on recognition of the importance of demes. The anadromy of salmon and their tendency to return to their natal streams to spawn results in a population structure in which metapopulations – clusters of demes – are important. Conservation of salmon must take that structure into account to achieve long-term survival of diverse salmon populations.

5. Management of salmon should be based on the genetic structure of their populations and should allow for separate harvest regimes for strong and depleted demes and metapopulations whenever possible. The aim is to assure adequate escapement for depleted populations. To achieve this aim, fishing should take place only where the demic identity of the salmon is known and where catching technology can reduce mortality rates in depleted demes. In many cases, this would require fishing to take place in the home-stream estuary or in the river upstream. In-river gear should be changed to live catch systems to the greatest possible extent, permitting release of members of depleted populations or species. Implementing this recommendation initially will require low fishing effort in many areas, especially in the ocean, and will require the cooperation of British Columbia and Alaska, because many salmon that originate in the Pacific Northwest are caught at sea in southeastern Alaska and British Columbia.

C. USFS/BLM Report – "An Assessment of Ecosystem Components in the Interior Columbia Basin and Draft Environmental Impact Statement"

Other than to comment on the effects of environmental variability on stock-recruitment relationships and their influence on determination of harvest levels, the USFS/BLM report did not offer any specific conclusions or recommendations on harvest management.

D. CRITFC – "Wy-Kan-Ush-Mi Wa-Kish-Wit, Spirit of the Salmon"

1. The existing basin-wide mechanisms of the CRFMP, the Fish and Wildlife Program, and FERC Orders should be modified to more fully implement treaty fishing rights to take fish at all usual and accustomed fishing places. The Endangered Species Act should be used in a manner that is consistent with implementation of treaty rights to natural resources. The processes for basin-wide anadromous fish restoration are based on existing statutory authority and treaties, and were developed by the federal, state and tribal entities of the region. They embody meaningful tribal participation but require additional authorities and measures… in order to protect imperiled anadromous fish populations throughout the upper basin and to implement treaty fishing promises.

2. Fishing regimes which are consistent with treaty fishing rights, and with allocation and conservation issues, can be achieved through the current management process. Consistent with court-approved standards of management of treaty fisheries, the parties have an opportunity to update the provisions of the Pacific Salmon treaty and the Columbia River Fish Management Plan based on the latest information on survival rates and catch levels by modifying escapement objectives and harvest rate schedules as appropriate. The parties should also increase coordination with processes in other areas, such as hydro operations and habitat protection, to ensure adequate sharing of the conservation burden.

3. Immediately seek, through Pacific Salmon Commission (PSC) processes, reductions in adult equivalent ocean exploitation total chinook mortalities in northern ocean fisheries, which will lead to completion of the chinook rebuilding program. Encourage reductions in incidental mortalities by reducing the number of chinook nonretention days. Establish within 3 years a mutually agreeable approach to managing Alaskan and Canadian ocean fisheries based on changes in chinook abundance. Annually review all ocean fishing regimes to determine effects on the chinook rebuilding program. Take empirical observations of survival rates into account in all ocean fisheries management, and adjust fishing regimes accordingly.

E. NMFS – "Proposed Recovery Plan for Snake River Salmon -- 1995"

1. The Plan proposes to amend existing inriver harvest management rules so that they incorporate explicit management criteria to protect Snake River salmon. To minimize the number of fall chinook caught in ocean fisheries, NMFS proposes to implement a management strategy that is consistent with the Pacific Salmon Commission's objective of meeting adult chinook goals by 1998. These goals are established for a number of stocks and are based on a chinook rebuilding program that was fully implemented in 1984. This approach takes a broad view of stock protection and focuses on the coastwide status of chinook stocks including those from Puget Sound, the Washington and Oregon coast, and the Columbia River.

2. Increase adult escapement for all listed species by modifying existing inriver harvest management rules. Modify the CRFMP to incorporate explicit management criteria to protect listed Snake River salmon.

3. Protect all listed species by developing harvest management rules to account for future fisheries. Develop Snake River subbasin harvest management plans that are consistent with long-term recovery objectives for listed spring/summer chinook salmon. Resolve legal restrictions limiting implementation of subbasin harvest plans.

