Conservation of Columbia Basin Fish

Final Basinwide Salmon Recovery Strategy

Volume 2

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Technical Information

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Prepared by:
National Marine Fisheries Service
in consultation with

The Federal Caucus

Army Corps of Engineers
Bonneville Power Administration
Bureau of Indian Affairs
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1. Habitat Element of the Basinwide Salmon Recovery Strategy

Solving the habitat puzzle across a mixed landscape of federal, state, tribal and private lands will play an essential part in salmonid conservation. In this section, we outline a habitat conservation strategy that commits federal agencies to a fast start on habitat protection and restoration, and lays a foundation for long-term habitat strategies geared to the unique conditions of each subbasin and watershed. The overall strategy has five parts:

Tributary Habitat

- *A fast start for nonfederal tributary habitat*. In certain high-priority subbasins, federal agencies will begin immediately to work with nonfederal partners to protect productive habitat and fix flow, passage and water diversion problems. Federal agencies will participate in the Council's program to complete subbasin assessments and plans for other subbasins, which will identify critical short- and long-term actions, and will be implemented in a watershed context. This information will be coordinated with science findings from ICBEMP subbasin review and stepdown processes to ensure that restoration actions on non-federal and federal lands complement one another, address other landscape risks that influence fish habitat, and use information from the Northwest Power Planning Council's subbasin analysis and planning effort to help establish priorities.

- *A comprehensive approach to federal tributary habitat*. Existing and planned federal lands strategies will protect existing high-quality tributary habitat, accelerate restoration in high-priority tributary subbasins, and restore other habitat over the long term. In the short term, federal land will be managed by current programs that protect important aquatic habitats. That program will be augmented in important subbasins by a targeted restoration effort. In the longer term, management on the east side of the Cascades will be guided by the Interior Columbia Basin Ecosystem Management Project (ICBEMP) as that strategy is put in place. As ICBEMP is implemented, subbasin and watershed assessments and plans will target further habitat work.

Mainstem Habitat

- *An experimental program for mainstem habitat.* A mainstem habitat program will improve habitat to mimic the range and diversity of historic habitat conditions in the Columbia, Snake and Willamette rivers and evaluate the results.

Estuary Habitat

- *A comprehensive approach to the estuary*. A comprehensive estuary restoration program will inventory, protect and restore key habitats; and implement a major monitoring, analysis and research program to evaluate progress toward rebuilding the productivity of the system over the long term. These actions will be closely coupled to actions affecting flow and hatchery reform.

Implementation

A well-organized implementation process. A solid infrastructure is being established to ensure that federal habitat initiatives are organized, focused and managed toward clear objectives and tracked to evaluate progress. To build this infrastructure, the federal agencies are entering into an agreement to form a Federal Habitat Team. The team will ensure a consistent federal strategy and provide non-federal parties with a predictable, collaborative federal partner. The agencies also commit to support development of performance standards and integrated research, monitoring and evaluation.

This five-part strategy is premised on a close linkage between federal and non-federal habitat efforts. Federal programs under the Endangered Species Act, the Clean Water Act, the National Forest Management Act and other laws provide important legal and regulatory underpinnings for species recovery efforts. They also constitute an unmistakable reminder that species conservation implicates national interests. At the same time, species conservation is not just an obligation imposed by federal law. It is abundantly clear that salmon are of the highest importance to the people of the Northwest. Many of the landmark salmon programs over the last twenty years – the *Columbia River Basin Fish and Wildlife Program, Wy-Kan-Ush-Mi Wa-Kish-Wit: Spirit of the Salmon*, the *Oregon Plan for Salmon and Watersheds*, the Washington Forest and Fish Agreement, the *Lower Columbia River Estuary Program* and others – have come from non-federal institutions. Salmon have deep roots in the Northwest, and protecting them did not become an urgent priority just because of the Endangered Species Act listings. The federal role in species recovery must be geared, then, not just to federal resource management, but also to non-federal conservation efforts. The commitments the federal agencies make in this section are to work with non-federal partners who in many instances hold keys to solutions. This five-part strategy is designed to link federal and non-federal programs in a powerful way, establishing clear priorities and compatible assessment, planning and coordination mechanisms while recognizing the distinct roles of federal, state, tribal and local interests.

Habitat Program Objectives

Over the long term, the federal agencies have three overarching objectives for habitat restoration:

- Protect existing high quality habitats.

- Restore degraded habitats on a priority basis and connect them to other functioning habitats.
- Prevent further degradation of tributary and estuary habitat and water quality.

Achieving these objectives would not fully restore historic habitat quantity and quality, but should ensure that no population is driven to extinction because of poor habitat.

These objectives are tied to the basic habitat needs of species of concern (see Table 1).

Table 1. Summary of Major Habitat Requirements for the Salmon's Life Cycle

HABITAT REQUIREMENTS	HABITAT CONCERNS
Adult Migration Pathways	
Adult salmon leave the ocean, enter estuaries and rivers, and migrate upstream to spawn in the stream of their birth.	Passage blockage (e.g., culverts, dams) Water quality (high temperatures, pollutants) Competition with exotic species High flows/low flows/water diversions Channel modification/simplification Reduced frequency of holding pools Lack of cover, reduced depth of holding pools Reduced cold-water refugia Increased predation resulting from habitat modifications
Spawning and Incubation	
Salmon lay their eggs in gravel or cobble nests called redds. To survive, eggs (and the alevins that hatch and remain in the gravel) must receive sufficient water and oxygen flow within the gravel.	Availability of spawning gravel of suitable size Siltation of spawning gravels Redd scour caused by high flows Redd de-watering Temperature/water quality problems Redd disturbance from trampling (human, animal).
Stream Rearing Habitat	
Juvenile salmon may remain in freshwater streams over a year. They must find adequate food, shelter, and water quality conditions to survive, avoid predators, and grow. They must be able to migrate upstream and downstream within their stream and into the estuary to find these conditions and to escape high water or unfavorable temperature conditions.	Diminished pool frequency, area, or depth Diminished channel complexity, cover Temperature/water quality problems Blockage of access to habitat (upstream or down) Loss of off-channel areas, wetlands Low water flows/high water flows Predation caused by habitat simplification or loss of cover Nutrient availability Diminished prey/competition for prey Stranding due to water level fluctuations Competition with exotic species

Smolt Migration Pathways	
Smolts swim and drift through the streams and rivers, and must reach the estuary or ocean when there are adequate prey and water quality conditions and must find adequate cover to escape predators as they migrate.	Water quality Low water flows/high water flows Altered timing/quantity of water flows Passage blockage/diversion away from stream Increased predation resulting from habitat simplification or modification Stranding due to water level fluctuations Competition with exotic species
Estuarine Habitat	
Estuaries provide a protected and food-rich environment for juvenile salmon growth and allow the transition for both juveniles and adults between the fresh and salt water environments. Adults also may hold and feed in estuaries before beginning their upstream migration.	Water quality Altered timing/quantity of fresh water in-flow Loss of habitat resulting from diking dredging, filling Diminished habitat complexity Loss of channels, eel grass beds, woody debris Increased predation resulting from habitat simplification Diminished prey/competition for prey Reduction/elimination of periodic flooding Competition with exotic species

Source: Modified from Pacific Fisheries Management Council. 1999. Amendment 14 to the Pacific Coast Salmon Plan. Appendix A: Description and Identification of Essential Fish Habitat, Adverse Impacts and Recommended Conservation Measures for Salmon. Portland, OR.

Tributary habitat

This section outlines major federal agency commitments to support conservation of non-federal habitat and federal land management initiatives in tributary subbasins. Federal agency support begins with a commitment to focus immediate attention on high-priority subbasins. The nonfederal priority subbasins are areas with significant potential for improvement in productive capacity, significant amounts of good federal habitat to anchor restoration efforts, and significant numbers of water diversions where short-term gains could be secured by addressing flow, passage and screening problems. Over the longer term, habitat initiatives in these subbasins will be shaped by subbasin and watershed assessment and planning processes. The federal land managers' priority subbasins reflect a high degree of protection under federal land management plans, excellent opportunities for cooperative, whole-watershed restoration, with large joint federal ownerships, state and tribal interest in cooperative habitat programs, and they have a strong likelihood of sufficient adult escapement to use restored habitat. Taken together, these measures will materially improve the biological productivity of tributary subbasins of the Columbia River Basin.

Nonfederal tributary habitat.

For nonfederal habitat in Columbia basin tributaries, the federal agencies propose a program that will give a fast start to protecting productive habitat and fixing flow, passage and diversion problems. This fast-start strategy identifies priority subbasins, priority actions, and demonstration programs to fund immediate actions. In addition, federal agencies will participate in the Council's program to complete subbasin assessments and plans that will identify critical short- and long-term actions. The assessment and planning strategy identifies the process for identifying and supporting both short- and long-term actions.

A. Federal Support for Fast-Start Actions in Priority subbasins

For nonfederal lands in the near term, the federal agencies have identified 16 priority subbasins in which to focus immediate attention. These priority subbasins are places with stronghold areas anchored by federal land in good condition, and where productive capacity could be significantly increased if problems related to water diversions (flows, passage and screening) were addressed. The priority subbasins, organized by evolutionarily significant unit, are:

Upper Columbia Spring Chinook and Steelhead:
- Methow
- Entiat
- Wenatchee

Snake River Fall and Spring/Summer Chinook and Steelhead:
- Lemhi
- Upper Salmon
- Middle Fork Clearwater
- Little Salmon

Mid-Columbia Chinook and Steelhead:
- North Fork John Day
- Upper John Day
- Middle Fork John Day

Lower Columbia Chinook, Steelhead and Chum:
- Lewis
- Upper Cowlitz
- Willamette-Clackamas

Upper Willamette Chinook and Steelhead:
- Clackamas
- North Santiam
- McKenzie

Federal agencies have identified three of these subbasins in which to focus resources on protecting productive habitat and addressing water, passage and diversion problems in the first year of implementation: the Methow in Washington, the Upper John Day in Oregon, and the Lemhi in Idaho. For future years, subbasins will be determined in the 5-year and annual implementation plans described in the FCRPS biological opinion. As new information is gained from subbasin assessments and other sources, this list may be updated. At the end of five years, work will be underway in at least sixteen subbasins. The analytical process by which these subbasins were identified is published on the Caucus Web site.

The short-term federal strategy in these subbasins will focus on three measures that are most likely to produce significant biological benefits in the near term:

- ***Restoring tributary flows***. Restoring flows to depleted streams is an essential way to immediately improve habitat productivity. Without sufficient water, tributary streams cannot support aquatic life, especially during summer months, regardless of other habitat restoration actions. Once provided, sufficient flows allow streams to recover productivity quickly and may reconnect important spawning and rearing areas.
- ***Screening and combining water diversions***. All fish that enter unscreened diversions are likely to die because of stranding, predation, entrainment, impingement, or adverse water quality. About a third of all legally-authorized water diversions in the Columbia River Basin are unscreened; of the remainder, fewer than 20% are screened to NMFS criteria. Screening to NMFS criteria is thought to reduce mortality almost to zero. Combining diversions can also reduce mortalities.
- ***Reducing passage obstructions***. Temporary berms, unladdered water diversion structures, low road crossings, bridge footings and culverts obstruct migrating fish and degrade streams. Once addressed, there is immediate benefit to migration, spawning and rearing conditions.

In each priority subbasin, the federal agencies commit to work with nonfederal entities to resolve all flow, passage and diversion problems, as required to mitigate for the impacts of ongoing federal projects and programs, by the end of ten years. The first such basins will be selected from the priority subbasins based on biological considerations and local interest in working through ESA issues. Working with states, tribes and others, the federal agencies will supply analysis, technical assistance, funding and Endangered Species Act and Clean Water Act regulatory coordination.

Much of the information, expertise, planning, monitoring and enforcement for this work must come from state agencies. Federal agencies will need to work closely with states to ensure that mechanisms to protect stream flows are effective, for example. The federal agencies will continue discussions with the states to develop agreements regarding these programs.

Fix flow, passage and screening problems:

Lead agencies: USBR, working with NMFS criteria and methodologies for screening, passage and flow restoration.
Objective: Address all flow, passage and diversion problems over 10 years (completed in years 10-16).

Scope and timing: Start programs in three subbasins in each of five years starting in 2001 with the Methow, Upper John Day and Lemhi, 16 subbasins total.
State support: Data, planning assistance and mechanisms for protecting flow (administrative processes, water masters, gauging).

B. Federal Support for Fast-Start Actions in All Subbasins

Restore tributary flows through a water brokerage:

Tributary flow problems are widespread, and solutions are, to this point, largely undemonstrated. For the most part, the feasibility of solutions—whether and how they can be implemented through existing laws and administrative processes—is an institutional question. To test innovative approaches to this problem, beginning in 2001 Bonneville will fund a project that will experiment with innovative ways to increase tributary flows by, for example, establishing a water brokerage to demonstrate innovative solutions for tributary flow problems —and where feasible, water quality problems in streams with significant non-federal water diversions. The project would take advantage of the fact that various entities, government and non-government, have developed the capacity to secure instream water over the last several years using voluntary, transactional mechanisms. The project would develop a competitive process to supply water to increase flows and water quality. The project would also develop a plan for a pollution bank through which water quality credits could be exchanged in markets, and evaluate whether such projects could in another ten years complete enough water quality and quantity improvements to fully protect the non-federal land portion of critical habitat for species of concern.

In order to ensure a broad test of these innovative approaches, the project would respond to requests from projects in priority subbasins, above, but would not be limited to such projects or to transactions in priority subbasins. The primary emphasis of this project is to demonstrate the viability of non-government methods of rebuilding stream flows. Transactions that are independent of federal projects are an appropriate way to compare the results of federal and non-government methods. In general, the project should target water that is likely to rehabilitate ecological function for vulnerable species, either connecting productive habitats or connecting productive habitat to potentially productive habitats.

The non-profit brokerage entity and the states would be responsible for negotiating state administrative and legal processes to enable these transactions. Federal and other agencies will be involved in the project only via a project oversight committee to supply support and policy guidance to the non-profit brokerage.

Specific expectations for this project are: 1) In year one, BPA will fund development of a methodology for ascertaining instream flows that meet ESA requirements, establish a new non-profit entity or contract with a non-profit entity(ies) to carry out this project, require the non-profit entity(ies) to develop an operations plan and initiate a trial round of water solicitations. 2) In years two through five, the non-profit entity should be fully operational, processing water solicitations and completing transactions according to the operations plan, and should explore possibilities for accomplishing water and other habitat objectives together. After five years, an objective third-party evaluator will evaluate the program, and a decision will be made whether to continue the project.

The estimated BPA expenditure for this project is $2.5 million in the first year, $5 million in the second year, and $5-10 million per year thereafter, as justified by prospective transactions. Decisions regarding funding beyond the $5 million per year base in years 2-5 should be made jointly by NMFS and BPA, and in cooperation with the Northwest Power Planning Council's prioritization process. Recognizing recent amendments to the Columbia River Basin Fish and Wildlife Program regarding a land and water trust fund, BPA and NMFS will explore the possibility of integrating this project with such a trust fund.

Lead agency: BPA, NMFS
Objective: Demonstrate effectiveness of voluntary transactional processes to secure tributary flows.
Scope: Any subbasin with listed populations;
Timing: January, 2001-January, 2006; decide in 2006 whether to continue.
State support: administrative mechanisms to protect water acquired through transactions.

Integrate Clean Water Act and Endangered Species Act Requirements through TMDL Programs

The federal agencies are committed to integrating Clean Water Act and Endangered Species Act compliance, and this commitment is reflected in two initiatives:

First, the agencies will seek funding for pilot programs to demonstrate how Clean Water Act and Endangered Species Act objectives can be accomplished in TMDL (total maximum daily load) planning efforts. These pilot programs would have five objectives:

- Integrate Endangered Species Act and Clean Water Act TMDL processes to avoid duplication of effort and sequential regulatory processes that frustrate grassroots watershed groups
- Develop one set of watershed goals that meet both Clean Water Act and Endangered Species Act requirements
- Provide watershed stakeholders with Clean Water Act and Endangered Species Act assurances to the extent allowable by law
- Preserve, protect and restore fish habitat consistent with the Clean Water Act and Endangered Species Act
- Develop and promote lessons learned by and from watershed groups.

Local watershed efforts typically involve multiple stakeholders who may have done watershed plans for various local, state, and federal requirements. Meeting the needs of ESA-listed species may require changes in existing plans or new plans altogether. Clean Water Act requirements for TMDL planning on impaired water bodies may require a different schedule, and could result in prescriptions that are different from those required under ESA. Some watersheds have successfully dealt with both laws; others are frustrated by lack of clear guidance, sufficient information or timely decisions.

The pilot projects will aim for watershed plans with integrated, measurable ESA/CWA goals and targets. Habitat and pollutant reduction plans should be complementary, but clearly should

produce an approvable TMDL with an implementation plan with a suite of specific actions to meet the goals with voluntary or regulatory actions. Uncertainty may be acknowledged through adaptive management. The greater the degree of uncertainty, the greater the importance of monitoring and evaluation design and implementation. Successful watershed projects are expected to educate and assist other watersheds. Each watershed will provide "lessons learned" reports, with which the federal agencies can create templates for other watersheds.

Pilot projects would be chosen on the basis of nominations from the states of Oregon, Washington and Idaho. Tribes could submit nominations for watershed planning for which the majority of the watershed is in a reservation. Again, priority would be given to subbasins included in "coordinated tributary solution" projects, above. Watersheds or subbasins should meet the following criteria:

- 303(d)-listed waters and ESA salmonids
- the watershed has a viable stakeholder group, with effective leadership
- stakeholders and the state want to meet both the ESA and CWA in one process
- the current TMDL schedule is compatible with the pilot, or can be accelerated
- the watershed is representative of problems of water quality for salmonids (large urban watersheds would typically not qualify)
- the watershed has a significant ESA population, and a reasonable opportunity for restoration
- the watershed agrees to use appropriate assessment guidance.

EPA, NMFS, USFWS, BPA, and other interested federal agencies will select watersheds in consultation with the nominators. Successful watersheds and/or the states will be asked to develop a plan to accomplish the ESA/CWA integration. Federal agencies will be available to consult, coordinate and assist in identifying funding options for implementation plans.

> Lead agencies: EPA, USFWS
> Objective: (1) Three TMDLs and implementation plans/HCPs over three years; (2) evaluate ways to integrate Clean Water Act and Endangered Species Act requirements.
> Scope and timing: Any subbasin with listed populations, giving priority to requests from coordinated tributary projects, above. Begin January 2001.
> State support: State leadership, adjustment of TMDL development schedules.

Second, the FCRPS biological opinion calls on BPA (and other Action Agencies with jurisdiction) to support development of 303(d) lists and TMDLs in the course of subbasin planning, and fund implementation measures with direct ESA benefit that are recommended in approved tributary TMDLs. The opinion also calls on BPA and the other Action Agencies to consult with state and tribal water quality entities to ensure that federal, state and tribal efforts complement each other.

> Lead agencies: BPA (and other Action Agencies if within their jurisdiction)
> Objective: (1) Support development of state or tribal 303(d) lists and TMDLs; (2) provide funding to implement measures with direct ESA benefit that are recommended in

approved TMDLs; and (3) consult with state and tribal water quality entities to determine how water quality efforts can complement each other and avoid duplication.
Scope and timing: Begin January 2001.

Additional Federal Programs to Protect Tributary Habitat

In the short term, there are several additional ways in which federal agencies can protect fish habitat on non-federal lands. To begin with, Federal agencies put high priority on protecting habitat that is currently productive, especially if at risk of being degraded. These habitats should be protected through conservation easements, acquisitions or other means, so they can serve as anchor points for restoration. Restoring degraded habitat is of lower priority. Undertaking difficult and expensive efforts to restore degraded habitat while losing existing productive habitat would be a poor bargain. Accordingly, this paper and the FCRPS biological opinion call for BPA to fund efforts to protect currently productive non-federal habitat in subbasins with listed salmon and steelhead. BPA shall, especially if at risk of being degraded, in accordance with criteria and priorities developed by BPA and NMFS by June 1, 2001

Lead agency: BPA, in accordance with criteria and priorities developed by BPA and NMFS by June 1, 2001, and working with non-profit land conservation organizations and others.
Scope: At-risk habitats that are currently productive, especially if a habitat type that limits an ESU's productivity.

A second example involves the federal Farm Service Agency, which funds the Oregon Conservation Reserve Enhancement Program (CREP) to establish forested riparian buffers. Under the program, farmers and ranchers may enter into 10-15 year contracts to plant riparian buffers or restore wetlands on streams that provide habitat for listed salmonids. Overall, the program can fund buffers ranging from 35 to 150 feet along 4,000 miles of streams in Oregon, including the estimated 1,750 miles of salmon streams that cross agricultural lands. While the existing CREP program secures temporary (10-15 year) buffers, experience with similar programs suggests that these buffers can be made permanent by adding 25% to the contract price. Under the terms of the Oregon program, that portion of the landowner's water right that is appurtenant to the enrolled acreage must be dedicated to instream flows under Oregon law for the duration of the contract. (NMFS 1999). Thus, funding an additional 25% increment for this program would have both long term benefit from riparian planting and near-term benefit from increased stream flow. This is an obvious opportunity to leverage BPA funding with other federal funding and, given its potential contribution to instream flows and water quality, should be considered in connection with coordinated tributary projects, innovative approaches to establishing instream flows, and ESA/TMDL integration projects, above.

Lead agency: BPA, FSA
Scope and priority: Aim to protect 100 stream miles per year pending refinement from subbasin and watershed assessments in accordance with criteria developed by BPA and NMFS by June 1, 2001.
State support: Coordinate reserve programs

State and Local Programs to Protect Tributary Habitat

Much of the work of conserving habitat for weak fish populations will require attention from federal, state, tribal and local jurisdictions with relevant regulatory authority. The December 1999 Habitat Appendix discussed the great variety of such programs that are underway. These programs are in many cases under review to determine whether adjustments are needed.