4. Protect all listed species through development of alternative harvest methods. Evaluate the size selectivity of current harvest regulations and evaluate the potential of increasing stock productivity by regulating size limit and mesh size regulations. Investigate opportunities for increasing terminal area fisheries. Continue research and development of a low-cost visual mark that can be applied on a massive scale with minimal handling mortality.

5. Protect all listed species through reduction in harvest capacity. Initiate a buy-back program designed to reduce harvest capacity of the Oregon and Washington commercial troll fishery by 50% and eliminate non-treaty gillnet fishing in the mainstem Columbia River.

VII. Institutions

A. ISG Report – "Return to the River"

The ISG Report did not reach any specific conclusions or recommendations with regard to salmon recovery institutions in the Columbia River Basin.

B. NRC Report – "Upstream"

1. The current set of institutional arrangements contributes to the decline of salmon and cannot halt that decline. For the most part, human institutions that affect salmon have taken only incidental account of salmon biology. Because of the character of the social processes by which institutional arrangements emerge and change, rational analysis is necessary but not sufficient for constructive change.

2. The current set of institutional arrangements is not appropriate to the bioregional needs of salmon and their ecosystems. A critical institutional need is to link a bioregional (ecosystem) perspective to cooperative management (i.e., joint management by a governing agency and a community of stakeholders) as a governing concept. Meeting this need is primarily a political task, not a scientific one.

3. Attempts to halt the decline of salmon over the last 30 years have led to institutional reforms in fishing management, funding, habitat conservation, dam operations, and protection of endangered populations. These have not halted the decline but have raised expectations that the decline would be ameliorated.

4. Hydropower prices, which internalize the full cost of growth, should be used to provide funding for rehabilitation of salmon and their ecosystems, especially in areas that are affected by hydropower projects.

5. The institutional framework for salmon management should be unified and streamlined. Three important principles must be adhered to:

- **a)** The institutional structure must allow for sharing of decision making among all legitimate interests.
- **b)** It must consist of local units small enough to ensure local legitimacy and to respond to local variations in environmental and socioeconomic factors, and it must make use of local knowledge.

c) There must be a mechanism to ensure that the larger-scale environmental and anthropogenic forces behind and consequences of local actions are taken into account, i.e., the interests of the greater region should not be submerged by or sacrificed to local interests.

6. With these three principles in mind, the following suggestions are made:

a) Organize a commission for management of each river basin, combining smaller groups into single groups.

b) Include American Indian tribes in the process of rehabilitation.

c) Organize cooperative-management groups to develop more selective fisheries and techniques, such as converting gill net to live-catch systems and developing techniques appropriate to terminal fisheries.

d) Activities of river basin commissions and recovery plans must be coordinated with the Northwest Power Planning Council, the Pacific Salmon Commission, the Pacific Marine Fisheries Commission, the National Marine Fisheries Service, and other institutions that have a multibasin focus.

7. Relevant agencies in the Pacific Northwest, including the National Marine Fisheries Service, should agree on a process to permit the formulation of salmon recovery plans in advance of listings under the Endangered Species Act and that the Pacific Northwest states, acting individually and through the Northwest Power Planning Council, provide technical and financial assistance to watershed-level organizations to prepare and implement these preemptive recovery plans.

C. USFS/BLM Report – "An Assessment of Ecosystem Components in the Interior Columbia Basin and Draft Environmental Impact Statement"

The USFS/BLM report identified concerns about the ability of federal land management agencies to formulate and implement resource management decisions in an ecosystem context. The Aquatic Assessment stressed the need for those agencies to work collaboratively with other public, tribal, and private resource managers to resolve issues that transcend federal land management boundaries and jurisdictions. The institutional need of USFS/BLM to move away from a traditionally functional commodity output orientation was viewed as fundamental to a change to ecosystem management. However, the DEIS does not offer specific conclusions or recommendations on these institutional or governance issues.