Lead: Northwest states and local governments
Scope and priority: Pending refinement from subbasin and watershed assessments, evaluate efficacy of existing laws and regulations in protecting habitat.

C. Support Subbasin and Watershed Assessment and Planning

In the long term, successful habitat recovery and watershed restoration for non-federal lands requires state and local stewardship and coordination across ownerships and programs. An overall framework for state and local stewardship can be created through subbasin and watershed habitat assessments and plans and ESU-scale recovery plans that establish integrated goals, objectives and priority actions. Subbasin and watershed assessment and planning templates and protocols are needed to guide local planning efforts and meet regulatory and funding needs. To this end, the federal agencies are working with the Northwest Power Planning Council (Council), fish and wildlife managers, states, tribes and others on a series of subbasin and watershed assessments and plans (described in the Draft Conceptual Recovery Plan, Habitat Appendix, Section F, pages 65-74). Subbasin and watershed assessment processes will be informed by scientific analysis indicating where habitat work would be most effective – for example, the Northwest Fisheries Science Center's analysis of habitat-productivity relationships, and the Council's Environmental Diagnosis and Treatment (EDT) analysis of where management actions would be most effective. Other useful analyses have been developed by the ICBEMP Science Team, state salmon conservation programs, watershed initiatives and others. Under current schedules, the Council's subbasin assessments will be completed in 2000 and 2001. The Council will develop subbasin plans based on the subbasin assessments. The federal agencies are relying on the subbasin planning process to include all relevant state agencies, tribes, local governments, stakeholders and federal agencies. The federal agencies are committed to working with the Council and state and tribal fish and wildlife managers to develop a planning process that will produce scientifically-based plans with broad local support. As these steps are completed, priorities, targets and schedules will emerge and the priorities outlined in this paper can be added to and adjusted.

Lead entity: Northwest Power Planning Council, BPA
Objective: Basin and subbasin objectives
Timing: Preliminary subbasin assessments by early 2001; preliminary subbasin plans by 2002

Once priorities have been established through subbasin assessment and planning, local groups can develop smaller-scale watershed restoration plans, including assessments and implementation actions that meet habitat and watershed restoration objectives and integrate local economic, social and environmental concerns. Based on these locally-developed watershed restoration plans, individual restoration projects and plans can be developed by cities, counties,

local agencies and organization, and private parties (including industrial forest land owners, ranchers and farmers). Watershed assessment templates should be compatible with the standardized template developed by the Northwest Power Planning Council, the States of Oregon and Washington, the federal land management agencies, the Environmental Protection Agency and others, to avoid inconsistent inventory and analysis and reduce time spent in review and revision. Individual reach and farm plans that meet the objectives of the watershed restoration plans should be developed and voluntarily implemented by private landowners. Restoration criteria and performance standards set through subbasin and watershed-scale plans will establish accountability for funding and regulatory compliance. Such a process should be implemented as follows:

- Establish subbasin and watershed assessment and planning templates and protocols. Where available, these should account for science information from the ICBEMP subbasin reviews and step-down process and information generated in the Northwest Power Planning Council's subbasin assessment process.
- Use a locally-led implementation process. Locally-led planning groups, with technical expertise from local, state, tribal and federal agencies, should develop watershed health plans to meet habitat needs, water quality requirements and local objectives. Implementation should be based on voluntary, incentive-based approaches within a regulatory context.
- Integrate watershed planning efforts on private lands with those occurring on public lands.
- Secure and coordinate funding, technical and financial assistance for nonfederal landowners. Significant additional funding must be provided for technical and financial assistance for watershed and habitat restoration on private lands.
- Evaluate existing federal agricultural incentive programs and improve their effectiveness.
- Make ESA and Clean Water Act clearance more efficient for landowners through, for example, programmatic consultations, 4(d) rules and other mechanisms. Regulatory agencies should also provide non-federal landowners with guidance on regulatory standards (including ESA and Clean Water Act), conservation standards and specifications.
- Create systems for storing and disseminating data, information and technology that are compatible across federal and non-federal ownerships. Overall planning and implementation at ESU, subbasin, watershed and farm level would benefit from more coordination.

Lead agency: Federal Habitat Team, working with NRCS, NMFS, EPA, NPPC and others
Objective: Watershed plans consistent with ESU and subbasin objectives in all priority subbasins in five years and remaining watersheds within the range of listed salmonids in ten years
Scope and priority: Pending refinement from subbasin and watershed assessments give priority to requests from coordinated tributary projects, above.
State support: Coordinate with state watershed planning and funding.

Subbasin and watershed plans must also be integrated with ESU-scale recovery plans, which will include biological recovery goals for ESUs, and specific actions to meet these goals. NMFS has appointed a Technical Recovery Team to establish biological goals for ESUs in the upper Willamette and lower Columbia and intends to establish an additional Technical Recovery Team for the interior Columbia basin. In consultation with the Council, states and tribes, NMFS will also appoint a Planning Recovery Team to develop ESU-scale recovery plans. These ESU-scale recovery plans will integrate subbasin plans geographically with each other, and with plans and actions in the other sectors (harvest, hatcheries and hydropower). They will also provide guidance on priorities to smaller scale subbasin and watershed planning efforts.

Lead agency: National Marine Fisheries Service
Objective: Establish recovery objectives, de-listing criteria and measures
Timing: Upper Willamette and Lower Columbia delisting criteria by 12/2001; recovery measures by 12/2002. Interior Columbia delisting criteria by 12/2002; recovery measures by 12/2003

D. Short-term funding for other projects.

The above priorities are not intended to exclude other initiatives, such as habitat acquisition, for which funding may make sense in agency, Council or state planning in the short term. In determining whether other actions should be funded, the federal agencies urge that the following criteria be applied: first, all necessary assessment and planning (e.g., NEPA) has been completed so the initiative can begin before September 30, 2001. In addition, initiatives should:

- Restore or acquire potentially productive habitats that will be largely self-maintaining after the activities are complete; or
- Address imminent risks to survival of one or more species; or
- Result in substantial, measurable benefits to species survival in not less than 10 years after implementation; or
- Be part of an action plan that is derived from science-based assessment; or
- Address a habitat enforcement issue and result in the protection of aquatic habitats.

D. Tributary Performance standards.

To ensure that habitat conservation in tributaries is focused, federal agencies will develop habitat performance measures for nonfederal habitat actions to ensure consistency among programs, link actions to objectives and provide a basis on which to determine progress.

Developing performance measures for tributary habitat actions is a challenge because it is so difficult to measure specific increases in salmon productivity from specific habitat improvements. Habitat improvements can take a decade or more to produce physical changes in the landscape or in the stream channel. Tracing the effect of these changes on salmon productivity takes time because salmon populations fluctuate naturally. Detecting change in productivity from habitat actions requires long-term data sets. Moreover, no single set of performance measures will apply at all geographic scales. Different measures will be relevant to basin, subbasin and watershed or stream-reach scales.

Notwithstanding these challenges, meaningful performance measures can be established to guide management. We will identify certain ecological problems that limit species productivity, steps that need to be taken to address these problems, and ecological and management indicators that allow us to judge whether the steps we are taking are successful. Because of the time needed to detect ecological and physical changes, management indicators showing that the right steps are being taken will be crucial for the first several years. Thus, both management and ecological indicators will be included in the habitat performance measures.

Ecological indicators must be related to the biological responses of the species of interest. Biological responses most sensitive to habitat changes are egg-to-smolt survival and the fitness of smolts. Linking these biological measures to performance standards that are good indicators of increases in salmon productivity (e.g., population growth rate) will provide the information needed to evaluate overall success. Performance standards can also be developed now that should be good indicators of increases in salmon productivity.

Based on our current understanding of the associations between ecosystem processes and salmonid populations, there are four key habitat factors that need to be linked to performance measures in tributary subbasins: instream flows; amount and timing of sediment inputs to streams; riparian conditions that determine water quality, bank integrity, wood input and maintenance of channel complexity; and habitat access. Changes in these attributes can be measured at the reach or watershed level and aggregated to larger spatial scales to evaluate progress at the subbasin or basin level. Any specific combination of actions among these four factors will vary by watershed and subbasin.

Federal agencies will develop by April 2001 an initial set of performance measures based on these four factors, and based on the management steps needed to improve habitat conditions. The four habitat factors will be tied to a set of hypotheses associating habitat improvement with expected biological response. Performance standards initially will be expressed as a desired trend in these attributes rather than a specific endpoint. These measures and the associated standards will then be developed and refined through subbasin assessments and finer scale analysis (see below), integrated into the monitoring and evaluation program described in this paper, and tested and improved through targeted research. The subbasin assessments will take advantage of current tools available for evaluating habitat quality and quantity and salmon productivity. The monitoring and evaluation section of this paper provides a framework for evaluating increases in salmon productivity. The tributary habitat performance measures will be tightly integrated with the monitoring and evaluation program. Monitoring, evaluation and research should enable policy makers to make adjustments in habitat programs, evaluate and refine hypotheses over time, and make future decisions on the contribution of habitat measures to restoring healthy salmonid populations.

We have sufficient knowledge now to begin taking substantial actions to improve fish habitat. We propose to act on this knowledge and make adjustments as we gain additional knowledge. Timely action requires a series of planning and decision cycles that fully utilize available knowledge and build on previous success.

Tributary Habitat on Federal lands

The Forest Service and the Bureau of Land Management manage over 60 percent of the currently accessible spawning and rearing habitat for anadromous fish in the Columbia River Basin, located in the upper and mid-elevation portions of tributary areas. Federal Land Managers are committed to maintaining existing high quality habitat and as funding becomes available restoring degraded habitat. Federal Lands have the potenial to provide a strong foundation for salmon recovery with the Columbia River Basin.

A. Aquatic habitat trends and current management of federal lands.

Some federal lands designated for timber harvest, livestock grazing and mineral extraction support salmonid habitat, but a lower level than historic levels. Federal lands designated and managed for wilderness and roadless values support habitat that is closest to historic conditions.

Recent scientific assessments indicate that overall, the habitat conditions on federally-administered lands are in an upward trend. However, the extent to which this habitat can benefit salmonid populations is influenced by the other major factors that impact salmon survival: hatcheries, harvest and hydropower.

In the Columbia River Basin, the Forest Service and the Bureau of Land Management manage salmonid habitat under the direction of PACFISH, INFISH and related biological opinions, and in western Oregon and Washington under the Northwest Forest Plan. PACFISH, INFISH and the Northwest Forest Plan aim to protect areas that contribute to the salmonid recovery and improve riparian habitat and water quality throughout the Basin. To meet these objectives, the Northwest Forest Plan and PACFISH/INFISH:

- Establish watershed and riparian goals to maintain or restore all fish habitat
- Establish aquatic and riparian habitat management objectives
- Delineate riparian management areas
- Provide specific standards and guidelines for timber harvest, grazing, fire suppression and mining in riparian areas
- Provide a mechanism to delineate a system of key watersheds to protect and restore important fish habitats
- Use watershed analyses and subbasin reviews to set priorities and provide guidance on priorities for watershed restoration
- Provide general guidance on implementation and effectiveness monitoring
- Emphasize habitat restoration through such activities as closing and rehabilitating roads, replacing culverts, changing grazing and logging practices, and replanting native vegetation along streams and rivers.

Biological opinions issued by NMFS and USFWS have concluded that PACFISH and INFISH avoided jeopardy and conserved recovery options until long-term restoration strategies could be established. In addition, ESA consultations on thousands of specific BLM and Forest Service land management activities are occurring, either individually or "batched" by watershed, following Interagency Streamlining Consultation Procedures established in May 1995. To oversee the implementation of these biological opinions, regional executives from BLM, Forest

Service, USFWS and NMFS chartered the Interagency Implementation Team (IIT), comprised of senior staff and managers from those organizations. Based on their semi-annual assessment, the NMFS and USFWS are satisfied with the progress the BLM and Forest Service have made to date in complying with the provisions of the PACFISH and INFISH biological opinions and the effectiveness of the IIT for tracking progress and resolving implementation issues.

B. Near-term priorities.

For the near term, BLM and Forest Service have chosen seven subbasins in the Columbia River Basin as highest priority for anadromous fish habitat restoration in a program to begin in fiscal year 2001. These subbasins were selected based on five criteria: (1) ICBEMP science assessments and restoration protocols developed by the Interagency Implementation Team; (2) the high degree of protection provided by key/priority watershed designation in the Northwest Forest Plan or consistency with the long-term aquatic restoration strategy of ICBEMP; (3) excellent opportunities for cooperative, whole-watershed restoration, with large joint BLM and Forest Service ownerships; (4) State and tribal government interest in cooperative habitat programs; and (5) they are below the four Snake River Dams, with a strong likelihood that they will have sufficient adult escapement for optimum utilization of restored habitat. These priority areas overlap with the priority watersheds identified in ICBEMP, and represent the best chance of restoring populations that are not substantially affected by upstream and downstream mainstem passage.

For investments on federal lands to reach their full potential, strong working partnerships will be needed with state salmon and watershed recovery programs, other federal agencies such as NRCS and non-federal landowners.

The fiscal year 2001 program, if funded, would begin a focused, five-year watershed restoration program for these watersheds. A multi-year program would ensure sustained and coordinated completion of high priority work. Restoration capability would increase by the third year of the program. A more detailed plan will be developed for fiscal years 2002 through 2006, in cooperation with the states, other federal agencies, tribal governments and willing non-federal landowners.

Table 2 Highest priority watersheds on federal lands and costs for fiscal year 2001 habitat restoration.

Subbasins	McKenzie		Hood River/ 15 Mile		Wenatchee/ Yakima		Entiat		Wind River		MF John Day		SF John Day		Totals	
Activities	FS	BLM	FS	BLM	FS	BLM	FS	BLM	FS	BLM	FS	BLM	FS	BLM	FS	BLM
Roads	300	185	900	–	400	–	300	–	300	–	500		300	15	3000	200
Upslope Habitat	100	55	300	–	100	50	–	60	–	–	100		100	190	700	355
Riparian Habitat	100	55	300	–	100	25	100	–	100	–	100		100	35	900	115
In-channel Habitat	200	110	200	–	–	25	100	40	100	–	200		100	25	900	200
TOTALS (thousands of dollars)	700	405	1700	–	600	100	500	100	500	–	900		600	265	5500	870

Table 3: Lower priority watersheds and costs for habitat restoration FY 2001.

Subbasins	Clearwater		Yankee Fork		Upper Salmon		Pahsimeroi		L. Grande Ronde		TOTALS (thousands of dollars)	
Activities	FS	BLM	FS	BLM	FS	BLM	FS	BLM	FS	BLM	FS	BLM
Estimated Costs	1500	100	500	–	500	175	–	375	750	225	3250	875

Fiscal year 2001 program elements include road decommissioning; fish passage and drainage.

Subbasins above the four Snake River dams were given a lower priority for investments in habitat restoration projects because adult anadromous fish escapement during the last decade has not been sufficient to seed existing high-quality federal habitat. Generally, anadromous and resident fish habitat quality of federal land in the Snake River Basin is considered to be in good condition. Approximately 70 percent of the priority watersheds with listed anadromous fish are in wilderness or roadless areas. However, there are habitat restoration opportunities on federal lands in the Clearwater, Pahsimeroi, Upper Salmon, and Grande Ronde Rivers for resident fish, watershed health, and anadromous fish, if adult escapement improves.

Fiscal year 2001 program elements include road decommissioning; fish passage and drainage improvements; upland improvements to improve slope stability and watershed conditions; riparian planting, fencing, and thinning to reduce erosion and improve shading; and restoring habitat complexity in impacted stream channels. Examples include: (1) White River Oxbow Rehabilitation, which would remove one mile of valley bottom road, opening access to a half-mile of prime oxbow habitat for Upper Columbia steelhead, spring Chinook, and bull trout; (2) Miles Creek Boundary Fence Project protecting 6,500 acres of riparian and forested upland to benefit threatened Mid-Columbia steelhead; (3) Chikamin Pumice Mine rehabilitation, stabilizing ten acres of abandoned mine site impacting spring Chinook, steelhead, and bull trout in the Chiwawa River system; (4) Ramsey Creek channel restoration, improving three miles of instream and riparian habitat for threatened steelhead in the 15-mile system; (5) reconstructing and reconnecting dewatered segments of the Pahsimeroi River.

One of the differences between nonfederal and federal land priorities is in the Salmon and Clearwater Basins. In those areas, relatively few adult fish return to spawn on federal lands because of problems with degraded rearing habitat on nonfederal land, dam passage and other problems downstream. Improving the condition of federal land in these areas would produce limited additional value for these fish. At the same time, some of the problems that limit returns to federal habitat are non-federal habitat problems. Dewatered streams, passage obstructions and inadequately screened diversions in nonfederal areas limit access to federal habitat. Moreover, the Salmon and Clearwater historically were among the most productive subbasins for spring and summer chinook. This fact suggests that correcting habitat problems in these subbasins is likely to produce a better response from the fish than efforts in areas where natural attributes don't support large numbers of salmon, especially once escapement has increased. Accordingly, nonfederal habitat priority subbasins include these areas. This restoration work should increase escapement to habitat on federal lands that, in turn, will increase the priority of federal habitat restoration in these subbasins. Regardless, ICBEMP and the interim PACFISH/INFISH strategies protect high-quality federal habitats to support nonfederal restoration efforts.

C. Long-term management in the interior basin: the Interior Columbia Basin Ecosystem Management Project.

The Forest Service and BLM, in cooperation with the USFWS, NMFS and EPA, are preparing a broad-scale, ecosystem-based strategy to manage federal lands in the Columbia River Basin. The strategy, known as the Interior Columbia Basin Ecosystem Management Project (ICBEMP)

addresses broad-scale issues of forest and range land health, terrestrial species habitats, social and economic conditions, and aquatic and riparian health. The aquatic component of this strategy will provide long-term guidance for the protection and restoration of aquatic habitat and, when finalized, will replace PACFISH and INFISH (interim strategies that currently guide federal land management in these areas). A final ICBEMP record of decision, expected in early 2001, will amend 62 land use plans for 32 Forest Service and BLM administrative units in the basin.

Key findings in the ICBEMP Science Assessment and Evaluation of alternatives are: 1) the aquatic conservation strategy proposed in the ICBEMP preferred alternative will improve aquatic habitats on federal lands over time, and 2) the preferred alternative's approach to assessing status, risk and opportunity at different geographic scales should lead to an effective approach to aquatic habitat restoration. In addition, the Science Assessment indicates that anadromous fish spawning and rearing capacity on many federal lands (especially in the upper Snake River Basin) is much greater than can be used by the small number of returning adult fish. This underscores the importance of integrating aquatic habitat restoration efforts on federal lands with similar efforts on non-federal lands and changes in harvest, hatcheries and hydropower programs.

The Forest Service and BLM have made the following commitments to ensure that federal land management under ICBEMP will help protect and recover listed fish (these principles may be adjusted by the ICBEMP NEPA process and Record of Decision):

- Retain or recharter the IIT (see above) or a similar interagency team to aid in the transition from interim aquatic management strategies and products developed by the IIT to the long term ICBEMP direction.
- Strategically focus Forest Service and BLM scarce restoration resources using broad scale aquatic/riparian restoration priorities to first secure federally-owned areas of high aquatic integrity and second, restore out from that core, rebuilding connected habitats that support spawning and rearing.
- Ensure that land managers consider the broad landscape context of site-specific decisions on management activities by requiring a hierarchically-linked approach to analysis at different geographic scales. This is important to ensuring that the type, location and sequencing of activities within a watershed are appropriate and done in the context of cumulative effects and broad scale issues, risks, opportunities and conditions.
- Cooperate with similar basin planning processes sponsored by the Northwest Power Planning Council, BPA and other federal agencies, states and tribes to identify habitat restoration opportunities and priorities. Integrate information from these processes into ICBEMP subbasin review when appropriate.
- Consult with NMFS and USFWS on land management plans and actions that may affect listed fish species following the Streamlined Consultation Procedures for Section 7 of the Endangered Species Act, July, 1999.
- Collaborate early and frequently with states, tribes, local governments and advisory councils in land management analyses and decisions.

- Cooperate with the other federal agencies (in particular NMFS and USFWS), states and tribes in the development of recovery plans and conservation strategies for listed and proposed fish species. Require that land management plans and activities be consistent with approved recovery plans and conservation strategies.
- Collaborate with other federal agencies, states, tribes and local watershed groups in the development of watershed plans for both federal and non federal lands and cooperate in priority restoration projects by providing technical assistance, dissemination of information and allocation of staff, equipment and funds.
- Share information, technology and expertise, and pool resources, in order to make and implement better-informed decisions related to ecosystems and adaptive management across jurisdictional boundaries.
- Collaborate with other federal agencies, states and tribes to improve integrated application of agency budgets to maximize efficient use of funds towards high priority restoration efforts on both federal and non-federal lands.
- Collaborate with other federal agencies, states and tribes in monitoring efforts to assess if habitat performance measures and standards are being met.
- Require that land management decisions be made as part of an ongoing process of planning, implementation, monitoring and evaluation. Incorporate new knowledge into management through adaptive management.
- Enhance the existing organizational structure with an interagency basinwide coordinating group and a number of sub-regional interagency coordinating committees. These coordinating groups and committees will ensure the implementation of ecosystem-based management across federal agencies' administrative boundaries, resolve implementation issues, be responsible for data management and monitoring, and incorporate new information through adaptive management.

Mainstem habitat

1. Scope and background.

One of the important elements of the Independent Science Group's *Return to the River* report was the hypothesis that important gains in salmon productivity could come from increases in mainstem spawning and rearing habitat. The federal agencies will take immediate steps to test this hypothesis by improving mainstem habitats of the Snake River downstream of Weiser, Idaho, the Columbia River extending from Chief Joseph Dam to Bonneville Dam, and the Willamette River below the Corps' multipurpose projects, and evaluating the results. The Columbia River mainstem below Bonneville Dam is discussed in the next section, Estuary Habitat.