D. CRITFC – "Wy-Kan-Ush-Mi Wa-Kish-Wit, Spirit of the Salmon"

1. Restoration of Columbia Basin salmon, sturgeon and lamprey depends upon institutional structures that efficiently coordinate the actions and resources of relevant government agencies and enlist the support and energy of individuals and non-governmental agencies. A comprehensive restoration effort will require authoritative actions addressing the redirection of funding and personnel by federal, state, local, and tribal entities in order to implement goals and objectives in a coordinated manner.

2. A dispute resolution process similar to the CRFMP and FERC agreements should be implemented, under the continuing jurisdiction of the federal district court, that addresses public lands and water project management as a means to support the Pacific Salmon Treaty, the Columbia River Fish Management Plan, the Fish and Wildlife Plan, and Endangered Species Act rebuilding goals for the implementation of treaty fishing rights. Federal hydro operations and structural modifications, as well as public lands management, are not subject to an authoritative basin plan or a dispute resolution process to resolve differences.

3. BPA fish and wildlife funding should be transferred in trust to the Fish and Wildlife Service for the time it takes to establish a new entity composed of the fishery agencies and tribes. The state and federal fishery agencies and tribes are the primary entities with responsibility to protect fish and wildlife. In order to link authority with this responsibility, BPA should transfer an amount of funding to be negotiated, including resources provided under cooperative agreements with other agencies, for meeting specified goals and objectives for basin anadromous fish. The fishery agencies and tribes should report annually to the region on the achievement of goals and objectives.

4. Coordinated enforcement of harvest regulations should be continued and law enforcement personnel should develop the capability to enforce habitat protection laws.

E. NMFS – "Proposed Recovery Plan for Snake River Salmon -- 1995"

1. An improved decision-making process is necessary to restore Columbia Basin ecosystem health and ensure Snake River salmon recovery. Such a process will also protect and improve habitat through the adaptive management process, prevent further listings, and conserve other fish and wildlife. To achieve these goals, NMFS will appoint, convene, and chair a Recovery Implementation Team which will represent state, tribal, and Federal policy leaders and thereby insure effective coordination, teamwork, and communication among all entities having responsibility for Snake River salmon recovery. To ensure that salmon recovery actions remain scientifically based, NMFS will also consider appointing and convening a Scientific Advisory Panel and technical committees to provide scientific and technical support to the Recovery Implementation Team.

2. Prevent losses of listed salmon by increasing the law enforcement presence throughout their range. Adopt Federal regulations consistent with state regulations on water diversion and screening regulations. Enforce the conditions of section 7 and section 10 (ESA) permits. Adopt regulations to protect spawning beds consistent with state and tribal regulations. Ensure the "gravel to gravel" approach continues by incorporating all participating enforcement organizations into the Columbia Basin Law Enforcement Council's enforcement strategy.

VIII. Monitoring and Evaluation

A. ISG Report – "Return to the River"

1. Although a large amount of effort is being expended in monitoring salmonids in the Snake and Columbia basins, monitoring and evaluation are not adequate for the present needs. Monitoring and evaluation of the status and trends of various salmonid life stages is accomplished through a variety of federal, state, and public utility programs and appears to be directed toward valid technical needs. The focus of monitoring has evolved to be larger than just the hydrosystem, befitting life cycles that extend from mountain streams to the ocean. A significant part of the monitoring effort has been heavily focused by current beliefs and oriented toward establishing relationships among volume of flow, water travel time, and fish travel time in mainstem reservoirs, most commonly in the lower Snake River. The current set of beliefs do not always have explicit statement, rigorous examination of the evidence in support of those beliefs (evaluation), framing of alternative hypotheses, and design of monitoring and evaluation to fairly test all reasonable hypotheses. Life-cycle models have become a popular analytical (evaluation) technique, but the results of the models are very sensitive to initial assumptions or beliefs built into their structure.

2. An integrated ecosystem monitoring and evaluation program, with emphasis on habitat conditions as well as fish abundance, is needed.

3. Metrics permitting monitoring of normative river conditions need to be implemented. These metrics could include effectiveness of peak flows in maintaining habitats, degree of channel and floodplain connectivity via surface and groundwater pathways, groundwater controls on water temperature and productivity, availability of microhabitats (e.g., deep pools, undercut banks, back bar channels, etc), condition of riparian communities, composition and dynamics of slack water communities, including but not limited to salmonid production, availability of flow cues for migration, water quality conditions including water temperature, status of stocks, mortality of each life stage, and a measure of the vitality of outmigrants to assess impacts on nutritional status associated with reservoir and dam transit and food web variations.

4. A metapopulation perspective suggests that monitoring and evaluation should focus on systems of local populations or subpopulations, their spatial arrangement or distribution within watersheds and the relationship of this distribution to spatial and temporal variation in habitat conditions, and connectivity among local populations which is related to their proximity and the favorability of connecting habitats. Thus monitoring metapopulation organization necessarily must be linked to habitat monitoring in an integrated metapopulation-habitat monitoring system appropriate at watershed scales.

5. Where possible reconstruction of historic habitat conditions and life history distributions must be undertaken to establish a normative river template against which progress toward normative conditions can be measured.

6. Monitoring and evaluation should occur in an adaptive management framework.

B. NRC Report – "Upstream"

1. Research has been adequately funded but inadequately guided. An independent, standing scientific advisory board should be established to ensure that the available research dollars are spent most productively to answer the most critical questions as soon as possible. The advisory board would encourage cooperation from other organizations and individuals in the region to help to design and evaluate research and wold serve as a conduit for information.

2. Much of the current uncertainty over the benefits of habitat improvement projects, hatcheries, and other management and restoration approaches results from lack of scientific monitoring and evaluation. Many habitat programs involving millions of dollars have been undertaken over the last 20 years with little or no monitoring. Even when monitoring has been undertaken, lack of replicates and controls, uneven measurement consistency, and lack of commitment to long term study have constrained the opportunities to learn from these programs.

3. Watershed analysis, adaptive management, a careful inventory, and strong regional monitoring programs are needed to provide the context within which management decisions can be made. A systematic evaluation of the condition of pacific Northwest watersheds and the status of salmon populations must be undertaken. A regional network of reference sites should be established for adaptive management experimentation. Integrative measures of watershed productivity (such as smolt production) must be monitored at many more locations than is the case today. Finally, a clearer picture of the status of salmon populations throughout the region is needed to increase confidence in decisions about how to allocate financial and human resources to solve the salmon problem.

C. USFS/BLM Report – "An Assessment of Ecosystem Components in the Interior Columbia Basin and Draft Environmental Impact Statement"

1. Development and implementation of monitoring to collect, report, and evaluate data in a manner that is both scientifically credible and economically feasible needs to be carefully designed and coordinated. The foremost needs are:

a) Develop and implement a common design framework and common indicators or environmental measurements

b) Identify specific indicators within each monitoring component or activity, along with protocols and methodologies for their measurement and quality assurance

c) Establish a required level of detection ability, data quality objectives, and precision

2. The monitoring framework that is established should be cost effective, permit data to be integrated through statistical or modeling approaches to provide quantitative inputs to the adaptive management process, and accommodate multiple geographical scales and provide a consistent process for establishing monitoring sites, frequency of sampling, level of sampling, and specific techniques for analysis, synthesis, and reporting. Following this approach is critical to ensuring that consistent collection, integration, and evaluation of monitoring data occur among projects, watersheds, regions, agencies, and tribes over long time periods. A five step process should be used to establish a monitoring network:

- **a) Establish linkages between and among agencies, tribes, advisory groups, and others**. An interagency monitoring committee could be formed under the direction of the interagency regional executives. The committee would develop specific technical details and guidance for monitoring the ecosystem at the project area level, integrating data-gathering needs into existing field data-gathering efforts, and assembling it into useful forms for project area evaluations. It would also develop a system to manage the monitoring data using existing agency organizational structures.
- **b) Identify information needs**. When additional monitoring objectives and questions are agreed upon, a list of relevant indicators must be developed. Each indicator on the list should be assessed using the following criteria: (1) Is there an explicit relationship to the questions and monitoring objectives?, (2) Do the indicators reflect changes in the resource condition, status, or value at multiple scales?, (3) Do these indicators distinguish between the system response and natural variability?, (4) Are protocols available and adequate for reliable and repeatable measurement?, and (5) Will the information from monitoring this indicator provide results within a useful time frame?
- **c) Survey and evaluate ongoing monitoring efforts**. After collecting information about existing monitoring, a detailed review and comparison of the developed information needs and existing monitoring should be conducted. Results from these activities will help to identify specific monitoring programs and requirements for information that are not available through existing programs.
- **d) Establish technical details**. This step in the monitoring design process involves several elements: information or data quality objectives, indicators, statistical design, measurement and sampling protocols, and a quality assurance program.
- **e) Establish a repository system for collected data, storage, and analysis**. The interagency monitoring committee could develop a protocol for collection and storage of new regional level monitoring data. The comparability of data collected by all agencies is a crucial issue to be resolved by the committee.

3. Concerns have arisen about the effectiveness of restoration activities. Restoration includes a great number of activities that address most of the components of ecosystems, including vegetation, disturbance, aquatic/riparian resources, and human needs. The success of meeting many objectives relies on agency abilities to conduct an integrated restoration program and to assure that activities are successful in meeting objectives. Since successful implementation of any alternative is based on how effective implementation activities are conducted, the BLM and Forest Service expect to review restoration actions and programs through the monitoring and evaluation process, and to work within existing authorities to apply appropriate adaptive management techniques to respond to the results.

D. CRITFC – "Wy-Kan-Ush-Mi Wa-Kish-Wit, Spirit of the Salmon"

1. As an adjunct to the Columbia River Fish Management Plan and the Fish and Wildlife Program, representatives of the federal government, the states and tribes need to establish a research and monitoring program that sets long-term priorities and provides dispute resolution. Because a comprehensive restoration plan requires a coordinated research, monitoring and evaluation program that incorporates all life stages of anadromous fish, the tribes propose establishment of a basin-wide research and monitoring program that sets long-term priorities and provides dispute resolution among federal, state and tribal entities.

2. Monitor and evaluate salmon responses to restoration measures to the hydropower system by developing experimental and sampling designs for estimating total hydrosystem passage survival. Also evaluate restoration actions by measuring changes to statistically sensitive life history parameters such as tie and size of juvenile entry into saltwater and timing and distribution of adult spawners.

3. Mass marking and selective fisheries will result in an increase in mortality rates of unmarked fish, and thus lead to decreased escapement. Mass marking will not enable managers to partition incidental mortalities among specific selective fisheries. Use the model being developed by the PSC Selective Fisheries Technical Committee to evaluate proposals for selective fisheries. Set up experimental designs (double and triple index tagging) to evaluate incidental mortalities in naturally spawning (unmarked) fish. Complete evaluations before proceeding with large scale implementation. Review selective fisheries proposals and analyze results as proposals are implemented.

4. Establish and monitor escapement checkpoints at mainstem dams and in each subbasin. Establish additional monitoring programs for each of the subbasin tributary systems to monitor habitat condition, adult escapement and resulting smolt production. By establishing improved monitoring programs, stocks can be tracked throughout the life cycle, and problem areas can be identified. Better information will increase the accuracy of projections of future run status and enable managers to establish more responsive harvest regulations.

E. NMFS – "Proposed Recovery Plan for Snake River Salmon -- 1995"

1. The Plan recommends monitoring, evaluation, and research on virtually all aspects of salmon recovery in the Snake River Basin and other parts of the Columbia Basin affecting the survival and viability of listed species. Specific monitoring and evaluation studies called for in the Recovery Plan are too numerous to mention. However, the kinds of evidence needed for delisting Snake River salmon include reasonable assurance that the following conditions are satisfied.

- **a)** Spawning and rearing habitats for listed stocks should show net gains in both quality and quantity to maximize the productivity of natural populations, and a significant portion of the presently degraded habitat should be restored to higher quality, and productivity should be provided between areas of high quality habitat.
- **b)** Migration conditions for juveniles and adults must improve immediately and permanently.
- **c)** Ocean and inriver harvests should be controlled to reduce impacts on listed stocks.

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