A recent report by Battelle Pacific Northwest National Laboratory and the U.S. Geological Survey's Western Fisheries Research Center. The report assesses the extent of riverine habitat lost to hydropower development, identifies the types of habitat modifications that have occurred as a result of lost habitat, and suggests areas or actions with most potential to restore mainstem

riverine habitat. The report identified three river reaches, all downstream of present migration barriers, as having high potential for restoration of riverine processes: the Columbia River upstream of John Day Dam; the Columbia-Snake-Yakima river confluences; and the lower Snake River upstream of Little Goose Dam. The report noted that no systematic assessment of habitat modifications from dam construction has been done, and that potential restoration sites and/or specific benefits to salmon and steelhead have not been identified.

Other mainstem reaches have different needs and opportunities for improvement:

- *Willamette River*: Prior to European settlement, the river had five channels set in a wide, partially forested floodplain with many alcoves, sloughs, ponds, lakes and side-channels. Navigation channels down-cut the riverbed and drained sloughs and channels. Today, the river runs mostly free, constrained by high banks and terraces. All large water development projects, primarily intended for flood control, are located on tributaries.
- *Columbia River between Chief Joseph and Bonneville Dams*: This reach is deeply incised between basalt cliffs and mountains, or constrained by basalt hills and cobble/gravel terraces. The substrate is predominately cobble and gravel with compacted sands. Before settlement, it was a series of pools interspersed between islands, gravel bars and rapids. There was little riparian vegetation except where the river was wide, on islands and in confluence areas. Except for the Hanford Reach, the reach is now largely a series of pools. Water development projects in the reach are run-of-the-river with little water storage capacity. Vegetated areas are largely integrated into wildlife management areas and refuges.
- *Snake River below Weiser, Idaho:* Before development, the lower Snake River was severely incised, with boulders, cobble, gravel and sand substrates. Water elevations would vary as much as 25 feet, limiting riparian vegetation. Today, the reach is primarily a series of pools from the upstream limit of the McNary pool to Lewiston, Idaho. The heavy sediment loads resulting from slow flows, proximity to the dams, and loss of shallow water habitat have adversely affected the diversity, distribution and abundance of aquatic invertebrates below the confluence areas.

Habitat use by salmonids. As the Battelle-USGS report finds, large-scale water development over the last 65 years has inundated and degraded mainstem habitat on a significant scale. Some populations such as fall chinook were highly productive historically, and spawned largely in the mainstem and in the lower reaches of major tributaries. With current development, however, mainstem habitat characteristics and salmonid use are difficult to survey, sample, monitor and evaluate. As a result, we lack basic information on mainstem distribution and abundance of fish and their use – or potential use – of the mainstem habitats. We also lack protocols for studies, monitoring and evaluation, and reference sites to monitor and evaluate changes.

Information needs. Scientists understand how salmonids use and respond to the biotic, physical and chemical attributes of small streams and rivers, but have only limited knowledge of their uses and responses in large rivers, especially those in the Columbia River Basin. However, studies in other river systems in the Pacific Northwest indicate that mainstem habitat

improvements can result in greater diversity, complexity and productivity. One of the threshold questions that must be addressed in designing a mainstem habitat program is the relationship of the size of an improvement to the size of the affected environment. While we can predict the response in diversity, complexity and function when we undertake a stream improvement, can we expect a comparable response in a much larger mainstem system?

2. Action plan.

The mainstem habitat program will: 1) develop a baseline data set; 2) develop and implement a habitat improvement plan that, insofar as possible, mimics the range and diversity of historic habitat conditions; and 3) develop and implement a rigorous monitoring and evaluation action plan that may lead to changes in the mainstem habitat program. These three actions are essential if we are to accurately assess the value of mainstem habitats to salmon and salmon recovery. Given the uncertainties, our approach begins with an assessment of the value and contribution of habitat system components to fish and water quality, and identification of cause-and-effect relationships between improvement actions and fish response.

In the Columbia mainstem above Bonneville Dam, habitat work will be undertaken largely by BPA as lead agency, working with the Bureau of Reclamation, Corps, Environmental Protection Agency, and the U. S. Geological Survey. Two Public Utility Districts (Chelan County and Grant County) have initiated habitat studies in the Mid-Columbia River. State and local government will be involved in activities in the Willamette.

More specifically:

A. Research priorities:

- Review historic habitat conditions.
- Given that a complete survey of conditions will be a large task and take considerable time, and the immediate need to help listed species, the research program will select a set of sampling reaches that can be used to characterize the mainstems. Data collection at these sites will be used to describe cause-and-effect relationships and to monitor future health and productivity. At least one site will be established in each of the impoundments below Chief Joseph Dam and Weiser, Idaho; three sites will be selected in the Willamette River (one below Eugene, one below Salem and one above the Multnomah Channel); at least three sites will be selected in the Columbia – above the Sandy River confluence, below the Multnomah Channel confluence, and below the Cowlitz River confluence. In identifying sites, the Battelle-USGS study will be carefully considered.
- Survey current bathymetric and topographical conditions (bottom of the channel to the top of the first bench or cliff above the 100-year floodplain), including substrate, water quality and quantity, nutrients; organic and benthic macroalgae availability, macro-invertebrates, fish, rooted aquatic plants, riparian vegetation and climate data.
- Identify further research needs based on monitoring at sampling reaches.

Lead agencies: BPA (lead), Corps, USGS, EPA, BR, NMFS
Objective: Identify sampling reaches; survey conditions; describe cause-and-effect relationships; identify research needs.
Timing: Begin October 2000

B. Immediate (I) and long-term (L-T) habitat improvement priorities for mainstem reaches generally:

- Excavate backwater sloughs, silted-in lateral channels, restore or create alcoves and side channels and create islands and shallow-water areas, to provide habitat adjacent to the main channels suitable for spawning, incubation, rearing, resting and predator cover. (I, L-T)
- Allow for reconnection of alcoves, sloughs and side channels to the main channel twice a year
- Reestablish and enhance historic and existing wetlands. (I, L-T)
- Stabilize reservoir water levels. Specifically, reduce daily and weekly fluctuations to improve productivity of existing shallow-water areas; enhance mainstem flows during critical periods to improve productivity of existing wooded wetlands, lakes, ponds, slough and alcoves. (I)
- Acquire from willing sellers a 100- to 325- foot land corridor in selected areas adjacent to the mainstems to allow for natural restoration; acquire other habitat through purchase, lease, easement or other means, to protect critical habitat. (I)
- Plant riparian and aquatic plants at appropriate locations. (L-T)
- Add large woody debris to increase organic material and enhance smolt habitat conditions by increasing pools and riffles, escape cover, a sediment sink and a nutrient source for macroinvertebrates. (I)
- Address non-point pollution from agricultural and urban runoff, improve animal management in shoreline areas, reduce pesticide and fertilizer use and improve stormwater treatment. (I)
- Complete TMDL compliance. (L-T)
- Develop and implement a monitoring and evaluation program. (I)
- Use information from sampling reaches to develop plans for other reaches. (L-T)

C. Habitat improvement action priorities by reach:

- Willamette River: Create and enhance alcoves, sloughs, marshes and other shallow water habitats; add large woody debris, especially in sand environments; improve water level management; acquire/protect shoreline corridors; reduce fertilizer use; improve flow management to enhance productivity of wooded wetlands.
- Snake River: Reduce and stabilize water level fluctuations, especially in lower river reservoirs; add large woody debris; enhance lake, slough and side channel connections to the main channel; create/enhance shallow-water areas in reservoirs, particularly near dam forebays and submerged benches and hillsides; acquire/protect/restore shoreline corridors around tributary confluence areas in the

reservoirs to preserve riparian vegetation and prevent/control siltation problems; vegetate newly created/protected sites.

- Columbia River (Chief Joseph Dam to Bonneville Dam): Add large woody debris; create shallow water areas; enhance alcove, slough and side channel connections to the main channel; establish emergent aquatic plants in shallow water areas; stabilize reservoir water levels.

  Lead agency: BPA (lead), Corps, EPA (water quality)
  Objectives: Restore habitat; acquire riparian corridors; modify flow regimes; reduce non-point pollution; develop improvement plans for all reaches.
  Timing: 200l-2012

D. Improving spawning habitat for lower river chum:

The federal dams on the Columbia have been a relatively important factor in the decline of this ESU. Bonneville and The Dalles Dams limit access to potential spawning habitat further upstream and Bonneville Reservoir inundated known habitat in Bonneville pool. Spawning is observed currently in only two areas: the Grays River system in the Columbia River estuary and the Hardy/Hamilton creeks/Ives Island complex downstream of Bonneville Dam. Although a majority of the existing subbasin populations and the ESU as a whole are on a slightly positive growth trajectory, water management operations will continue to limit spawning habitat in Bonneville pool and the Ives Island complex in most water years. In light of these effects, the Federal Agencies and NMFS will work with regional prioritization and congressional appropriations processes to fund two initiatives:

1. A study of the feasibility, biological benefits and ecological risks of habitat modification to improve spawning conditions for chum and chinook salmon in the Ives Island area. The objectives of the feasibility study will be to determine whether it would be beneficial to increase the frequency of access to spawning habitat or the geographic extent of spawning habitat by means other than flow augmentation. The study will evaluate actions to: alter the hydraulic control points that limit flow in the Ives Island area to provide the same extent and quality of spawning habitat (including such characteristics as upwelling through the gravels) at lower levels of Bonneville discharge; reconstruct spawning channels to increase the extent of habitat available at a given level of Bonneville discharge; and maintain hydraulic connections between tributary habitats and the mainstem Columbia River to allow entry for adults and emergence channels for juveniles.

   Lead: BPA, the Corps and the Bureau of Reclamation
   Scope and priority: feasibility study
   Funding: BPA and federal appropriations

2. BPA will: a) fund surveys of existing and potential tributary and mainstem habitat in the Columbia River between The Dalles Dam and the mouth of the Columbia River for suitable protection and restoration projects, b) develop and implement an effective habitat improvement plan, and c) protect, via purchase, easement, or other means existing or potential

spawning habitat in this reach and adjacent tributaries (i.e., protect, restore, and/or create potentially productive spawning areas). The overall goal of this effort will be to ensure the survival and recovery of CR chum salmon by ensuring the availability of diverse, productive spawning habitats over a wide range of water years.

Lead: BPA
Schedule: fund surveys in 2001, develop and implement plan to protect and restore habitat in year 2 and beyond

Estuary habitat

1. Scope and background.

The Columbia River estuary extends from the ocean to Bonneville Dam at river mile 146. The estuary is where the river and migratory fish make the transition between salt and freshwater. In fact, the estuary is formed and modified continuously based on complex biological and physical interactions such as type and value of habitat, river flow, bathymetry (depth), and other physical processes such as sediment transport, which impact habitat access and quality for salmon. In addition, there is evidence that the Columbia River plume (fresh water flowing west of the River's mouth) may extend biological and physical estuarine habitat features that are critical to salmon survival. The plume may also provide a unique salmon habitat through its interaction with the California Current and local ocean conditions off the mouth of the Columbia River.

A combination of natural and human-caused factors have changed the Columbia River estuary. Natural sediment accretion causes gradual uplifting, which converts marsh to willow and spruce swamp. Swamp-dominated floodplain is the end product of the estuarine process. Construction and operations of the federal hydropower system in the upper portion of the river, construction and maintenance dredging of the federal navigation channel in lower portion of the river, diking and filling of wetlands and other development have: caused extensive loss of tidal swamps, marshes, and emergent and forested wetlands; isolated tidal channels; reduced total sediment discharge by one-third; increased potential for salmon predation through disposal of dredged material; reduced the extent, speed, thickness, and turbidity of the River's plume; degraded water quality; altered the timing and volume of natural flow; and reduced flooding. Overall, these changes have simplified estuary habitat and changed water salinity, temperature and velocity. All of these problems can constrain salmon production.

While all Pacific salmon species use the estuary, the nature, degree and duration of use varies considerably, and this usage is the key factor in assessing the benefit to be gained from estuarine habitat actions. Historical evidence shows that juvenile salmon used the estuary for extended periods of time (from March to October at least, and very nearly the entire year). Some juvenile salmon populations experience 50 to 100% growth during residence in the estuary from April through August.

Hatcheries practices influence how juvenile fish use the estuary. Hatchery stock run times are much more compressed than those for native stocks. The scientific evidence also suggests that hatchery fish primarily use the channel margins, while native stocks tend to use the tidal and emergent forested marshlands. Hatchery fish traveling through the estuary to the ocean show no evidence of growth comparable to that observed in native fish. Restoration efforts must take these differences into account.

The lower river is also complex institutionally, with 19 federal agencies, 22 state agencies, 14 regional entities, 37 local governments, 14 ports, 4 treaty tribes and 44 non-governmental organizations involved to varying extents in managing, regulating, using and planning for the area. The Corps (permitting), NMFS and USFWS (biological opinions and incidental take permits), BPA (hydropower operations and mitigation funding), EPA (Clean Water Act regulation), the Lower Columbia River Estuary Program (planning and coordination), the Northwest Power Planning Council (project funding and subbasin planning), the Port of Portland (mitigation action associated with development), the Columbia River tribes (trust and treaty interests) and the states of Washington and Oregon (regulatory actions and LCREP participation), are all actively involved in estuary programs. Improved coordination among jurisdictions would minimize competing, uncoordinated or conflicting plans and programs, foster timely policy decisions, facilitate actions and reduce habitat improvement costs.

2. Action Plan

Estuary protection and restoration must play a vital role in rebuilding the productivity of salmon runs throughout the Columbia Basin. The states of Oregon and Washington, with congressional authorization under the Clean Water Act, have developed a management plan to help rebuild the estuary through the Lower Columbia River Estuary Program (LCREP). The federal agencies strongly support the elements of this plan that support salmon recovery, and seek to expand on them. In 1999, the LCREP completed a consensus-based Comprehensive Conservation and Management Plan to provide a framework for managing and protecting the lower Columbia River and estuary. The plan aims to guide actions by federal, state, local and tribal governments and non-governmental interests to preserve and enhance habitat and water quality. The plan has established a foundation, and will have a permanent Implementation Committee in place in late 2000 (Mgt. Plan Action 13). Actions 1 through 6 are based largely on the Management Plan's recommendations. Federal programs are also engaged in habitat acquisition activities in the estuary and should be coordinated in the implementation process. Under the North American Waterfowl Management Plan, a program called Pacific Coastal Joint Ventures Plan is acquiring waterfowl habitat and exploring associated anadromous fish habitat. The Partners for Fish and Wildlife Program administered by USFWS works with private landowners to restore wetlands. The Coastal Program administered by USFWS has funds for habitat acquisition.

A. Assessment: Inventory estuary habitat; model physical and biological features of the historical lower river and estuary; and develop restoration criteria (Mgt. Plan Action I and general study).

Lead agency: BPA and Corps
Schedule: 2001

B. Adapt current plan to the specific ecological needs of salmon:

- Building on the LCREP plan, establish clear goals for salmon conservation in estuary to support the full range of salmon life history types
- Identify habitats whose characteristics and diversity support salmon productivity, and important connections among them
- Identify potential performance measures (see 5.2.4.3, below)
- Identify flow requirements necessary to support estuarine habitat requirements for salmon
- Include a concurrent program of research, monitoring and evaluation

Leads: BPA and Corps (federal lead), working with LCREP and NMFS
Schedule: 2001-2003

C. Habitat acquisition and restoration: Protect identified high quality habitats (Mgt. Plan Action 2) and restore habitat through an aggressive ten-year acquisition and restoration program. The program's purpose would be to anchor a band of high-quality habitat on both sides of the river to support salmon rebuilding. A high priority should be put on restoring 10,000 acres of tidal wetlands and other key habitats to rebuild productivity in the lower 46 river miles (as more information is acquired, the target acreage will be revised). Federal agencies will provide key technical and financial assistance. Restoration priorities should include:

- Acquiring rights to diked lands and breach levees at these sites
- Improving wetlands and aquatic plant communities
- Enhancing moist soil and wooded wetland via better management of river flows
- Re-establishing flow patterns that have been altered by causeways
- Supplementing nutrient base by importing nutrient-rich sediments and large woody debris into the estuary
- Modifying abundance and distribution of predators by altering their habitat
- Creating wetland habitats in sand flats between the north and south channels
- Creating shallow channels in inter-tidal areas
- Enhancing connections between lakes, sloughs, side channels and the main channel

Objective: anchor habitat on both sides of the river to support salmon recovery, including 10,000 acres of tidal wetlands and other key habitats to rebuild productivity in the lower 46 river miles.
Leads: Corps (federal lead) and BPA, working with NMFS, USFWS and LCREP
Schedule: begin 2001, complete by 2011

D. Floodplain restoration. Remove structures that inhibit restoration of priority flood plain habitat; construct setback levees to protect important farmland and structures while partially restoring flood plain.

Leads: LCREP, FEMA working with state conservation districts
Schedule: 2001-2010

E. Predator control.

Lead agency: Corps, with USFWS, NPPC (research funding); State resource agencies
Objective: Significantly reduce Caspian tern and cormorant predation on salmonids.
Scope and Timing: Short term: preclude Caspian Tern nesting on Rice Island. Intermediate term: prevent tern nesting on disposal islands around Rice island and prevent cormorant use of Corps-maintained pile dikes. Long-term – disperse tern population to range of historic nesting in Pacific states.

G. Information management and public education: Build a major information management and public education initiative through the LCREP to focus on endangered species, habitat loss and restoration, biological diversity and human activities that impact the river.

Leads: LCREP-designated entity, with support from USFWS, NPS, NMFS, CORPS, Sea Grant, Marine and Environmental Research and Training Station, Columbia River Estuary Study Task Force
Schedule: 2001-2010

H. Science.

- Implement a major monitoring and research program to estuary ecosystem the estuary and evaluate the efficacy of management actions to rebuild the productivity of the system over the long term. (Mgt. Plan Action 28)

Leads: Federal and state science entities and LCREP, expanding on LCREP monitoring plan.
Schedule: 2001-2010

- Develop a conceptual model focusing on critical linkages between estuarine conditions and salmon population structure and resilience to assess estuarine influence on salmon populations in the Columbia River. The model will highlight linkages that are likely impacted by upper river hydropower and water management and identify information gaps that need to be addressed in developing recommendations for FCRPS management and operations. (Ongoing)

Lead agencies: NMFS, BPA
Objective: A model of critical linkages between estuary conditions and salmon population structure and resilience for the Columbia River system.
Scope and timing: 1999 - 2000
State support: Oregon Department of Fish and Wildlife, University of Washington
Other support: Oregon Graduate Institute of Science and Technology

3. Performance measures and monitoring and evaluation

The federal agencies will develop performance measures for these actions using a similar approach as outlined for tributaries (see section 5.2.2.2.B):

Three broad habitat characteristics limit species productivity in the estuary: (1) shallow water habitats in the tidal freshwater reaches of the estuary, (2) oligohaline areas of the estuary such as emergent forested marsh lands, tidal marsh lands, and tidal channels, and (3) connectivity and diversity of estuarine habitat. In the planning process (see 2.B, above), the agencies will work with non-federal partners to develop a more detailed description of the three habitat categories, focusing on their function and value to the survival and recovery of anadromous fish.

Performance measures linking changes in these characteristics to expected biological responses will be developed based on testable hypotheses. The hypotheses will help organize modeling and restoration work, and establish a framework for monitoring, evaluation and research. These hypotheses will relate to such matters as:

- Individual habitats whose characteristics support salmon productivity
- Physical and biological connections among functioning habitats to improve ecological value
- Diversity of habitats needed to support a full range of life history types in the estuary
- Flow requirements needed to support estuarine habitat for salmon.

Leads: Federal and state science entities, working in LCREP planning process described in 2.B, above.
Schedule: 2001-2002

Information from monitoring, evaluation and research developed in the 2.B planning process will provide information with which to measure progress, refine hypotheses and adjust habitat actions.

4. Coordination

Infrastructure for Implementation.

A. Inter-agency and inter-jurisdictional coordination: the Federal Habitat Team.

Clear, regular and predictable lines of coordination between federal natural resource agencies need to be established at the basin scale in order for federal efforts to interact productively with state, tribal and local habitat initiatives. There should be many opportunities to coordinate habitat initiatives to maximize their effectiveness. The federal agencies propose to ensure this coordination through a Federal Habitat Team. The team will ensure consistency among federal agencies and coordinate at the basin level with non-federal entities and programs. By proposing a basin-scale coordination arrangement, the federal agencies do not at all suggest that habitat

initiatives should be driven solely from the top down, however. Habitat recovery must also come from the watershed up. Effective habitat planning should integrate local, watershed thinking and basinwide goals and constraints. Federal agencies need to work together to communicate effectively with state and tribal governments at the basin-scale, and to develop ways to support local watershed efforts.

With this in mind, the federal agencies—the U. S. Forest Service, Bureau of Land Management, Bonneville Power Administration, National Marine Fisheries Service, Fish and Wildlife Service, Environmental Protection Agency, Bureau of Indian Affairs, Army Corps of Engineers and Bureau of Reclamation (and, if appropriate, the Natural Resource Conservation Service, the Farm Service Administration and U. S. Geological Survey)—propose to enter into a memorandum of agreement by December 2000, to accomplish the following functions:

Coordinate among federal agency habitat programs.

- Coordinate with those doing biological feasibility assessments (ESU by ESU and subbasin by subbasin) to achieve targeted improvements in salmonid habitat.
- Ensure that federal agency priorities are clear and that policies are interpreted in a consistent and coordinated manner.
- Facilitate ESA consultation.
- Coordinate budgeting among federal agencies to ensure efficiency and focus resources where they can best achieve targets.
- Ensure use of common watershed and subbasin assessment, planning, and monitoring and evaluation protocols.
- Provide for dispute resolution among federal agencies by, e.g., establishing a pool of respected agency and non-agency professionals, from which dispute resolution panels could be drawn.
- Link and share data: the federal agencies should facilitate the collection of habitat data for monitoring, ensure that it is supplied to parties responsible for monitoring and evaluation, and ensure its widespread availability.

Coordinate with nonfederal entities.

- At the basin scale, work with state, tribal and local governments and other entities in forums such as the Columbia Basin Forum and/or the Northwest Power Planning Council, and/or other forums that states and tribes prefer.
- Establish clear understandings with states and tribes regarding roles and responsibilities for executing the programs described above.
- Coordinate federal funding with non-federal budget processes, especially the Northwest Power Planning Council's prioritization process, the Bonneville fish and wildlife funding memorandum of agreement, and other budget mechanisms.
- Expand the availability of coordinated federal funding and technical support for local watershed programs.

- Ensure use and implementation of common watershed and subbasin assessment, planning, and monitoring and evaluation protocols.
- Streamline ESA and Clean Water Act compliance processes.

Support research, monitoring and evaluation. The federal agencies propose to ascertain and report federal agency progress in carrying out habitat initiatives, including the availability of resources and implications for the agencies' ability to carry out this strategy. These reports would also be geared to support long-term biological monitoring to assess the contribution of habitat improvements to improvements in population growth rates or other biological indicators.

Implementation. To accomplish this work, the federal agencies propose to dedicate senior staff with authority to carry out coordination functions, resolve implementation issues, and organize sub-groups to address technical implementation issues. This group would be aided by appropriate levels of financial and staff support.

Lead agency: Interior, NMFS, BPA
Objective: Develop memorandum of understanding by 2001.

Improving habitat in the lower Columbia River estuary on a broad scale presents a significant governmental and management challenge. To spark debate on the best way to manage the challenge, the federal agencies will consult with the states of Oregon and Washington and the Lower Columbia River Estuary Program to consider alternative means to structure, fund and manage a long-term habitat improvement action program. The agenda will include:

- Preparing a detailed list of tasks, with schedules and estimated costs
- Reviewing the responsibilities and authorities of agencies with jurisdiction and expertise, and preliminary identification of one or more lead entities
- Identifying gaps in structure and authority that must be addressed

Leads: *Ad hoc* group organized by LCREP, NMFS, Oregon and Washington
Schedule: Prepare and circulate a draft report for review by 2001

Analysis of Habitat Element:

1. Tributary subbasins.

The extensive program proposed for tributary habitat is premised on the idea that securing the health of these habitats will boost the productivity of listed stocks, in coordination with programs to address other "Hs." The available information tends to confirm the hypothesis that an effective habitat program could significantly improve tributary habitat productivity over the long term for all ESUs except Snake River fall chinook. A synopsis of this information follows.

Estimates of potential tributary habitat improvement provide a general idea of the range of possible improvement in freshwater habitat productivity from an effective habitat program such as would come from a well-executed subbasin and watershed assessment and planning process (which will include the estuary). The estimates in Table 4 were derived from the Northwest Power Planning Council's subbasin planning data. Table 4 shows the potential improvements in smolt production possible if habitat (as rated by subbasin planners) were improved from fair to good.

TABLE 4

ESU	Range of incremental increase in smolt production (%)
Snake River	0-80 (Sp/Summer Chinook) 0-35 (Steelhead)
Upper Columbia	47-78 (Spring chinook) 0-45 (Steelhead)
Middle Columbia Steelhead	1-36
Lower Columbia	0-46 (Chinook) 1-34 (Steelhead)
Upper Willamette	3-80 (Chinook) 4-41 (Steelhead)

To develop these estimates, we reviewed historic data from Fulton and the systematic survey of anadromous fish production capacity that was developed as part of the Northwest Power Planning Council System/Subbasin Planning effort in the late 1980's. We calculated the total smolt production in each subbasin rated by system/subbasin planners as "fair," and asked what the change in smolt production would be if those subbasins were improved and maintained to "good" through protection and restoration. We estimated the potential change in smolt production by multiplying the increment of smolt production currently rated "fair" by a factor of 1.8 (the ratio of smolt capacity rated "good" to that rated "fair"). The increment of improvement in smolt capacity divided by the original total for a subbasin is an estimate of the relative contribution of the improvement.

We then considered whether there were habitat measures that, by virtue of the relative significance of impact or spatial scale of distribution, were more likely than others to improve habitat productivity. A recent National Marine Fisheries Service study using a model called "SWAM," looked at correlations between chinook salmon spawner abundance and various watershed scale physical factors in the Salmon River Basin (Feist, et al.). The study shows positive correlations between salmon abundance and annual precipitation, ambient air temperature, and total area of naturally non-forested riparian vegetation. Abundance negatively correlated with human-influenced factors, particularly cattle grazing and water diversions. The study did not distinguish the importance of water diversions and grazing compared to natural factors such as geology. However, the study is consistent with the hypothesis suggested by the ecological evidence that grazing and water diversions tend to correlate negatively with salmon abundance.

The ecological evidence that grazing and water diversions tend to correlate negatively with salmon abundance comes from several sources:

Cattle grazing can reduce water quality by increasing nutrient loading, sediment delivery, water temperatures and reducing dissolved oxygen concentrations (Tiedemann and Higgins 1989, Platts 1991). Grazing-related impairment involves such things as increases in channel width and depth associated decreased bank stability, loss of gravel, increases in sediment, modification of channel form, and altered pool frequency and distribution (Duff 1977, Platts 1981). Cattle adversely impact hydrologic patterns by increasing overland and peak flows, increasing stream velocity, and lowering water tables (Kovalchik and Elmore 1992, Stevens et al. 1992). Ultimately, cattle grazing has adverse impacts on the diversity, composition, and productivity of aquatic and riparian dependent species and communities (Stuber 1985, Rinne 1988, Dudley and Embury 1995, references in Platts et al. 1999, Clary et al. 1999, Belsky et al. 1999).

Salmon resources are negatively affected by water withdrawals throughout the west (Nehlson et al. 1991). Water diversions were ranked as the second, behind water degradation, in relative importance of factors contributing to the decline of anadromous fish in California (Moyle 1994). Salmonids are similarly affected by water withdrawal throughout the Columbia River Basin. Early water diversions often blocked migrating salmon. Diversions usually lacked screens to keep juvenile fish from being diverted onto fields. Return flows warmed streams and loaded them with silt. In 1893, the Yakima River's temperature reached 60 degrees in the summer. In the summer of 1906, its flows had dropped from an average of 3900 to 105 cubic feet per second. Salmon declines were noticed in the Umatilla River in the 1870s and in the Deschutes in the 1880s. By 1892, much of the Umatilla was blocked to salmon migration. (Taylor, 1996). In areas of the Basin that could still be reached by salmon, irrigation diversions eliminated populations in the lower reaches of many tributaries like the Boise, John Day, Umatilla and Walla Walla rivers. (Independent Scientific Group 1996.) Salmon spawning runs in the Yakima, were drastically reduced from 1890 to 1905, a period of intensive development of irrigation (Sober et al. 1979). The Pacific Fishery Management Council (1985) identified irrigation diversions, in combination with dams and channelization, as reducing anadromous fish runs in the mainstem of the Snake and Grande Ronde Rivers. Low-flow problems now exist in many parts of the region east of the Cascade Mountains. Comprehensive data on streams that are dried up by water diversions are unavailable, but there is no reason to dispute the conclusion of the System Operation Review: "Most streams in the Pacific Northwest are fully or over appropriated." (Columbia River System Operation Review, November 1995.)

Quantitative relationships between grazing and salmonid population dynamics are few and primarily localized. Platts (in Chapman et al. 1991) states that in the Salmon River basin, streams in cattle-grazed meadows on average produce at least 35% less juvenile salmon than would be produced under natural ungrazed conditions. Salmonid biomasses in ungrazed stream reaches have been observed to be 250-400% higher than in grazed stream reaches (May and Somes 1981).

Similarly, quantitative relationships between instream flow characteristics and salmonid productivity have not been well defined. However, stream flow diversion in the upper Salmon

River Basin substantially reduced chinook salmon production capability (Chapman et al. 1991). Although direct estimates of increased salmon productivity in response to increase instream flows are not well developed, small-scale studies suggest that addressing impaired stream flows can increase salmonid populations. For example, Andrews et al. (1987) calculated an anticipated increase in annual smolt production of 120,000 smolts if instream flow conflicts in Alturas Creek were resolved. Increases in summer base stream flows of 50% have been proposed to increase effective pool and riffle area by 30% with a corresponding increase in fish production, particularly in coho, steelhead, and resident trout (Koning and Keeley, 1997). Where increased flows resulted in an increase in spawning gravel per unit area of stream, Keeley et al. (1996) predicted an average 8.5-fold increase in chum, pink, and sockeye salmon production.

Habitat effects related to water diversion and certain impacts associated with grazing affect mortality rates of salmon in a density-independent manner. De-watering a channel or generation of lethal water temperatures will eliminate virtually all fish inhabiting a stream reach. Therefore, correcting these types of problems should have a consistent, beneficial effect on salmon population performance regardless of the current population density. In the context of the empirical studies mentioned above, SWAM results suggest that reduction in water withdrawal and improved management of range systems are likely avenues for improving spawning and rearing habitat, presumably increasing spawner and juvenile densities. Immediate actions structured as management experiments have a high probability of both improving population performance and identifying and quantifying the causal relationships between these key land-use activities and salmon habitat quality.

The habitat program is crafted to respond to this information. In the Basinwide Salmon Recovery Plan, the agencies identified subbasins with significant amounts of habitat shown as "fair" in the subbasin planning data (where productive capacity could be increased by improving the habitat to "good" condition), significant amounts of strong federal habitat (an anchor for restoration efforts), and significant numbers of water diversions (where addressing flow, passage and screening problems could produce short-term benefits). The habitat program focuses on addressing water diversion-related problems in these subbasins in the short term because correcting such problems can be expected to produce the quickest results. Screening diversions, restoring water to depleted streams and removing passage barriers can improve habitat productivity relatively quickly. In contrast, reducing grazing is likely to manifest themselves over a much longer period of time as riparian vegetation grows back, channels reestablish themselves, water quality improves and other habitat factors repair themselves.

The longer-term strategy is aimed at extending the type of analysis that was done in the Salmon River Basin (Feist, et al.) to the basin as a whole through subbasin and watershed assessments, and undertaking finer-scale analysis. With those assessments, specific strategies can be designed for specific subbasins and watersheds. Given differences in the landscape, these strategies are likely to differ from those suggested in the Salmon River Basin. However, subbasin and watershed assessment and planning should lead to strategies that respond appropriately to conditions in particular areas. Moreover, the program calls for research, monitoring and evaluation to enable managers and policy makers to make mid-course

corrections. As initial assumptions about habitat potential are refined, and as experience with program effectiveness accrues, priorities and programs can be revised.

Performance standards and measures will play a critical role in assuring that the habitat program is properly focused and delivering expected benefits:

- Above, we make preliminary estimates of the potential to improve habitat productivity basinwide, and potential short-term effects of measures in priority subbasins.
- The All-H program identifies habitat attributes that can serve as performance measures: in-stream flows; amount and timing of sediment inputs to streams; riparian conditions that determine water quality, bank integrity, wood input and maintenance of channel complexity; and habitat access.
- The federal agencies, working with CRI, Watershed Process Program, and EDT analysts, will establish hypotheses regarding the effect of strategies and actions on these habitat attributes.
- The federal agencies will establish an initial set of performance standards for achievement of habitat attributes and for achievement of management actions (for example, standards for number of actions taken within a given time frame). Standards for habitat attributes will be described in terms of desired trends.
- Initial performance standards will be developed and refined through subbasin assessments and finer-scale analysis. Subbasin assessments will take advantage of available tools for evaluating habitat quality and quantity and salmon productivity, including EDT, HVSP and CRI analysis.
- Performance standards will be integrated into a monitoring and evaluation program that tests and improves measures and standards through targeted research, enables policy makers to evaluate and refine hypotheses, make adjustments to habitat measures, and make further decisions on the contribution of habitat protection and restoration to recovery.

2. The Estuary

The CRI and other analyses strongly suggest that significant opportunities exist for securing additional improvements in overall population trends by reducing the substantial mortality in the estuarine and early ocean life stages. Improving estuarine conditions has the added benefit of potentially benefiting all stocks within the Columbia River Basin. Studies in the Skagit River estuary tend to confirm the hypothesis that increasing estuarine habitat quantity and quality on the Columbia River would have a significantly positive effect on salmon survival. These studies, which involve subyearling chinook in the Skagit River in Washington, provide the only recent data with which to evaluate potential productivity increases from restoring estuarine habitat. The Skagit analysis suggests that estuarine habitat is an important bottleneck in the productive capacity of the Skagit system as a whole. There, for every hectare of high-quality estuarine habitat that may be restored, there is a projected increase of 22,000 smolts in the system's production overall -- a significant increase in survival.

All Columbia Basin salmon and steelhead pass through the estuary and are affected to some degree by conditions there. Humans have affected the Columbia and Skagit River habitats in a

similar manner. Restoration actions taken on the Columbia River estuary are likely to have similar benefits for salmon survival, although the magnitude of increase may be different from that predicted for the Skagit. Snake River fall chinook are likely to benefit more from estuarine restoration in because they spend more time in the estuary. It is unclear whether the potential for increasing high-quality habitat in the Columbia estuary is as significant as that in the Skagit. For these reasons, the program concludes that increasing estuarine habitat quantity and quality on the Columbia River will have a considerable but unquantifiable effect on survival of all Columbia basin ESUs. Further monitoring and evaluation will allow better quantification of benefits.

The estuary element of the habitat program aims to maximize improvements for listed ESUs by building on the existing program of the Lower Columbia River Estuary Program, concentrating and refining LCREP's focus on listed species, and expanding the program to target habitat types that are most likely to benefit listed ESUs. Performance standards will be developed through logic similar to that described in the tributary habitat section.

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2. Harvest Element of the Basinwide Salmon Recovery Strategy

Determining an appropriate harvest option poses difficult challenges. While it is intuitively obvious that killing fewer listed fish for any reason would be better, the strong runs targeted in fisheries are frequently intermingled with listed runs in the same fisheries. Thus, reductions in a fishery to save a few fish from weak stocks can mean foregoing the harvest of a great many fish from the stronger runs. Most of the harvest of Columbia Basin fish today occurs in treaty-protected tribal fisheries. Nevertheless, state, tribal, and federal fishery managers have been successful in recent years at implementing many harvest reforms to reduce what had historically been a chronic pattern of overfishing of weak stocks, such as discontinuing the formerly-widespread practice of managing mixed stock fisheries for hatchery fish. Where fisheries affect listed stocks, the states, tribes, and NMFS (using its authorities under the ESA) have imposed additional, even tighter restrictions to protect those stocks. The general thrust of the harvest option presented in the Basinwide Salmon Recovery Plan is to embrace the harvest reforms that have occurred and, to the extent possible, develop, test, and implement additional reforms where necessary and appropriate.

Harvest reductions produce immediate increases in spawning escapement, thereby reducing the near-term risks of extinction more quickly and certainly than other conservation measures. However, larger escapements have relatively little impact on the capacity of the environment to produce fish if that capacity has been reduced due to habitat degradation. Once chronic overfishing has been eliminated – as it largely has been – additional harvest reductions mainly buy time for management measures in the other H's to take effect. Based on our analysis, we have concluded that a large number of the listed natural stocks have a high risk of extinction. The harvest rates recommended herein are based on those conclusions and our best judgment about what the wild stocks can withstand.

Overall Approach

The recommended harvest option is to constrain harvest rates at recent levels and, in some cases, aggressively pursue opportunities to reduce them even further when doing so is necessary and effective for recovery. In mixed stock fisheries – places where natural and strong stocks are intermingled – the harvest rates must be based on the abundance of the weakest natural stocks or stock groupings, not on surplus hatchery or strong natural stocks. The harvest rate caps used to effectuate harvest constraints represent ceilings on the incidental harvest of listed stocks; they are not intended to represent catch entitlements nor to sanction any particular level of incidental harvest when lesser impacts are feasible and practical. Opportunities would continue to be identified, developed, and pursued to further reduce impacts on listed ESUs by, for example, developing alternative harvest methodologies that enable a broader range of selective fisheries.

Specifics of the recommended approach are described in subsequent sections separately for ocean and freshwater fisheries, reflecting differences in affected fisheries and ESUs. In general, the recommended approach most closely resembles "Option 2" from the December 1999 draft of

the Conceptual Recovery Plan. Ocean harvest levels would be set consistent with the new fishery regimes negotiated and approved in 1999 by the United States and Canada under the Pacific Salmon Treaty (PST). In the Columbia River mainstem and other freshwater fisheries, the harvest rate limitations approved under the ESA for the 1999 fall season and 2000 spring season fisheries would continue until such time as recovery efforts led to demonstrable improvements in the status of the listed ESUs. The many details associated with managing in-river fisheries consistent with these guidelines should be developed by the applicable parties within the *U.S. v Oregon* forum.

Although the measures described herein define the basic parameters applicable to the harvest sector, opportunities for reducing harvest rates even further for several of the listed ESUs should continue to be pursued in cooperation with relevant fishery managers. There is no doubt that it will take a number of years before recovery measures in the non-harvest sectors have fully borne fruit. Therefore, the most likely and immediate source of relief from tight harvest restrictions lies in achieving greater catch selectivity, either through use of more selective fishing gear or by expanding fishing opportunities in known-stock, terminal areas. Accordingly, the fishery managers and the FCRPS action agencies should work together to implement an aggressive program for identifying, developing and implementing such opportunities. An improved fishery monitoring and evaluation program to support an adaptive approach to harvest management will be a critical part of the program. Over time, those efforts should provide additional benefits both to listed species and fisheries. As recovery progresses, controlled and modest increases in harvest rates in years of greater abundance may be appropriate, provided the recovery effort is not unduly impeded.

Tribal harvest considerations

Any plan or policies affecting harvest must address the issue of tribal fishing. All fisheries, including tribal fisheries, have been severely reduced in the last several years. A significant portion, in some cases the majority of the remaining harvest of listed fish now occurs in tribal fisheries. Capping or further reducing harvest rates seriously impacts the exercise of tribal fishing rights; protecting those rights constitutes a national legal obligation overlying all actions affecting the fishery resource in the Columbia Basin. The federal government has a trust obligation to uphold and protect those rights. (See the section on Government to Government Discussions for a further description of the nature and importance of this obligation.)

The Basinwide Salmon Recovery Strategy attempts to balance the conservation of listed fish with the Federal government's trust obligation to provide meaningful tribal harvest, both today and in the future. Where tribal fishing is involved, we recommend accepting a level of risk that is greater than the biology might strictly imply. Specifically, some populations are at such critically low levels that biological analyses supports a strong argument that all harvest should be eliminated (e.g., Snake River spring/summer chinook; upper Columbia spring chinook). Nevertheless, the Basinwide Salmon Recovery Strategy recommends an acknowledgment that there is an "irreducible core" of tribal harvest that is so vital to the trust obligation that the federal government will not eliminate it. For other populations, the biological analysis shows they can withstand some level of harvest. When tribal fishing is involved in those cases, the

Basinwide Salmon Recovery Strategy again recommends allowing a level of tribal harvest that respects the trust obligation, even though it means tolerating some additional risk and/or slowing the pace of recovery. Additionally, the Basinwide Salmon Recovery Strategy recognizes the priority legal standing of the tribal fishing right; this is reflected in fishing regimes that result in tribal fishery impacts on listed fish being higher than in non-tribal fisheries. It is noted that in some situations, tribal catch could be substantially increased if the tribes were to expand their use of selective fishing methods.

It will no doubt be the focus of on-going government-to-government discussions between the tribes and the federal government to sort out whether the approach described herein successfully reconciles the near-term requirement for continued harvest restrictions with the Federal obligation to conserve the fish. Those discussions will require difficult decisions by all affected parties. Most importantly, they will require a great deal of additional patience and forbearance by the basin's tribes. Their willingness to offer more will depend in large part on how they perceive the region's commitment to restore the salmon resource, its efforts to provide fair and meaningful tribal fishing opportunities during the recovery period, and how it allocates the conservation burden.

Ocean Fisheries

Summary of ocean approach. The recommended approach for the ocean fisheries is to fully implement the recently negotiated agreement between the United States and Canada under the Pacific Salmon Treaty. It is assumed that U.S. commitments under that agreement are fully funded by Congress and it stays in place for the agreed period of time. The fishing regime for chinook salmon constrains the annual harvest in northern fisheries off Canada and Southeast Alaska based on the aggregate abundance of U.S. and Canadian chinook stocks. Fisheries off the coasts and in the rivers of Washington and Oregon are constrained by a "general obligation" that reduces the adult-equivalent mortality rate on depressed natural stocks in those fisheries by at least 40 percent relative to 1979-82 levels. Additionally, NMFS' jeopardy standard for Snake River fall chinook will continue to apply to ocean fisheries managed by the Pacific Fisheries Management Council (PFMC), thus ensuring at least a 30 percent reduction in overall ocean exploitation rates for that ESU, relative to the 1988-93 base years. A number of non-Columbia Basin weak stock constraints also can be expected to limit ocean fisheries off Washington and Oregon — sometimes more so than the PST general obligation or Snake River fall chinook jeopardy standard — for the foreseeable future. With these constraints in place, we do not foresee the need for additional management actions in ocean fisheries with respect to Columbia Basin stocks.

Discussion. Ocean exploitation rates on Snake River fall chinook have actually been reduced by an average of 38 percent since 1996; the expected reduction in 2000 is 42 percent, well in excess of the jeopardy standard for that ESU. The new PST regime, which represents the result of years of protracted negotiations between the United States and Canada, will be in place through the year 2008 (2010 for Fraser River sockeye), ensuring that ocean fisheries off Canada and Southeast Alaska also will be predictably and sufficiently constrained for many more years. Because Canadian fisheries are beyond U.S. jurisdiction, management actions taken in Canadian

fisheries are the result of negotiated bilateral agreements and/or additional actions decided by Canada. Fortuitously, Canada has taken decisive action in recent years to greatly reduce ocean fishery impacts — even more than required by the PST agreement — out of concern for its own stocks, and can reasonably be expected to continue doing so for the next several years. Because the new PST regime will expire before the recovery effort is complete, the parties will have to negotiate an extension to the current regime or a replacement regime at the appropriate time.

The new PST agreement was reviewed by the NMFS under section 7 for consistency with the ESA. In its biological opinion of November 1999, NMFS determined that the new PST agreement meets the requirements of the ESA.

ESU-specific discussion. Of the 12 Columbia Basin ESUs listed under the ESA, nine are not appreciably affected by ocean harvests. Those nine include the five steelhead ESUs (**Lower Columbia River, Upper Willamette River, Middle Columbia River, Upper Columbia River, and Snake River steelhead**); **Snake River sockeye**; **Columbia River chum**; **Upper Columbia River spring chinook**; and **Snake River spring/summer chinook**. This information is derived from an extensive time series of catch and stock composition data collected over many years, and most particularly from the coastwide coded wire tag (CWT) program. Literally millions of coded wire tags have been placed in salmonids from the Columbia River in the past three decades. Fisheries from California to Alaska have been routinely sampled to recover CWTs. These data support the conclusion that ocean fisheries have little or no effect on these nine ESUs. Additionally, catch data, run timing information, and other scientific information derived from various techniques such as genetic stock identification corroborate this conclusion. Because these ESUs are not appreciably affected by ocean fisheries, no significant improvement in population growth rates for the populations in these ESUs is likely to be feasible as a result of further constraints on ocean fisheries. Notwithstanding this conclusion, harvest monitoring programs should continue to ensure that fishery impacts are being fully accounted for in the data.

Three Columbia Basin ESUs — **Lower Columbia chinook, Upper Willamette chinook, and Snake River fall chinook** — are taken in significant numbers in ocean fisheries. Because migratory habits differ among these three ESUs, so do the fisheries that most affect them, as noted below.

Lower Columbia chinook are comprised of both spring stocks and fall "tule" and "bright" stocks. The tules are most significantly impacted in Canadian fisheries, particularly off the West Coast of Vancouver Island (WCVI), and in ocean fisheries off Washington State. The spring and bright stocks migrate farther north than do the tule stocks. Approximately 60 percent of the ocean catch of the Lower Columbia ESU is comprised of tule stocks taken in the Canadian troll and sport fisheries off WCVI and in fisheries managed by the Pacific Fisheries Management Council (PFMC). The other 40 percent is comprised of spring and bright stocks caught in the more northerly fisheries off Northern British Columbia and Southeast Alaska.

Under the new PST regime, the WCVI, Northern British Columbia, and Southeast Alaska ocean fisheries will be managed based on the aggregate abundance of chinook in those fisheries. Of these three fisheries, the WCVI fishery was by far the most sharply reduced and constrained by

the new PST agreement relative to previous regimes. This result was a primary objective of the U.S. in the treaty negotiations because that fishery greatly affects many listed U.S. stocks originating in both the Columbia Basin and Puget Sound. In addition, as noted above, Canada has taken decisive action in recent years to reduce its ocean fisheries even beyond what is required by the new PST agreement. These voluntary measures by Canada will provide very real benefits for Lower Columbia chinook and other listed U.S. salmon, including Puget Sound chinook.

In its biological opinion on the PST agreement, NMFS concluded that harvests allowed under the new chinook salmon regime, taking into account PFMC management, will not impede recovery of this ESU.

Upper Willamette chinook and **Snake River fall chinook** tend to migrate farther north than Lower Columbia chinook as a whole, appearing in ocean catches off Northern British Columbia and Southeast Alaska. While the Southeast Alaska and northern British Columbia fisheries were not reduced as much by the new PST agreement as the WCVI fishery, Upper Willamette and Snake River fall chinook will benefit substantially from the overall limits contained in the new agreement. The impact rate for these ESUs in the two northern PST fisheries will remain quite small, and certainly much reduced from the treaty's base period (1979-82) levels. The exploitation rate on SRF chinook in Southeast Alaska fisheries, for example, averaged about 4 percent for the years 1993-96; Willamette chinook were affected at similar or lesser rates. The overall impact on the Snake River fall chinook ESU in the total package of Alaskan and Canadian fisheries will be reduced and constrained significantly under the new PST agreement. Based on the analysis presented in NMFS' biological opinion on the PST agreement, harvest impacts at these lowered rates will not prevent recovery of these ESUs. The more recently-available CRI analysis concludes that the complete elimination of harvest for this ESU would result in a significant boost in its growth rate (a "lambda" well in excess of 1.0). However, recovery can be achieved with a less dramatic set of reductions in the various ocean and freshwater fisheries.

Like Lower Columbia chinook, the Upper Willamette chinook are expected to benefit substantially from changes in hatchery practices and concomitant changes in the harvest management regime, particularly in the freshwater fisheries. Due to their earlier migratory timing, Upper Willamette chinook tend not to be harvested much in the more southerly ocean fisheries; the great majority of harvest of these fish occurs in the mainstem of the Columbia and Willamette rivers. Oregon is now mass marking its hatchery chinook production in the Willamette and intends to move entirely to mark-selective recreational fisheries in the terminal area by the 2002 fishing season. As a result, Oregon expects that freshwater exploitation rates on Upper Willamette natural chinook will be reduced to 10 percent or less, a dramatic harvest reduction relative to previous levels that approached as high as 50 percent. This very significant reduction in harvest impacts is expected to result in a significant improvement in population growth rate, well in excess of that required to reduce extinction risk to less than 5 percent in 100 years, according to CRI analysis, and thus will contribute significantly to the overall recovery effort for this ESU.

Freshwater Fisheries

Selecting a preferred option for the freshwater fisheries presents particularly difficult choices for the Federal Caucus. On the one hand, in contrast to ocean fisheries, all of the listed ESUs are vulnerable to some extent to fisheries in the Columbia River mainstem. Many of the listed ESUs simply cannot withstand any significant harvest impact, especially given all the other factors likely to affect them for many more years. On the other hand, reductions in harvests were turned to first as the status of natural populations worsened and overall abundance began to decline in recent years. As a result, most fisheries within the Basin already have been repeatedly and severely reduced, so much so that today's fisheries reflect only a remnant of former fishing activity. As noted previously, most of the remaining fishery impacts occur in tribal fisheries, except for those ESUs originating below Bonneville Dam.

Summary of freshwater approach. The recommended approach for the freshwater fisheries would cap fishery harvest rates on the listed ESUs at levels no greater than those approved under the ESA for the 1999 fall and 2000 spring seasons. In all cases, management of fisheries must be keyed to the status of listed natural runs — employing weak stock management — as opposed to managing fisheries based on the aggregate abundance of hatchery and natural fish, or the abundance of intermingled but unrelated populations or ESUs. This will, in some cases, involve significant changes in the mechanisms used to set fishery harvest levels compared to those in the expired Columbia River Fish Management Plan.

It should be noted at the outset that adherence to harvest rate caps for listed natural fish will cause difficult challenges for the fisheries. The numbers of returning hatchery fish will vary significantly from year to year, often in unpredictable ways and even if the production of juveniles remains constant over time. Inevitably, there will be years when large numbers of hatchery fish return that are surplus to broodstock needs but which cannot be harvested in non-selective mixed stock fisheries. Nevertheless, there is no more important harvest reform than discontinuing the former practice of overfishing natural fish to fully harvest hatchery fish. Unless and until more effective selective fishing techniques are used, it will be difficult or impossible to fully realize the benefits of hatchery programs.

Fisheries in the Columbia Basin are generally divided for management purposes into a winter/spring/summer season (the "spring season") and a fall season, reflecting the timing of the various runs. What follows is a general description of how the fisheries would be managed under this approach, and the resulting impact on listed ESUs. As noted previously, the *U.S. v Oregon* parties should develop sufficiently detailed plans to implement this conservation-based approach.

Winter/Spring/Summer season ("spring season"). The spring season fisheries should continue to be limited to conservation level fisheries until such time as recovery efforts in the other sectors show demonstrable improvements in the status of the listed ESUs. Inter-annual variations, if any, in allowable harvest rates (stepped harvest rates) would be keyed to the status and abundance of listed natural-origin fish. The *U.S. v Oregon* managers should develop the

linkages between threshold escapement levels and annual variations in abundance. The overall harvest rate on Snake River and Upper Columbia spring chinook should continue to be capped at 6-9 percent, depending on the run sizes of the natural origin fish. These rates are intended primarily to accommodate a base level fishery for the tribes; thus the vast majority (if not all) of the harvest under this cap would occur in tribal fisheries. In past agreements the state and tribal parties envisioned even lower harvest levels for Snake River spring/summer chinook when the natural components of the ESU falls below certain levels. Because those features would provide additional benefits to the listed species, tribal and state managers should consider such reductions and also explore the feasibility of developing analogous natural stock escapement thresholds for Upper Columbia spring chinook. Impacts on the summer component of the Snake River spring/summer chinook ESU should continue to be substantially less, in the range of 2-3 percent, consistent with recent years' conservation level fisheries. These impacts would also occur primarily, if not entirely, in tribal fisheries.

The biological opinion for the spring 2000 fisheries focused on Snake River spring/summer, Upper Columbia spring, and Upper Willamette spring chinook ESUs as the fishery "driver" stocks. Going forward, tribal and state spring fisheries would continue to be managed actively and conservatively so as not to exceed the impact limits specified for these three ESUs in the biological opinion. For each of the several other ESUs that are incidentally harvested in the spring fisheries, but at lower rates than the driver stocks, the spring biological opinion set harvest rate caps at the upper range of recent years' levels. These caps were based on the assumptions that (1) the fisheries would be managed much as they had been in recent years, and (2) that actual impacts likely would be less in any given year than the upper end of the range. Even if the upper caps are reached, those rates would not jeopardize those species. The *U.S. v Oregon* parties should develop more detailed harvest plans to ensure that impacts on the co-mingled "non-driver" ESUs remain below the upper caps approved for the spring 2000 season and to provide for the possibility of new management approaches, such as selective fisheries, that may change the way the fisheries are managed.

Discussion. Already greatly constrained for decades due to the poor and declining status of upriver spring and summer chinook runs, the spring season fisheries were reduced further by a management agreement among the state, tribal, and Federal *U.S. v Oregon* parties after the Snake River spring/summer chinook listings. That agreement originally covered the 1996-98 seasons, then was extended through the 1999 season. For the 2000 season, despite repeated attempts, the *U.S. v Oregon* parties were unsuccessful in their attempts to reach an agreement for the spring fishery. NMFS analyzed the state and tribal proposals, concluding that the combined impact of the proposals for 2000 would jeopardize the continued existence of the Upper Columbia spring chinook and Snake River spring/summer chinook ESUs. For these reasons, NMFS concluded that a reasonable and prudent alternative to the proposed fisheries would be to limit the impact on Snake River and Upper Columbia spring chinook to 9 percent or less, given the forecasts for the 2000 runs.

Like NMFS' biological opinion on the spring fishery, this Basinwide Salmon Recovery Plan is strongly informed by recent CRI analysis. That analysis confirms that spring chinook ESUs are in extremely dire shape, having a substantial risk of extinction even in the near term. CRI also

confirms that harvest reductions taken in previous years substantially benefited these now-listed populations — in some cases probably preventing them from already becoming extinct. Given the low level of current fisheries, however, further reductions in spring fishery harvest rates would have relatively small, albeit potentially important effects on the growth rates of affected ESUs. On the other hand, because even modest increases in harvest rates could easily thwart the overall recovery effort, especially in the next several years and no matter what is done in the other Hs, it will be necessary to cap harvest rates in spring fisheries for some time, while continuing to seek and take advantage of any opportunities for further reductions in harvest rates. As stated previously, the success of this strategy in contributing to the recovery effort depends substantially on continued participation by the tribes. Because in all cases harvest rates limitations are expressed in terms of natural fish, the tribes could increase their total catch by employing greater selectivity to target hatchery fish in their fisheries.

Fall season fisheries. The fall season mainstem fisheries should continue to be limited by the existing jeopardy standard for Snake River fall chinook, which caps the in-river harvest rate on that ESU at a level 30 percent below the 1988-93 base period. The harvest rate on intermingled Snake River "B" run steelhead for the mainstem Columbia River fall fisheries should be capped for the 2000 season at no greater than 17 percent, as applied in 1999 and which then accommodated the minimal incidental impact needs of both the tribal and recreational mainstem fisheries. However, it must be noted that still-ongoing analysis of extinction risk for listed steelhead ESUs may well suggest that the 1999 harvest rate caps may be too high, and that reducing them may be necessary to achieve survival and recovery standards. Anticipating this eventuality, the general program noted previously for identifying and developing ways to further reducing incidental impacts on listed fish should prioritize its initial focus on the catch of "B" run steelhead during the fall season fisheries. No specific caps on other listed ESUs present in the fall fisheries is recommended at this time, based on the presumption that sufficient protection will be afforded those ESUs as long as the mainstem fisheries continue to be actively managed to stay within Snake River fall chinook and "B" run steelhead impact limits. The *U.S. v Oregon* parties are encouraged to develop harvest plans that ensure impacts on co-mingled listed ESUs will remain limited to the degree they currently are by the Snake River fall chinook and "B" run steelhead constraints. Such plans might address new management approaches, including selective fisheries, that may change the way the fisheries are structured and managed.

Discussion. NMFS' CRI analyzed the change in population growth rates that could be expected by changes in harvest rates relative to previous years. Not unexpectedly, the extent to which additional harvest reductions can contribute some more to the survival and recovery of a listed ESU depends on the how much it is still impacted in fisheries. The harvest rates on most listed ESUs have already been reduced significantly in recent years, so much so that in many cases little additional survival benefit would accrue even if fishing was discontinued everywhere. However, one ESU in particular, Snake River fall chinook, are still incidentally harvested at relatively high rates, albeit at much lower rates than prior to listing. Approximately 40-50 percent of the Snake River fall chinook are taken in the total of all fisheries, ocean and freshwater. These rates of impacts are not extraordinarily high for a healthy natural stock, or even one experiencing a temporary decline due to natural causes, but they are undeniably high for a listed stock. For this reason, the recommendation to continue to allow incidental harvest

rates at recent levels requires careful examination and justification in relation to the overall recovery effort for this ESU.

ESU-specific discussion. **Snake River fall chinook** survive and depend today on spawning habitat within a very small portion of their geographical range, which historically included the mainstem Snake River above Hells Canyon. Since construction of the Hells Canyon Dam, Snake River fall chinook have been blocked from about 80 percent of their historical range. Much of the remaining 20 percent of their historical habitat is now under reservoirs behind the four lower Snake River dams. As a result, naturally reproducing Snake River fall chinook today depend on relatively marginal habitats in a small segment of the Snake River below Hells Canyon and in colonized areas in the lower reaches of several Snake River tributaries.

The Snake River fall chinook ESU is comprised today of a single homogenous population; whatever population structure that may have existed historically was lost after construction of the dams. The population has been and continues to be routinely supplemented with hatchery production from the Lyons Ferry Hatchery. Besides providing a safety net for this ESU, the hatchery program serves as a biologically appropriate source of juveniles for release at off-station sites to supplement natural production. The supplementation program is scheduled to be expanded over the next several years into additional areas, such as the Clearwater River, as the Nez Perce Tribal Hatchery fall chinook program becomes operational.

Both the PATH and CRI analyses suggest that near term risks of extinction for Snake River fall chinook are relatively low in comparison with most other Columbia Basin listed ESUs. CRI suggests the likelihood of extinction in the long term for this ESU is largely dependent on assumptions relating to spawning effectiveness of hatchery fish. Even considering the worst-case hatchery fish assumption, the risk of extinction could be reduced target levels with a relatively modest increase in the average annual growth rate, a change that could be achieved either by breaching or by additional cuts in the harvest rates. As noted earlier, recent CRI analysis concludes that the complete elimination of harvest for this ESU would result in a significant boost in its growth rate (a "lambda," or average population growth rate, well in excess of 1.0). However, it must be considered that the substantial majority of the remaining incidental harvest of this ESU occurs in the fall season mainstem tribal fishery, and that such dramatic reductions may not be necessary for recovery.

The lack of remedy to the principal cause of the current status of Snake River fall chinook — blockage from its historical range and thus most of the suitable fall chinook spawning habitat — should be taken into account in determining which of several possible combinations of recovery options is appropriate. For many of the other ESUs, it can be argued that additional reductions in harvest impacts will help prevent extinctions and thereby buy sufficient time for the other efforts to recover the ESU to take effect and restore the ESU to naturally-sustainable, productive levels. Indeed, that is the principal underlying rationale for continuing the harvest constraints articulated throughout this Basinwide Salmon Recovery Plan. However, there is relatively little immediate risk of extinction for the Snake River fall chinook under current conditions, and none of the recommended habitat measures, nor any changes in operation of the FCRPS short of breaching, will result in significant increases in the basic productivity of Snake River fall chinook.

A number of additional points should be noted. The benefits of actions taken in the last few years to improve juvenile Snake River fall chinook survival rates during downstream migration have not been fully realized and are not yet fully reflected in the CRI's analysis of the status of the ESU. Similarly, the benefits of recently revised ocean and in-river fisheries regimes may not yet be fully reflected. Indeed, those actions may have already increased the population growth rate sufficiently to meet extinction risk and recovery standards. Still on-going discussions to secure additional flows from the upper Snake may also provide additional benefits for this ESU and others.

The Federal Caucus is cognizant of the ramifications of its recommended option, including the fact that it may involve accepting a certain increment of additional risk. However, that increment of additional risk is really quite low, especially in the near term. Considering the severe impact that further reductions in SRF impacts would have on the mainstem tribal fishery, the Caucus believes that a small increment of additional risk is justified in this case. Accordingly, the Caucus recommends that the 1999 fall season constraints be continued, coupled with carefully planned supplementation programs. These measures, intended to stabilize the population at or above current numbers, would be continued the next 8-10 years or until such time as there is an appreciable change in either the status of this ESU, its productivity, or the habitat available to it.

Snake River, Upper Columbia River, Middle Columbia River, and Lower Columbia River steelhead ESUs. The Snake River fall chinook limit likely will be most constraining on the mainstem fall season tribal fishery in most years, so the actual impact rate on intermingled steelhead ESUs will be substantially less than the 17 percent limit specified herein as the initial cap on harvest rates for the "B" run component of the Snake River steelhead ESU. In 1999, for example, the actual impact rate on "Bs" was estimated at about 10 percent and 1-2 percent in the mainstem tribal and non-tribal fisheries, respectively. Resulting harvest rates on "A" run summer steelhead, which comprise the other component of the Snake River steelhead ESU as well as all the other listed ESUs in this fishery, are generally substantially lower than the "B" run harvest rates, on the order of 1-7 percent in 1999 depending on the ESU, because of their earlier timing and smaller size. Recently agreed measures designed to further reduce steelhead impacts, notably including the use of larger mesh gill nets in the tribes' fall season fishery, should lower steelhead impact rates even further. Nevertheless, CRI analysis concludes that the extinction risk is unacceptably high for these ESUs, and that lower harvest rates on steelhead may be needed. A lower harvest rate would not necessarily constrain the fall chinook fishery if effective selective harvest methods are adopted. Impact rates in tributary recreational fisheries, already managed as mark-selective fisheries targeting hatchery fish, should continue to be capped at recent levels, estimated to be less than two percent for natural steelhead, and verified by additional monitoring and evaluation studies.

Selective Fishing

Selective fishing provides a means to further reduce harvest rates on listed ESUs while preserving and/or expanding harvest opportunities. For this reason, selective fishing is

emphasized throughout the Basinwide Salmon Recovery Plan, not only as a "bridging" strategy during the recovery period, but also as a key to healthy and sustainable fisheries in the future. Once the status of currently listed natural stocks is clearly improved, non-selective mixed stock fishery constraints could be relaxed somewhat. Nevertheless, there will always be some stocks, particularly hatchery stocks, that can sustain higher harvest rates than others. Accordingly, the recommended harvest option includes the vigorous identification, development, application and expansion of new as well as traditional selective harvest methods and opportunities. These should be pursued with an appropriate balance between both of two objectives in mind: (1) further reducing incidental impacts on listed species, and (2) allowing increases in the harvest of abundant stocks, particularly hatchery stocks, in ways that have little or no impact on listed species.

As used here, "selective fishing" is a generic term that encompasses a broad range of harvest methods and management strategies. Within this range are at least three categories, in roughly ascending order of unrealized conservation potential: time selectivity; area selectivity; and gear selectivity with visual sorting.

Time selectivity. This is the simple notion underlying fishing seasons. The idea is to open the fishery when the target fish are present, but to close it when depressed (i.e., listed) fish comprise a pre-defined portion of the catch. Long a staple tool of fish managers, the potential for additional benefits to listed fish using this approach is likely to be very limited, both in the ocean and the mainstem Columbia.

Area selectivity. Fisheries can be located in areas that minimize the harvest of non-target stocks to the extent possible, subject to various constraints like mobility (e.g., tribal usual and accustomed fishing areas), jurisdictional constraints, and flesh quality (market demand) of the catch. Terminal fisheries can be used in some cases to provide alternative harvest opportunities to mixed stock fisheries. The general trend in recent years has been to lower harvest rates in mixed stock fisheries, resulting in lower ocean catches and, in some cases, increased availability of fish in terminal areas. Now, however, even many of the areas once considered terminal areas have been found to significantly impact listed fish. Relatively few unutilized opportunities exist to move existing fisheries or provide alternative fishing areas, but those that do exist should be identified and developed, especially given the need to provide meaningful tribal fishery opportunities. Significant potential benefit could accrue to some listed stocks by moving some of the remaining in- river fisheries out of the mainstem (e.g., commercial fisheries to "Select Areas;" sport fisheries out of the Columbia and into the Willamette); and/or providing tribal fishing opportunities at Hanford Reach and/or in suitable tributaries. Such opportunities will be limited also by cultural, legal, and economic considerations.

Gear selectivity, visual sorting, and mark-selective fisheries. The general idea here is to use gear types that tend to catch fish without killing them or that catch only certain types or sizes of fish. Catching fish without killing them makes it possible to release non-targeted fish. A number of different techniques already exist, such as using certain gill net mesh sizes that catch one species rather than another, or by sinking gill nets below the water surface, thereby lowering encounter rates with species like steelhead that tend to swim near the surface. Recently, the BPA provided

funding to tribes for larger mesh gill nets for their fall season fishery to reduce impacts on steelhead, which are smaller than the chinook being targeted by the fishery. Additional opportunities may exist to expand this program, at relatively modest cost. Note, however, that some of these kinds of approaches can be biologically counterproductive over time, for example, by selectively removing the oldest, largest, and most fecund fish from the spawning populations. Other potentially promising approaches include the expanded use of tangle nets, beach seines, fish wheels, or other live-capture methods that enable sorting of live fish and the release of unmarked fish or natural fish and/or non-targeted species. In some cases, institutional barriers must be overcome, such as regulations that prohibit the use of certain types of gear, like beach seines and traps.

The most promising potential, the one gaining most of the recent attention, involves **mark-selective fisheries**. These fisheries combine the use of live-capture gear with the ability to visually discriminate between natural fish and hatchery fish. Before they are released as juveniles, hatchery fish can be marked, usually by removal of their adipose fin, allowing them to be identified as hatchery fish after they have grown and are caught in a fishery. This strategy has been used successfully for many years to enable selective freshwater fisheries for steelhead, and increasingly is being used for coho salmon in both freshwater and mixed-stock marine areas. Mass marking of all hatchery fish formerly was prohibitively expensive because of the high labor costs involved, especially for species released at very small sizes or in very large numbers. Now, the technology exists to mechanize the marking process, making it much more efficient and cost effective. Although the primarily focus has been on hook-and-line sport fisheries, the concept can be applied to any fishery that uses non-lethal gear.

Mass marking and mark-selective fisheries are not without problems, however. For nearly three decades, fishery managers coastwide agreed to "sequester" the adipose fin clip. This meant that any fish that had its adipose fin removed was also carrying an internal binary coded-wire tag (CWT). By recovering and reading these tags, fishery managers and researchers could determine the survival rates, migratory patterns, timing, and a wealth of other stock specific, fishery specific, and hatchery specific information. Millions of these tags have been released and recovered over the years, providing data that now forms the informational backbone of fishery management and stock assessment programs coastwide. Maintaining the viability of the CWT program is an international commitment embodied in the Pacific Salmon Treaty. In the last few years, however, most fish produced in hatcheries have had the adipose fin removed for the purposes of monitoring hatchery straying and enabling selective fisheries, not simply to signify the presence of a CWT. Now, fish caught with a missing adipose fin may or may not have a CWT in it. Determining which fish carry CWTs requires the use of electronic detection devices and a whole new fishery catch sampling scheme. Furthermore, the statistical viability of the original CWT program relied on the assumption of randomness – a fish with a CWT was no more or less likely to be killed in a fishery than one without the tag. A selective fishery, by definition, is non-random. Consequently, the ability of the CWT program to provide statistically reliable fishery and stock specific information is threatened. A number of new and promising statistical and modeling techniques are under development to address these problems, but they have not yet been fully solved, particularly for chinook fisheries in mixed stock marine fisheries. Fisheries that occur in terminal and freshwater areas pose relatively fewer problems.

Besides the sampling and statistical problems, selective fisheries can result in significant incidental mortalities on the unmarked fish that are caught and released. This is particularly a problem in marine areas for long-lived species like chinook salmon that are vulnerable to multiple captures and releases, or fisheries occurring in freshwater areas with elevated water temperatures. Costs for mass marking and electronic detection sampling programs are high, in the millions of dollars annually.

Despite these complications, mass marking and selective mark fisheries present very promising opportunities to both reduce fishery impacts on listed salmon and the chance to preserve or increase fishery benefits. Accordingly, the Basinwide Salmon Recovery Plan recommends an intensive effort and sufficient funding to expand the use of selective fisheries in the recovery effort. Additionally, the fishery managers should work with the hydrosystem operators (including the FCRPS) to develop positive incentive-based approaches to harvest management. Such approaches could better align the interests of the fisheries in catching fish with the interest of the hydrosystem in achieving offsite survival benefits for listed fish. Mechanisms should be developed that credit reductions in incidental fishery mortality on listed fish toward both the objective of reducing fishery impacts on listed fish and the objective of increasing the total catch of unlisted fish in the fishery. As an example, the new Pacific Salmon Treaty Agreement has a mechanism whereby reductions in incidental mortalities can be divided between the fishery and the escapement from that fishery, i.e., half the savings can be used by the fishery to increase its total catch, and half can be used to reduce total mortality. Analogous mechanisms could be developed for Columbia Basin fisheries.

Potential Additional Harvest Reforms

As noted previously, the basic approach to harvest recommended in the Basinwide Salmon Recovery Plan is to rely on a set of harvest rate limits in extant fisheries that impact listed stocks until such time as their status is improved. Meanwhile, it is also recommended that fishery managers consider and/or develop other potential and innovative opportunities for further reducing harvest impacts on listed fish while improving harvest opportunities. In addition to expanding selective fisheries as discussed above, a menu of potential additional options might include, but may not be limited to, commercial fishing license buy-backs; fishery conservation easements, commercial catch price enhancements and improved marketing of fish and fish products. The Federal Caucus recommends that NMFS facilitate discussions among the fishery mangers and the FCRPS action agencies, for example, to explore these opportunities.

Performance Measures

The harvest rate constraints described in the Basinwide Salmon Recovery Strategy for each fishery group (ocean and freshwater) comprise the performance measures for harvest. For some listed ESUs, a specific harvest rate cap is identified for a particular set of fisheries. For example, the “southern” U.S. ocean fisheries and the in-river fall season fishery are to be managed so as not to exceed the established jeopardy limits for Snake River fall chinook. For all chinook, ocean fisheries must also be managed in compliance with the new Pacific Salmon Treaty regime,

which constitutes a set of calculable, stock-specific harvest constraints. Southern U.S. ocean fisheries must comply with the Magnuson-Stevens Fisheries Management and Conservation Act and the adopted Fishery Management Plan covering salmon fisheries off Washington, Oregon, and California, as well as with biological opinions issued by NMFS. For both ocean and in-river fisheries, existing fishery management institutions annually provide reports that contain the metrics used to assess performance relative to the recommendations in the Basinwide Salmon Recovery Strategy.

Implementation

Except as noted, implementation of the harvest measures identified in this document will occur primarily through a number of existing harvest management fora that have significant federal participation (NMFS and USFWS) at both the policy and technical levels. For ocean fisheries off British Columbia and Southeast Alaska, the primary forum is the Pacific Salmon Commission (PSC), created by the Pacific Salmon Treaty. The PSC oversees implementation of the agreed ocean fishery regimes by the two countries through their respective domestic management agencies. One of the four United States representatives on the Commission represents the U.S. federal government; the other three represent the treaty tribes, Alaska, and Washington/Oregon. The actual regulations for ocean fisheries in U.S. waters off Washington, Oregon, and California are developed annually by the Pacific Fisheries Management Council, created pursuant to the Magnuson-Stevens Fisheries Management and Conservation Act. The Council includes, as a permanent member, the Regional Administrator of the NMFS. The Council's recommendations are promulgated by the Secretary of Commerce, provided they are consistent with approved fishery management plans and "other applicable federal law," which in this case certainly includes the ESA. Fisheries on the Columbia River mainstem are managed within the *U.S. v Oregon* framework.. Both NMFS and USFWS participate as the federal parties in that forum. Finally, the NMFS and/or the USFWS must issue biological opinions and incidental take permits pursuant to the ESA for any proposed fishery that may affect one or more listed species.

Through its role in these various fora and processes, NMFS has the opportunity and authorities necessary to advocate harvest regimes and regulations consistent with the recommendations in the Basinwide Salmon Recovery Strategy and recovery plans. In most cases, this will mean ensuring that incidental fishery harvest rates on listed stocks contained in annual fishery management plans are consistent with the ESA. Additionally, NMFS will also participate in these fora to identify and pursue various additional harvest reforms and alternative harvest opportunities, activities that may require federal resources for implementation. Harvest-related activities will be coordinated with the Federal Caucus to ensure that they are complementary and consistent with the overall recovery effort. As additional harvest reforms are identified and implemented that provide survival benefits to listed fish beyond the identified performance measures (caps), these will reported through the Caucus structure.

3. Hatchery Element of the Basinwide Salmon Recovery Strategy

Overview

An extensive amount of artificial production of salmon and steelhead occurs in the Columbia River Basin today. Many hatchery programs started decades ago specifically to replace natural production lost as a result of the FCRPS and other development, not to protect and rebuild natural populations. The original design and operation of many programs and facilities reflect scientific knowledge and policy decisions of a previous era. Traditionally, the objective of those hatchery programs was to provide harvest opportunities, a mitigation obligation that remains today. Most were never called upon to produce fish that are viable in nature. To a large degree, the programs succeeded in producing harvestable salmon and steelhead to maintain fisheries even as natural production declined.

In more recent years, the importance of natural populations and the potential negative effects of hatcheries have became better understood, and are reflected in changing policies. Many artificial production reforms have been implemented, reforms that strive to reduce negative effects of hatchery production on natural populations while retaining its proven production and potential conservation benefits. For example, hatchery programs throughout the region are in the process of or have already completed phasing out use of improper brood stocks, such as out-of-basin or out-of-ESU stocks, replacing them with fish derived from or more compatible with locally-adapted populations. Producing fish that are better suited for survival in the wild is the explicit objective of programs such as the Yakama Nation's Cle Elum hatchery. Many programs incorporate improved production techniques, such as the NATURES rearing program utilized by the Nez Perce Tribe. The basic thrust of many of these reforms has been to produce fish that pose less risk to natural populations, either by minimizing interactions with natural populations or making hatchery fish more compatible with them.

Nevertheless, it is recognized that recovery cannot be achieved simply by releasing more hatchery-produced fish in natural production areas, regardless of their ancestry or how well they are produced. Hatcheries cannot provide the productive conditions necessary to restore self-sustaining populations in their natural habitats.

Hatchery Reform

Hatchery reform is an undertaking that began several years ago when the deleterious effects of hatcheries became better understood. Much has been accomplished in recent years to eliminate the most egregious of the historical practices. However, it is also recognized that some artificial programs and facilities could be further reformed because they still have deleterious effects on natural populations and/or mask their status. The overarching goal of the reforms called for here is to reduce or eliminate adverse genetic, ecological, and management effects of artificial production on natural production while retaining and enhancing the potential of hatcheries to

contribute to basin wide objectives for conservation and recovery. The goal still includes providing fishery benefits to achieve mitigation mandates, but now must also incorporate an increased emphasis on conservation and recovery, a mission for which many older programs were not designed.

Reforms of existing hatchery programs and facilities that began several years ago must be accelerated and broadened to apply a variety of new and improved artificial production techniques that include supplementation, captive brood stock, and other strategies designed to minimize the risk of artificial production and/or maximize its conservation benefits. These reforms require substantial and costly changes in existing programs and facilities, beginning with a rigorous review of their goals and objectives. An implicit but fundamental premise of the approach recommended by the Federal Caucus is that artificial production programs can be operated consistent with, and complementary to the goals of the ESA while still achieving fishery mitigation objectives. Because there exists a range of scientific and policy opinions regarding the purpose and appropriate application of artificial production in specific circumstances, a variety of strategies, coupled with an adaptive management approach is warranted and recommended.

In applying the ESA to listed species, NMFS focuses on biological requirements, deriving its information from many sources, including the general conservation literature, specific studies of salmon by NMFS and others, and recommendations of the tribes, state, and other federal fish and wildlife agencies and experts. NMFS recently published a compilation of scientific information in "Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units" (McElhany et al. 2000). This "VSP" document identifies criteria and guidelines relevant to the needs of salmonid populations. Hatchery programs can affect these biological needs. Accordingly, subsequent to the listings, NMFS began to address these programs in biological opinions issued or still in progress under sections 7 and 10 of the ESA for hatchery programs throughout the Basin. In those biological opinions, as in this one, NMFS focuses on reducing the deleterious effects of artificial production on listed species. Deleterious effects must be eliminated or sufficiently reduced to avoid jeopardizing listed species and provide for their survival and recovery. NMFS' biological opinions, as well as the findings by state and tribal co-managers, have led to substantial changes in the conduct of artificial production programs throughout the region.

A number of studies and reviews of artificial production in the Columbia Basin have occurred in recent years; some are described below. Although their scope varies, their findings and recommendations regarding artificial production are generally quite consistent, and inform the measures recommended here. In general, the standards and guidelines that emerge from these reviews are aimed at improving the effectiveness of artificial production programs, minimizing deleterious impacts on natural populations, meshing hatchery production and policies with harvest objectives, and increasing accountability and efficiency in hatchery programs. Integrating hatchery and harvest policies is especially important to meeting obligations for tribal and non-tribal fisheries.

Some of the recent studies that result in hatchery reform recommendations include the Northwest Power Planning Council's (NPPC) Artificial Production Review (APR), several scientific reviews such as the National Research Council's (NRC) Upstream report and the NPPC's Return to the River report, and others found in the published literature. NMFS has published several papers relevant to artificial production, including the Interim Policy on Artificial Propagation of Pacific Salmon under the Endangered Species Act (April 5, 1993, 58 FR 17573), and the previously mentioned Viable Salmonid Populations report. In general, these studies reach similar conclusions about the types of reforms necessary to reduce deleterious effects while still allowing continued use of hatchery production to provide tribal and non-tribal harvest opportunities.

The detrimental impacts of artificial production can be categorized into 1) genetic effects resulting from domestication, artificial selection, inbreeding, straying, and stock transfers; 2) ecological interactions such as competition and predation; and 3) management effects, such as occurs when fisheries are managed at high rates to take hatchery fish, resulting in excess harvest of natural fish. In addition, there is the masking effect of hatchery fish that confounds the ability to determine the status of natural populations. While many hatchery reforms have been or are in the process of being implemented, there remains much that can be done.

From these and other recent studies, a fairly extensive menu of measures has been identified and specific actions to implement the measures have emerged. This does not imply that they are all "ready to go." In fact, the process of hatchery reform involves a systematic review, program-by-program and hatchery-by-hatchery to determine on a case-by-case basis which of the measures and actions apply and when and how they should be implemented. The actual implementation of these measures and actions, whether they involve capital expenditures, operation and maintenance improvements, staffing, and/or other matters constitutes what is meant by artificial production "reform." Efforts to apply these reforms, already underway in many cases, must be expanded and accelerated to programs and facilities throughout the basin to aid in the recovery effort. Hatchery reform should occur within a broader context of planning in the basin designed to clarify goals, objectives, and performance criteria of a basin wide approach for all species to improve accountability and effectiveness. This broader approach includes the development of subbasin plans for management of all species and recovery plans for listed species. They will include, among other things a better integration of hatcheries and harvest objectives and strategies. The menu of reform measures and actions is represented in the following list:

Reform measures to clarify the goals, objectives, and performance criteria of hatchery programs to improve accountability and meet subbasin and recovery plan objectives:

- Develop, clearly articulate, and commit to specific artificial propagation plans.
- Identify and implement specific monitoring and evaluation protocols at all relevant scales (i.e. varying from basinwide to facility-specific).
- Apply adaptive management principles by linking future activities to research, monitoring and evaluation outcomes.

Reform measures to manage genetic risks to listed species and meet subbasin and recovery plan

objectives:

- Discontinue inter-basin transfers of stocks.
- Phase out inbred, domesticated, and inappropriate composite broodstocks.
- Produce fish derived from locally adapted stocks to the extent feasible and appropriate.
- Employ mating protocols designed to avoid genetic divergence from the biologically appropriate population.
- Manage the number of hatchery-produced fish that escape to spawn naturally, employing limits that will vary depending on the origin of the broodstock, the management objective, and the status of the affected natural populations.
- Employ hatchery practices that reduce unwanted straying of hatchery fish, for example by acclimating them to desired return areas.

Reform measures to manage ecological risks to natural populations and meet subbasin and recovery plan objectives:

- Minimize competition between hatchery and natural fish, for example by avoiding production that exceeds the carrying capacity of limiting habitats.
- Minimize predation and other negative interactions between hatchery and natural fish by, for example, producing fish similar in size, behavior and life history characteristics to the naturally produced fish in the same waters.

Reform measures to improve hatchery effectiveness and meet subbasin and recovery plan objectives:

- Design hatchery facilities to mimic natural incubation and rearing conditions.
- Design facilities for acclimation and release of smolts to improve homing fidelity.

Reform measures to avoid management risks associated with hatchery production and meet subbasin and recovery plan objectives:

- Design, implement, monitor, and evaluate the hatchery program consistent with a comprehensive restoration plan.
- Design and conduct fishery augmentation programs so fish can be harvested without undue impacts on weaker runs.
- Mark hatchery-produced fish to distinguish natural from hatchery fish on spawning grounds, in dam counts and in fisheries.

To facilitate the application of hatchery reforms to specific artificial production programs and projects, fishery managers employ what is called a Hatchery and Genetic Management Plan (HGMP). The HGMP was developed by federal, tribal, and state agencies. It provides a standardized planning approach and consistent body of relevant information about artificial production programs. It contains a clear statement of the purpose and goals of the program or project and its relationship to harvest and other management goals. It comprehensively addresses facility and operational details relevant to reform measures and action items identified above. It requires that an appropriate monitoring and evaluation plan encompassing relevant performance indicators be developed and implemented for that facility or program. Research critical to the success of the project must also be identified.

NMFS considers an approved HGMP to be a necessary step in assessing artificial propagation programs, relying upon it in its application of the ESA. It is anticipated that HGMPs will evolve over time into more comprehensive and detailed documents as additional focus and resources are brought to bear on hatchery reform and as new information becomes available.

The development of approved HGMPs is a substantial task that must be completed before many actual reforms can be implemented. Priority should be assigned to circumstances that affect populations in the most critical condition. Additionally, the process of hatchery reform does not end with a completed HGMP. Rather, hatchery reform will be a continuing process of implementing, monitoring, evaluating, and revising the HGMP plans.

Scientific knowledge regarding the benefits and risks of artificial production is incomplete, but improving. Artificial production measures have proven effective in many cases at alleviating near-term extinction risks, yet the potential long-term benefits of artificial production as a recovery tool are unclear. Scientific uncertainty remains about whether and to what extent hatcheries, as they are currently operated reflecting several years of reforms, pose a continuing risk to natural populations. The Federal Caucus recommends additional investments in research, monitoring and evaluation to address these uncertainties, investments that may eventually manifest themselves in improved survival of listed fish.

CRI has especially highlighted the need to enable differentiation between hatchery and naturally produced salmon. Uncertainty about the number of hatchery-origin versus natural-origin fish on the spawning grounds confounds our ability to assess and monitor natural population status and growth rates. This masking problem can be addressed by marking hatchery production, but must also include improved sampling efforts, and specific experiments (e.g. radio tagging) to determine relative distribution and timing of hatchery and natural spawners. It is most urgent to mark the most at-risk species such as spring chinook and steelhead.

“Safety Net” and Conservation Hatchery Activities

A number of salmon and steelhead populations in the upper Columbia and Snake River Basins are at particularly depressed levels, with many facing high risk of extinction in the near term. For many of these, new “safety-net” and other kinds of conservation hatchery projects designed to intervene with artificial production techniques may be appropriate to prevent extinction and arrest further decline. Safety-net and conservation hatchery projects may be as intensely intrusive as the Stanley Basin sockeye recovery program, which anticipated taking the entire population into a captive broodstock program for several years. Others may involve short-term interventions for one or two generations using more conventional artificial propagation methods such as supplementation, using appropriate brood stocks. Preferably, intervention would occur before a population declines to the point that highly intrusive techniques are necessary. Supplementation and other conservation projects should not be viewed as permanent, as they do not serve as a substitute for addressing the factors of decline.

To address the most at-risk populations urgently in need of new safety-net actions, the Federal Caucus recommends that a four-step process be followed, starting with an extinction risk analysis to identify populations that are candidates for intervention. Second, intervention options should be developed and a proposed strategy outlined. Third, a benefit-risk analysis for the proposed strategy should be conducted to determine whether intervention is warranted. Fourth, an HGMP should be developed to guide implementation of the safety-net project.

The very nature of the safety-net concept is such that the planning process needs to be conducted on an accelerated basis so that, if warranted, the project can be implemented expeditiously. The planning process will necessarily rely on available information that will vary significantly between populations and species. The purpose of the safety-net program will not be achieved, and additional populations may go extinct, if the process suffers from excessive delay, or awaits additional information that simply may not exist or be available for some time.

A factor that clearly will affect the scope of the safety-net program over time is future environmental conditions, especially ocean conditions. If environmental conditions improve significantly, the number of populations needing safety-net interventions will decrease. Alternatively, if environmental conditions remain poor or worsen, then more populations will require intervention to arrest further decline in abundance. Given the high costs involved, and the uncertainty over future environmental conditions, and the considerable uncertainty of the benefits and risks of intervention, the safety-net approach necessarily and appropriately will involve a mix of strategies. Some projects should begin as soon as possible while others would not occur unless populations continued to decline.

Additional work is needed to identify candidates for the safety-net program; several initial candidates located in the Snake River are identified in the FCRPS biological opinion. Some already have been started, albeit with insufficient resources; the Federal Caucus recommends the cost of these programs be augmented by the FCRPS Action Agencies. Some of the currently most at-risk populations are in the upper Columbia River; the immediate safety-net needs in that area are and should continue to be addressed pursuant to existing and planned processes tied to non-FCRPS mitigation programs, including the Mid-Columbia PUDs. The need for additional safety net actions in any part of the Columbia and Snake River basins will on assessments of population status that should be ongoing.

PERFORMANCE OBJECTIVES for Hatcheries:

Performance objectives and standards should be established for hatcheries and incorporated in approved HGMPs. Following is an initial list of performance objectives and standards that the Federal Caucus recommends be applied to artificial production programs:

1. GENETIC INTROGRESSION: Local, within-ESU broodstock is utilized in all propagation programs within Critical Habitat, unless associated with an “Isolated” program. Hatchery broodstocks used in supplementation programs represent the genetic and life-history characteristics of the natural population(s) they are intended to supplement. Non-isolated

hatchery programs regularly infuse natural-origin fish into the broodstock as described in an approved HGMP.

2. HATCHERY-ORIGIN FISH STRAYING: For naturally-spawning populations in critical habitats, non-ESU hatchery-origin fish do not exceed 5%; ESU hatchery-origin fish do not exceed 5% - 30%, unless specified in an HGMP for a conservation propagation program.

3. MARKING: Hatchery populations are properly marked so as not to mask the status of the natural-origin populations or the capacity and proper functioning of Critical Habitat.

4. VIABLE & CRITICAL POPULATION THRESHOLDS: Hatchery operations do not appreciably slow a listed population from attaining its viable population abundance. Hatchery operations do not reduce listed populations that are at, or below, critical population abundance.

5. HARVEST EFFECTS: Federal hatchery mitigation fish produced for harvest do not cause subsequent overharvest of listed stocks such that their recovery is appreciably slowed. Harvesting reforms are implemented to maintain and enhance harvest of mitigation fish in consideration of the constrained productivity of listed stocks caused by the FCRPS and other development.

6. HATCHERY PLANNING: Hatchery goals and objectives, operational protocols, monitoring and evaluation, anticipated effects, and relationship to other critical management and planning processes are fully described in approved HGMPs.

7. RESEARCH: Scientific knowledge is increasing on the effects of hatchery supplementation and captive broodstock programs on the survival and recovery of natural-origin populations. The quality and survival of hatchery supplementation fish is increasing.

Analysis of the Hatchery Element:

1. Hatchery Reforms

The Basinwide Salmon Recovery Strategy recommends major and extensive reforms at existing mitigation hatcheries that are designed to eliminate or minimize the adverse effects of past propagation practices. Adverse effects include decreased fitness as a result of hatchery fish interbreeding with naturally spawning fish, and decreased survival as a result of hatchery fish competing with naturally spawning fish for space and food. The effects of some practices can be substantial, although few definitive studies have been done that quantify the harmful effects of hatcheries on naturally spawning populations. It is nevertheless possible to examine qualitatively the potential benefits of hatchery reforms.

Long term research on steelhead in the Kalama River, WA. demonstrated that the reproductive competence of domesticated, non-locally derived hatchery fish in the wild was substantially less than the indigenous natural-origin fish. The hatchery fish were only 30% as successful as the

wild fish at producing smolts and only 10% as successful at producing returning adults (Chilcote et al., 1986)

In the Clearwater River, ID hatchery steelhead survived to subyearling size in the wild 80% as well as naturally-produced fish, and survival to the presmolt size was only 60% of the naturally-produced fish. (Reisenbichler 1997)

Hatchery steelhead in the Deschutes River basin, OR that were only 2 generations removed from the natural populations were found to survive at 80% of the rate of the naturally-produced population (Reisenbichler and McIntyre 1977)

For coho salmon, Fleming & Gross (1993) found indicators of strong selection against fish of hatchery origin and suggest that the behavior of the hatchery fish led to their poor reproductive success.

Highly domesticated Atlantic salmon females had less than 1/3 the reproductive success as wild females, while similar male fish had only 1-3% the reproductive success of wild males.

Where domesticated hatchery fish, particularly of non-indigenous origin, stray onto the spawning grounds, their effects can be substantial. If these fish mate with each other, their immediate adverse effect may only be with later competition for food and space of any juveniles produced. If, however, the misplaced hatchery fish mate with indigenous fish, they can impart less adaptive traits to the native fish, reducing their productivity and survival. If this occurs on a significant scale over sufficient years, the overall productivity of the indigenous populations can be severely impacted.

It is not currently feasible to quantify with any certainty the potential improvement to the survival and productivity of natural-origin, listed fish populations by eliminating interbreeding with hatchery fish. Neither is it feasible to estimate how long it would take for benefits to accrue. Nevertheless, the fitness of certain indigenous, listed populations may be substantially improved over time by eliminating this risk. The studies cited above suggest that the productivity of hatchery fish (spawner-to-spawner) can be 20-90 percent less than the productivity of naturally spawned fish. Where hatchery fish interbreed to a significant extent with naturally spawned fish, and assuming the offspring survive at a rate no greater than hatchery fish, eliminating harmful interbreeding could improve the survival of the natural fish an equivalent amount. No studies currently exist that confirm the potential range of benefits from reduced interbreeding. For populations less significantly affected by poor hatchery practices, the improvement would be less marked. The program would stop the practice of using non-indigenous broodstock in the basin, except in a very few instances where it can be demonstrated that straying does not occur.

Adverse ecological effects from hatchery fish are also being addressed in the hatchery reforms. Hatchery programs have been documented as limiting natural populations through predation and competition for food and space between that hatchery and natural-origin fish. Although it is not

possible to quantify the potential benefits from these reforms, the tables below provide a qualitative estimate of the degree of benefit likely to accrue from hatchery reforms for each ESU.

2. Safety Net and Conservation Hatchery Activities

A number of upriver salmon and steelhead populations may require immediate intervention with artificial propagation, as the risks for near-term extinction appear especially high. These emergency safety net conservation programs are needed for 2-4 generations until habitat improvements that increase population productivity become effective. A variety of intervention techniques should be employed, reflecting specific circumstances and the considerable uncertainty that exists regarding long-term effectiveness.

Supplementation of natural-origin populations is still an experimental approach to enhancing self-sustaining populations; continuing research will be important to determine the most effective reintroduction strategies. Supplementation research to date has demonstrated that high egg-to-smolt survivals can be achieved using artificial propagation, generally resulting in adult:adult replacement rates in excess of 1.0 -- replacement rates currently greater than those of naturally spawning fish. Supplementation is therefore a reasonably reliable strategy to enhance the abundance of listed fish, keeping their effective population size above critical levels. When applied to a sufficient number of individual populations within a listed ESU, it can also improve the prospects for overall diversity and stock structure within an ESU. Increasing abundance and stock structure within a seriously depressed ESU can therefore reduce the short-term probability of extinction.

Another important contribution of a supplementation program applied to severely depressed salmon populations relates to nutrient enhancement. Fish raised in hatcheries do not take severely limited nutrients from the riverine ecosystems, yet when these fish return from the ocean, they can deposit significant nutrients to assist future generations of natural-origin fish. Current depressed runs of salmon are only 6-7% of the historic biomass that returned to Pacific Northwest streams. This current nutrient deficit may be one cause of the salmon's ecosystem failure and a limiting factor for their overall recovery to self-sustaining levels.

What is not yet known is whether supplementation can provide long-term benefits. Little information is available about the performance of fish from contemporary, state-of-the-art supplementation techniques, or how their progeny perform in the natural environment. No data exist on the long-term effectiveness of supplementation in recovering a self-sustaining natural population. Therefore, while short-term benefits can be expected, it is unknown whether they will provide long term benefits. It seems evident only that supplementation can provide a short-term safety net to avoid extinction.

Summary of benefits of hatchery actions

Tables 5- 14 provide a qualitative assessment of the extent to which each listed ESU and their associated populations are affected by adverse hatchery practices that would be eliminated or substantially reduced by the reforms detailed above. The tables also consider the value of safety-

net projects and conservation supplementation for an initial number of critically depressed populations. A review of the tables' information generally indicates that Upper Willamette River Winter Steelhead ESU would be little benefited by planned hatchery reforms. Small benefits to survival and productivity would be expected for Snake River Spring/Summer Chinook, Snake River Sockeye, Upper Willamette River Spring Chinook, Lower Columbia River Chinook, and Columbia River Chum ESUs. Small to moderate benefits would be expected for Snake River Steelhead, Mid-Columbia River Steelhead, and Lower Columbia River Steelhead ESUs. Moderate benefits would be expected for the Snake River Fall Chinook and the Upper Columbia River Spring Chinook ESUs. Finally, moderate to high benefits would be expected for the Upper Columbia River Steelhead ESU.

Legend for following tables:

-- Expect little or no benefit associated with hatchery actions
x Expect relatively small benefit associated with hatchery actions
xx Expect relatively moderate benefit associated with hatchery actions
xxx Expect relatively high benefit associated with hatchery actions

Table 5 Snake River Spring Chinook ESU
Qualitative Assessment of Potential Improvements for Listed Populations by Implementing Hatchery Reforms and Federal All-H Preferred Alternative (Fed-1 Plan)

Basin/Population	Preservation of Populations	Enhancement Actions	Implementing Hatchery Reforms	M&E for Adaptive Management	Summary of Potential Benefits
Tucannon River	xxx	--	--	x	xxx
Grande Ronde					
Minam River	--	--	--	--	--
Lostine River	--	xx	--	x	xx
Wenaha River	--	--	--	--	--
Catherine Creek	--	xx	--	x	xx
Upper River	--	xx	--	x	xx
Imnaha River					
mainstem		x	--	x	x
Big Sheep	extinct?	x	--	x	x
Snake River					
Asotin Creek	extinct	xxx	--	x	xx
other tribs		--	--	xx	--
Lower Salmon River	--	--	--	--	--
Little Salmon River					
Little Sal. R.	--	--	--	--	--
Rapid River	--	--	--	--	--
South Fork Salmon River					
Upper mainstem	--	x	--	xx	xx
Lower mainstem	--	--	--	x	x
Secesh River	--	--	--	x	x
Johnson Creek	--	xx	--	xx	xx
E.F. South Fork	--	--	--	x	x
M.F. Salmon River					
mainstem to Indian Cr.	--	--	--	xx	x
mainstem Indian to Bear Cr.	--	--	--	xx	x
Marsh Creek	--	--	--	xx	x
Bear Valley and Elk Creeks	--	--	--	xx	x
Sulphur Creek	--	--	--	xx	x
upper Loon Creek	--	--	--	xx	x

Basin/Population	Preservation of Populations	Enhancement Actions	Implementing Hatchery Reforms	M&E for Adaptive Management	Summary of Potential Benefits
lower Look Creek	--	--	--	xx	x
Camas Creek	--	--	--	xx	x
lower Big Creek	--	--	--	xx	x
upper Big Creek	--	--	--	xx	x
Lemhi River	--	xx	--	xx	xx
Pahsimeroi River	--	xxx	-	xx	xx
Upper Salmon River					
North Fork Salmon River	--	--	--	xx	x
lower East Fork Salmon River	--	--	x	xx	x
Herd Cr. and upper East Fork	--	x	--	xx	x
Yankee Fork	--	x	x	xx	x
upper Valley Creek	--	x	--	xx	x
lower Valley Creek	--	x	--	xx	x
mainstem below Redfish Lake Cr.	--	--	x	xx	x
mainstem above Redfish Lake Cr.	--	xx	--	xx	xx

Table 6 Snake River Steelhead ESU
Qualitative Assessment of Potential Improvements for Listed Populations by Implementing Hatchery Reforms and Federal All-H Preferred Alternative (Fed-1)

Basin/Population	Preservation of Populations	Enhancement Actions	Implementing Hatchery Reforms	M&E for Adaptive Management	Summary of Potential Benefits
Tucannon River	--	xx	xxx	xx	xxx
Asotin Creek	--	--	--	--	--
Grande Ronde River					
lower Grande Ronde R.	--	xx	xxx	xx	xxx
upper Grande Ronde R.	--	xx	-	xx	xx
Lostine/Wallowa R.	--	xx	xxx	xx	xxx
Minam	--	--	--	xx	--
Wenaha	--	--	--	xx	--
Joseph	--	--	--	xx	--
Imnaha River					
Sheep Creek	--	x	--	xx	x
Camp Creek	--	-	--	--	--
lower mainstem tribs	--	x	--	xx	x
upper mainstem tribs	--	-	--	--	--
Clearwater River					
lower mainstem “A” run tribs	--	xx	--	xx	x

Basin/Population	Preservation of Populations	Enhancement Actions	Implementing Hatchery Reforms	M&E for Adaptive Management	Summary of Potential Benefits
lower mainstem “B” run tribs	--	xx	--	xx	x
South Fork Clearwater	--	xx	--	xx	x
Lochsa River	--	x	--	xx	x
Selway River	--	--	--	xx	x
Salmon River					
lower mainstem tribs	--	x	xxx	xx	xxx
South Fork Salmon River	--	--	--	xx	x
Middle Fork Salmon River	--	--	--	xx	x
Upper Salmon River	--	xx	xxx	xx	xxx
Mainstem Snake River					
Tributaries	--	xx	xxx	xx	xxx

Table 7 Snake River Sockeye Salmon and Fall Chinook Salmon ESUs Qualitative Assessment of Potential Improvements for Listed Populations by Implementing Hatchery Reforms and the Federal Preferred Hatchery Alternative (Fed-1)

Basin/Population	Preservation of Populations	Enhancement Actions	Implementing Hatchery Reforms	M&E for Adaptive Management	Summary of Potential Benefits
Snake River Sockeye Salmon	--	--	--	x	x
Snake River Fall Chinook Salmon	--	xx	x	xx	xx

Table 8 Upper Columbia River Spring Chinook ESU
Qualitative Assessment of Potential Improvements for Listed Populations by Implementing Hatchery Reforms and the Federal Preferred Hatchery Alternative (Fed-1)

Basin/Population	Preservation of Populations	Enhancement Actions	Implementing Hatchery Reforms	M&E for Adaptive Management	Summary of Potential Benefits
Okanogan River	extinct	xxx	x	xx	xxx
Methow River					
Twisp River	x	x	--	x	x
Methow River	--	x	xxx	x	xxx
Entiat River	--	--	xxx	xx	xxx
Wenatchee River					
Chiwawa River	xx	xx	--	xx	xx
Nason Creek	xx	xx	--	xx	xx
White River	xx	xx	--	xx	xx
Little Wenatchee River	--	--	--	xx	x
Icicle Creek	--	--	x	x	x

Table 9 Upper Columbia Steelhead ESU
Qualitative Assessment of Potential Improvements for Listed Populations by Implementing Hatchery Reforms and the Federal Preferred Hatchery Alternative (Fed-1)

Basin/Population *	Preservation of Populations	Enhancement Actions	Implementing Hatchery Reforms	M&E for Adaptive Management	Summary of Potential Benefits
Okanogan River	--	xxx	xx	xx	xxx
Methow River	--	xxx	xx	xx	xxx
Entiat River	--	x	xx	xx	xx
Wenatchee River	--	xx	xx	xx	xx

* Steelhead population structure within each River has not been designated at this time.

Table 10 Mid-Columbia Steelhead ESU
Qualitative Assessment of Potential Improvements for Listed Populations by Implementing Hatchery Reforms and the Federal Preferred Hatchery Alternative (Fed-1)

Basin/Population	Preservation of Populations	Enhancement Actions	Implementing Hatchery Reforms	M&E for Adaptive Management	Summary of Potential Benefits
Yakima River					
Satus Creek	--	--	--	x	x
Toppenish Creek	--	--	--	x	x
Naches/Upper Yakima River	--	--	--	x	x
Klickitat River					
Winter Steelhead	--	--	xx	xx	xx
Summer Steelhead	--	--	xx	xx	xx
Walla Walla					
Touchet River	--	xx	xxx	xxx	xxx
South Fork	--	--	--	xxx	xx
Mill Creek	--	--	x	xxx	xx
Umatilla River	--	--	x	x	x
John Day River	--	--	x	xx	x
Deschutes River					
Warm Springs River	--	x	--	xx	x
Deschutes River	--	--	xx	xx	xx
Fifteenmile Creek					
Winter Steelhead	--	--	--	xx	x

Table 11 Upper Willamette River Spring Chinook ESU
Qualitative Assessment of Potential Improvements for Listed Populations by Implementing Hatchery Reforms and the Federal Preferred Hatchery Alternative (Fed-1)

Basin/Population	Preservation of Populations	Enhancement Actions	Implementing Hatchery Reforms	M&E for Adaptive Management	Summary of Potential Benefits
Clackamas	--	--	xxx	xxx	xxx
Mollala	extinct	--	--	--	--
North Santiam	--	--	xx	xx	xx
South Santiam	--	--	--	xx	x
Calapooia	extinct	--	--	--	--
McKenzie	--	--	xx	xxx	xx
Middle Fork Willamette	--	xx	x	x	x
Coast Fork Willamette	extinct	--	--	--	--

Table 12 Upper Willamette River winter steelhead ESU
Qualitative Assessment of Potential Improvements for Listed Populations by Implementing Hatchery Reforms and the Federal Preferred Hatchery Alternative (Fed-1)

Basin/Population	Preservation of Populations	Enhancement Actions	Implementing Hatchery Reforms	M&E for Adaptive Management	Summary of Potential Benefits
Tualatin	--	--	--	--	--
Mollala	--	--	--	--	--
North Santiam	--	--	--	x	x
South Santiam	--	--	--	xx	x
Calapooia	--	--	--	--	--
Yamhill	uncertain if population existed here historically	--	--	--	--
Luckiamute	uncertain if population existed here historically	--	--	--	--
Rickreall	uncertain if population existed here historically	--	--	--	--

Table 13 Lower Columbia River Chinook ESU
Qualitative Assessment of Potential Improvements for Listed Populations by Implementing Hatchery Reforms and the Federal Preferred Hatchery Alternative (Fed-1)

Basin/Population	Preservation of Populations	Enhancement Actions	Implementing Hatchery Reforms	M&E for Adaptive Management	Summary of Potential Benefits
Grays River					
Fall Chinook (Tule)	--	--	x	x	x
Elochoman River					
Fall Chinook (Tule)	--	--	xx	xx	xx
Abernathy Creek					
Fall Chinook (Tule)	--	--	--	--	--
Cowlitz River					
Spring Chinook	--	xxx	x	xx	xx
Fall Chinook (Tule)	--	xx	xx	xx	xx
Kalama River					
Spring Chinook	--	--	x	xx	x
Fall Chinook	--	--	x	xx	x
Lewis River					
Spring Chinook	--	--	x	x	x
Fall Chinook	--	--	x	x	x
East Fork (Tule)	--	--	x	x	x
NF & EF (Brights)	--	--	x	x	x
Washougal River					
Fall Chinook (Tule)	--	--	x	x	x
Wind River					
Fall Chinook	--	--	x	x	x
Little White Salmon River					
Fall Chinook (URB)	--	--	x	--	x
White Salmon River					
Fall Chinook (URB)	--	--	x	--	x
Lewis and Clark River					
Fall Chinook (Tule)	--	--	--	--	--
Klaskanine River					
Fall Chinook (Tule)	--	--	--	--	--
Big Creek					
Fall Chinook (Tule)	--	--	--	--	--

Basin/Population	Preservation of Populations	Enhancement Actions	Implementing Hatchery Reforms	M&E for Adaptive Management	Summary of Potential Benefits
Gnat Creek					
Fall Chinook (Tule)	--	--	x	x	x
Claskanine River					
Fall Chinook (Tule)	--	--	--	--	--
Clackamas River					
Fall Chinook (Tule)	--	--	x	x	x
Sandy River					
Spring Chinook	--	x	xx	xx	xx
Fall Chinook (Bright)	--	--	x	xx	x
Hood River					
Spring Chinook	--	x	x	--	x

Table 14. Lower Columbia River Steelhead ESU
Qualitative Assessment of Potential Improvements for Listed Populations by Implementing Hatchery Reforms and the Federal Preferred Hatchery Alternative (Fed-1)

Basin/Population	Preservation of Populations	Enhancement Actions	Implementing Hatchery Reforms	M&E for Adaptive Management	Summary of Potential Benefits
Cowlitz River					
Late-winter upper basin	--	xxx	x	xx	xx
Toutle River	--	x	xx	x	xx
Kalama River					
Winter Steelhead	--	x	x	x	x
Summer Steelhead	--	x	x	x	x
Lewis River					
North Fork	--	--	xx	x	xx
East Fork	--	--	xx	x	x
Salmon Creek	--	--	xx	xx	xx
Washougal River					
Winter Steelhead	--	--	xx	x	xx
Summer Steelhead	--	--	x	x	x
Wind River					
Summer Steelhead	--	--	--	x	x
Winter Steelhead	--	--	--	x	x
Clackamas River					
North Fork	--	x	x	x	x
Eagle Creek	--	x	xx	xx	xx
Lower mainstem and tribs	--	--	xx	x	xx
Sandy River					
Late winters	--	x	xxx	xx	xxx
Hood River					
Winter Steelhead	--	--	x	x	x
Summer Steelhead	--	--	x	x	x
Columbia River Gorge Tribs	--	--	--	x	x

4. Hydropower Element of Basinwide Salmon Recovery Strategy

FEDERAL HYDROPOWER

The Basinwide Salmon Recovery Strategy identifies actions that, combined with other ongoing and anticipated measures in the Columbia River basin outlined in the other elements of this paper, will probably ensure the long-term survival of listed species with a moderate to high likelihood of recovery. Based on the best available scientific information, the following fundamental components of the RPA allow the FCRPS to avoid jeopardizing the listed species.

Performance Standards

The 2000 FCRPS Biological Opinion defines certain performance standards that will, when attained, meet the jeopardy standard. There are several distinct types of performance standards. They include: Programmatic Standards to assess whether anticipated actions are being implemented; Biological Standards to assess the status of the ESUs and the effectiveness of implemented measures; and Physical Performance Standards to express ecological and management indicators in terms of habitat attributes (e.g., water quality). Biological Standards to assess the effectiveness of implemented measures are further broken down into Hydro and Offsite standards.

Hydro Performance Standards includes specific adult and juvenile survival levels (direct and indirect) expected to result from implementing the best or most aggressive actions that NMFS and the Action Agencies agree are biologically and technically feasible and within the authority of the Action Agencies. The Action Agencies are committed to attainment of the hydropower standards by 2010.

Offsite Mitigation Standards include non-discretionary implementation of specific measures identified in the other elements of the Basinwide Salmon Recovery Strategy. The Action Agencies are committed to implementation of the offsite mitigation measures described in these sections. Details of the level of additional improvements to be attained through actions in other life stages as described in the Basinwide Salmon Recovery Strategy (including, but not limited to improvements to be attained through offsite mitigation by the FCRPS action agencies), are described in FCRPS biological opinion.

Hydropower Actions

This section outlines operational and structural fish passage improvements at FCRPS projects to increase the survival of listed fish. This section describes the specific hydro measures that, based upon the best scientific information available, NMFS has determined are:

- Biologically feasible and implementable

- Sufficient to achieve performance standards that represent the best the hydro system can do without dam breaching

- Sufficient to result in a high likelihood of survival and a moderate to high likelihood of recovery, in combination with offsite mitigation defined in below and with other improvements affecting the listed species elsewhere described in the Strategy.

The hydrosystem measures included in this section are expected to reduce juvenile and adult salmonid mortality attributable to passage through the hydro system and to attain the hydro performance standards in the FCRPS biological opinion by 2010. The measures are broken down into the following categories:

- Water management—management of natural flows and system storage to meet salmon flow objectives

- Juvenile fish transportation—collection and barge transportation of fish to avoid mortality at mainstem hydro projects and in reservoirs

- Juvenile fish passage—configuration and operational actions and research activities at FCRPS projects that are designed to improve juvenile fish survival at the dams

- Reservoir passage—operations and active management of salmonid predators in the mainstem to improve the survival rates of juvenile fish passing through the reservoirs

- Adult passage and research—configuration and research activities to improve adult passage survival

- Water quality—improvement in total dissolved gas levels and water temperatures within the mainstem while working toward attainment of water quality standards

- Fish facility operations and maintenance—increase commitment and ability to operate and maintain aging and new fish passage facilities to the highest possible effectiveness through enhanced effort and adequate funding

Current activities within the FCRPS include actions in all of these categories. These and additional actions to be taken in each of the categories are identified and described in the Biological Opinion. NMFS has determined that all of these actions are necessary to achieve the hydro system performance standard. However, the strategy for achieving the objective stated above relies on the continued monitoring and evaluation of progress and the use of the information gathered to adjust or refine the actions taken. The specific measures may be revised over time through the annual and 5-year planning process.

There are seven areas of particular emphasis, which are discussed in the sections below:

- Improving water management
- Improving juvenile project passage survival
- Improving juvenile reservoir survival
- Improving adult passage survival
- Improving water quality
- Resolving critical uncertainties
- Enhanced operation and maintenance of fish passage facilities

Improving Water Management. Improved water management provides several direct and indirect survival benefits to salmon. Measures include managing reservoir draft and refill operations so they do not adversely affect salmon, and the use of stored water to improve salmon survival or water quality by augmenting flows. For many ESUs, the benefits are primarily measured in terms of improving the probability of achieving spring and summer flow objectives for migrating fish. Others ESUs, however, are also affected by the spawning, incubation and rearing conditions created by hydro operations. All ESUs may also be affected by estuarine and near-shore ocean conditions, which are in turn influenced by water storage activities. The new FCRPS biological opinion continues many of the 1995 Biological Opinion and 1998 and 2000 Supplemental Biological Opinion measures, including the following:

- Flow objectives at Lower Granite, Priest Rapids, McNary, and Bonneville dams
- In-season management for operational flexibility and best use of available water volumes
- Guidance on reservoir elevations in early spring, early summer, and at the end of the summer augmentation season
- Coordination with water releases from Canada, the upper Snake River, and the Hells Canyon Complex

In addition, there are several actions to improve water management for salmon, including the following:

- Additional drafts of selected FCRPS reservoirs
- Additional water from other sources
- Shifts of flood control among projects

- Implementation of VARQ flood control operations at Libby and Hungry Horse reservoirs

- Review of system flood control objectives

- Continued research on summer-migrating SR fall chinook salmon population losses

Improving Juvenile Project Passage Survival. Survival of juvenile salmon during their downstream migration through the FCRPS to the ocean can be further improved by providing safer, more effective passage alternatives. Different actions are prescribed for different projects depending on their current configuration and survival levels. In general, the following actions are emphasized:

- Increased spillway passage using gas abatement and longer spill hours to allow increased spill volumes, spill pattern refinements and the evaluation of removable spillway weirs to improve spill efficiency

- Spillway passage research to identify additional potential survival and passage improvements

- Increased screen/bypass system effectiveness through extended screens, new outfalls, and improved hydraulic conditions

- Development and testing of surface bypass technology, with implementation as appropriate

- Improved turbine designs and operating guidelines

- Improved passage system operations and reliability

Improving Juvenile Reservoir Survival. Measures to identify and address mortality factors in the mainstem reservoirs are a significant component of the overall goal to increase the survival of downstream migrating salmon. Actions include hydro operations, predator management, and habitat modifications that may reduce the effect of predators on salmonids. Furthermore, research and evaluation of passage survival through dams and reservoirs will continue, with emphasis on the effect of passage delay in the forebay and tailrace at dams and the relationship between dam passage and reservoir mortality. Numerous measures are planned to improve reservoir survival rates, including the following:

- Increased flow augmentation for summer migrants, particularly in the low water years

- Management of reservoir and run-of-river projects to reduce extreme water level fluctuations

- Management of predator populations (fishes, birds, and mammals)

- Implement passage measures which move fish quickly through the forebay and tailrace of dams.

Improving Adult Survival. Passage improvements are expected to reduce the direct and pre-spawning mortality of upstream migrating adult fish. Actions include a mix of research and configuration measures to identify and correct delay and mortality problems. Areas of emphasis include the following:

- Development of measures to increase the survival of adults that fallback and reduce the rate of fallback

- Increased facility reliability and the ability to maintain operating criteria

- Investigation of measures to protect steelhead kelts

- Investigation of pre-spawning mortality

Improving Water Quality. Water quality is vital to the overall health of the aquatic ecosystem as well as to the survival of listed anadromous fish. Two water quality parameters are of particular concern: total dissolved gas supersaturation and water temperature. Dissolved gas supersaturation is primarily a result of spill at dams; therefore, both operational and structural changes to dams are planned to reduce dissolved gas levels. Elevated water temperature is a more complex issue, stemming from land use practices throughout the basin as well as storage impoundments and dam operations. Numerous measures are planned to improve water quality, including the following:

- Structural and operational modifications at spillways (e.g., spillway deflectors, improved spill patterns)

- Development of alternative fish passage measures (e.g., surface bypass)

- Cool water releases from storage reservoirs (e.g., Dworshak Dam)

- Special powerhouse operations (e.g., McNary Dam)

Resolving Critical Uncertainties. Although we have a substantial amount of information regarding salmonid survival throughout the life cycle, there continues to be unexplained significant mortality that cannot be attributed to specific causal factors. While there are several plausible hypotheses to explain this mortality, many of the possible causes are unrelated to the hydrosystem. Of particular concern are potential delayed effects of hydrosystem actions. If the unexplained mortality is linked to identifiable hydrosystem actions, similar proposed actions could have a much lower survival benefit than predicted by direct survival estimates. Conversely, eliminating those actions (e.g., through breaching) could have a much higher benefit

than what might be expected from changes in direct survival alone. Therefore, resolving uncertainties about unexplained mortality is a prerequisite to an estimate the effects of an aggressive non-breach approach or alternative actions.

In the Biological Opinion, NMFS does not propose limits on actions in any of the areas affected by uncertainty. NMFS proposes active investigation to reduce or resolve the uncertainty.

The hypothesis that delayed mortality results from passage through the hydrosystem is the most critical uncertainty regarding the effects of the hydrosystem on fish survival. It is a critical element in evaluating the effectiveness of measures on survival. Several hypothesized forms of delayed mortality are:

- Delayed mortality of transported juvenile migrants (D value when expressed relative to the survival of non-transported migrants below Bonneville Dam). This will affect the degree to which transport improves survival rates.

- Delayed mortality of inriver juvenile migrants (extra mortality). This will affect the degree to which breach, transport, and juvenile dam passage actions could contribute to improving survival rates.

- Delayed mortality and/or passage effects on adults. This includes remedies to reduce unaccounted losses or unsuccessful spawning.

- Estuarine/ocean survival. Differential timing or distribution in the estuary and ocean may help explain mortality that is otherwise attributed to the hydrosystem. Examples of this are the delayed mortality of transported and inriver juvenile migrants, discussed above.

Empirical data on these issues are limited. An improved understanding is critical because decisions on major hydrosystem configurations and/or operations will depend on the magnitude of delayed mortality and factors that contribute to it. For example, if unexplained mortality is significant, and it is solely associated with delayed effects of the hydrosystem, corrective measures within the hydrosystem can be identified to reduce it. However, if unexplained mortality is not significant regardless of its cause, addressing it would be a lower priority. If unexplained mortality is significant, but it is associated with conditions that affect fish before or after they encounter the hydrosystem, relevant non-hydro actions would be appropriate. The potential implications of unexplained mortality, and whether or not it is delayed hydrosystem mortality, make resolution of this issue a central component of the 5-year check-in and breach decision.

Offsite Mitigation Actions

The Basinwide Salmon Recovery Strategy also calls for offsite mitigation. These additional actions are included to improve the productivity of the listed salmon populations beyond the level of improvement that would be possible through hydro actions alone because, even with

survival improvements in passage of fish at and between dams, significant mortality associated with FCRPS/BOR operations will continue to occur. The hydropower element, therefore, advises the Action Agencies that this additional offsite mitigation in other Hs (habitat, hatcheries, and harvest) is needed to achieve recovery. The strong support of the Action Agencies for actions in these other areas will increase the certainty and reliability of attaining potential improvements.

The offsite mitigation provided by the Action Agencies does not preclude the necessity of improvements in the other Hs by other Federal or Non-Federal parties, nor does it diminish the obligation of these other parties to seek improvements. It is intended to be complementary to, not in lieu of, actions taken by other entities affecting these Hs.

1- and 5- Year Plans

An annual, multi-year planning process to refine, implement, evaluate, and adjust annual efforts is a critical element to achieving the FCRPS hydro and off-site performance standards within the duration of the FCRPS biological opinion. This will be accomplished through development and implementation of one- and five-year plans to achieve both hydro performance standards and the off-site mitigation performance standards. The plans will cover all operations, configuration, research, monitoring, and evaluation actions. The plans will also describe habitat, hatchery and harvest actions to be funded or otherwise carried out by the Action Agencies as off-site mitigation. The plan allows for revision to the specific measures over time through the one- and five-year plans, as long as the Action Agencies make steady progress toward meeting performance standards, and remain on track for full attainment of the hydro standards by 2010.

Comprehensive Three-, Five- and Eight-Year Check Ins

As with any assessment of future conditions there are risks associated with NMFS' determination that the actions to be implemented consistent with this plan will be adequate to ensure the long term survival of the listed ESUs. To manage that risk, NMFS has included critical monitoring and evaluation and specific performance measures and actions levels to trigger additional actions if needed. The region must be prepared to move forward with these alternative measures given the fact that it is possible that on-site and off-site measures will not have the predicted results, or that subsequent information will show the predicted improvements to be inadequate. The FCRPS biological opinion describes the performance standards and measures and the steps for review and decision-making regarding the adequacy and effectiveness of the actions. The plan calls for annual progress reports, major progress evaluations in 2003, 2005 and 2008, and pursuit of other options, including possible breaching of dams if necessary, to avoid jeopardy in the future.

If NMFS finds that the hydropower strategy fails to meet ESA standards despite the Action Agencies' exercise of their current authority, NMFS will identify additional actions that would satisfy those standards if implemented by the Action Agencies, even though the Action Agencies lack the necessary authority and/or appropriations. Such actions would likely include the breach of one or more dams for those Snake River stocks that would benefit from such actions. As of the date of this biological opinion, dam breaching is likely to significantly improve the survival

of Snake River ESUs and is the likely remedy for a failure to achieve performance standards, due to implementation failure or an adverse change in stock status, for the Snake River ESUs. Thus, this biological opinion presumes that it would be necessary for the action Agencies to seek this additional authority. For Mid-Columbia and Upper Columbia ESUs a comparable remedy may be appropriate, though the state of the science is not as well developed as of the date of this biological opinion. NMFS will make this "red zone" determination using the best science then available.

NMFS must be able to find, using the best science available, that the Action Agencies' continuing implementation of the hydropower strategy, as detailed in the 1- and 5-year plans, satisfies ESA standards for a specified duration reasonably sufficient to obtain and exercise the necessary authority and appropriations. This is particularly appropriate for FCRPS and BOR Projects because their operation is ongoing and cannot be stopped while new authority is obtained. In this situation, therefore, the Action Agencies may seek the authority and/or appropriations for the necessary measures, within the time period specified by NMFS. During this period they would otherwise continue to implement the Strategy. Continued implementation of the Strategy would be essential to the survival of all ESUs in life stages not affected by dam breaching. NMFS' report, prepared in coordination with the Action Agencies, would provide the available scientific and technical data and analysis demonstrating the likely feasibility and effectiveness of the measure. Failure to obtain the requisite authority or appropriation within the specified time period would trigger a reinitiation of consultation under section seven of ESA.

Monitoring, Evaluation, and Progress Reporting

Considerable uncertainty exists on the effectiveness of measures identified in this plan and with regard to the benefits of breaching dams, principally with regard to delayed mortality associated with fish passing dams by means of transportation or remaining in river. To resolve these uncertainties, all measures undertaken to benefit fish must be undertaken as scientific studies with rigorous monitoring and evaluation, to learn new information about which measures work and do not work. The plan also calls for monitoring and evaluation of measures to assess an agency's progress in implementing its actions and the benefits resulting from the agency's implementation. The biological opinion establishes a set schedule of measures, milestones, standards and decisions to ensure that this evaluation process is disciplined and rigorous. Monitoring and evaluation may lead to revisions in measures undertaken by Action Agencies to meet performance standards.

While improved knowledge will reduce uncertainty, NMFS is cognizant that learning can entail delay, and delay can entail risks of extinction. A delay to gather additional information, for instance, could increase risks and still end with the "answer" not certain. The plan's provision for ongoing monitoring and evaluation, annual and five-year planning, rigorous review of progress, and use of breach as an option mitigate delay.

Advance Planning for Breach or Other Additional Actions

NMFS has given significant consideration to the options involving breach of the Lower Snake and possibly other dams. Generally, any action that removes or eliminates a source of adverse effects from the listed species' life cycle increases certainty of improvements in survival. By reducing the effects of one type of human activity, breaching the four Lower Snake River dams provides more certainty of long term survival and recovery than do other measures.

To allow for the possibilities that hydro and offsite mitigation actions included in these RPAs will not provide the anticipated increases in survival, or that subsequent information shows the predicted improvements are inadequate, the FCRPS biological opinion requires Action Agencies to take specifications to ensure that alternative approaches are available. Although it does not rely on breach of any dams to avoid jeopardy, it does require further development of breach as a future option in the event that future conditions warrant it. NMFS recognizes that breach is a major action requiring NEPA compliance, congressional authorization, and appropriations before it can be implemented. This plan, therefore, calls for the FCRPS Action Agencies to conduct or continue analysis preliminary to seeking authorization from Congress, such as preliminary engineering and mitigation studies. The specific actions will reduce the time needed to seek congressional authorization for breach, and reduce the time needed for possible implementation, thereby avoiding risks of delay should breach later become a preferred approach.

Breach Triggers

The FCRPS biological opinion establishes a schedule for determination of whether to pursue breach as a means of avoiding jeopardy. This schedule addresses possible breach of one or a combination of hydroelectric projects. The schedule provides for a rigorous mid-point review of progress in 2005, another comprehensive review in 2008, and a determination under certain conditions to pursue breach if NMFS issues a failure report on the plan following one of these reviews.

Independent Peer Review

It is important that the public and the courts have confidence in the actions that the Action Agencies are taking and in the science that supports the plan and the biological opinion. Accordingly, the plan calls for independent peer review of the implementation progress reports developed by the action agencies in years five and year ten, and the updated extinction risk analyses prepared by NMFS in years five and eight.

Immediate Actions and Benefits

Because listed Columbia Basin anadromous fish are in such fragile condition, and in light of the uncertainties surrounding breaching, an immediate focus on areas and measures that provide short-term gains (1-10 years) for these populations is essential.

For the hydro system, the measures intended to provide these short term gains and the expected effects of those actions on juvenile and adult survival levels are described in detail in the FCRPS biological opinion. The commitment of the Action Agencies is to implement the specified

Hydro measures and/or such additional measures as are needed to fully attain these system survival levels by 2010. These benefits and uncertainties are summarized briefly below.

Analysis of the Federal Hydropower Element

The 2000 FCRPS Biological Opinion describes a set of specific hydropower actions that NMFS has determined, on the basis of available scientific information and professional judgment, will achieve the FCRPS hydropower performance standards. Most of the measures are aimed at improving passage survival through FCRPS dams and reservoirs through changes in project operations and improvements in project configuration. They include: enhanced spill and spillway improvements to facilitate higher spill levels without exceeding dissolved gas standards; improved flow management; physical improvements to both juvenile and adult fish passage facilities; increased use of barges (reducing the reliance on trucks to transport summer migrants); and continuation of spill at collector projects in the spring to improve in-river survival of juvenile migrants. NMFS' estimate of the combined adult and juvenile survivals (direct and indirect) that will result from the implementation of these measures is the basis of the hydropower standard. The Action Agencies are committed to attainment of the hydropower standards by 2010. The Biological Opinion also describes an annual planning process to implement these necessary measures, or such additional measures as deemed by NMFS to be necessary to meet the performance standards and avoid jeopardy to listed salmon populations.

NMFS' best estimate of the additional improvement in adult and juvenile survival levels associated with these measures is modest and accrues primarily to in-river migrants and primarily in the Lower Columbia River. The following summary provides point estimates for the sake of illustration. The biological opinion describes ranges associated with all of these estimates and also discusses the significant uncertainties associated with the estimates.

For Snake River spring/summer chinook juvenile in-river survival is estimated to increase from 40.8 percent under current operations to 49.6 percent under the reasonable and prudent alternative. Since such a large portion of Snake River fish are transported, this effect is somewhat masked in the system survival estimate, including delayed mortality, which changes from 57.1 percent under current operations to 57.6 percent under aggressive hydro. The estimated change in survival for adult fish from Bonneville to Lower Granite is from 82.5 percent to 85.5 percent.

For Snake River fall chinook—

10.2% to 14.3% in river juvenile
11.7% to 13.5% juvenile system with transport [note: this assumes a "D" (delayed mortality) value of .24]
71.0% to 74.0% adult system

For Snake River steelhead—

41.51% to 51.6% in river juvenile
47.8% to 50.8% juvenile system with transport
77.3% to 80.3% adult system

Estimated survival improvements for Upper Columbia, Mid-Columbia and Lower Columbia populations are based on the number of FCRPS projects that they encounter, four, four and one, respectively. Since very few, if any, of these ESUs are collected and transported under either current operations or aggressive hydro, the estimates are more straight-forward and less dependent on assumptions related to the delayed effects of transportation. They are:

	Juvenile	Adult
UC spring chinook	57.5 to 66.4	90.7 to 92.2
UC steelhead	58.6 to 67.7	87.8 to 89.3
MC steelhead	58.6 to 67.7	87.8 to 89.3
LC chinook	72.1 to 77.6	95.8 to 96.3
LC steelhead	86.9 to 90.8	96.8 to 97.3

Analysis of the risks and benefits of breaching the four Lower Snake River dams reveal multiple uncertainties that cast doubt on the necessity of breaching at this time.

The extent of delayed mortality of non-transported fish under current operations and after breaching four dams is unknown. If delayed mortality is high and it all goes away after breaching four dams, this creates a major survival improvement associated with breaching. If there was little or no delayed mortality, or if there was a lot but breaching four dams only gets rid of a small part of it, the fish most likely will not perform better at meeting survival and recovery goals than with the aggressive option.

The extent of differential delayed mortality associated with transported fish is also unknown. This is important because, after breaching, there would be no Snake River transportation program. If differential delayed mortality is low before breaching, when a large percentage of the run is transported, this creates an apparent big jump in survival after breaching. The opposite is true: if differential delayed mortality is high, survival benefits for transported fish after breaching are likely to be minimal.

It is not clear at this point whether breaching would benefit adult fish returning to spawn. There is no clear evidence to suggest adult survival would be better with dams than without, an uncertainty that must be resolved in order to make an informed decision on breaching.

A final key uncertainty surrounding the benefits of breaching is whether juvenile survival in free-flowing stream reaches that used to be reservoirs would change dramatically. While this factor may be less important than those mentioned above, it is nonetheless unknown at this time.

NONFEDERAL HYDROPOWER

In addition to federal dams, there are a substantial number of major and minor nonfederal hydroelectric projects in the Columbia Basin that influence the survival and recovery of listed fish.

- Eleven dams owned and operated by the Idaho Power Company, including Hells Canyon;
- Five dams owned and operated by Chelan, Douglas, and Grant County PUDs on the mainstem Columbia River below Chief Joseph;
- The Pelton-Round Butte dams on the Deschutes River, and Marmot Dam on the Sandy River, and North Fork , Faraday and Rivermill dams and the Oak Grove Project on the Clackamas River, and the Sullivan Plant on the Willamette River owned and operated by Portland General Electric;
- the Leaburg/Walterville, Blue River and Carmen-Smith Projects on the McKenzie River owned and operated by the Eugene Water and Electric Board;
- the Chelan Falls project on the Chelan River, owned and operated by Chelan PUD;
- the Yale and Merwin Projects on the Lewis River and the Condit Project on the White Salmon, and the Wapatox Project on the Naches River and the Powerdale Project on the Hood River owned and operated by PacifiCorp; and,
- the Mayfield and Mossyrock Projects on the Cowlitz River owned and operated by Tacoma City Light.

These projects have had a number of adverse effects on salmon and steelhead, including inundation and alteration of habitat, blocked or impaired passage, inadequate minimum instream flows, blockage of bedload and woody debris transport, unstable river levels flows and water quality alterations. Much of the existing mitigation for nonfederal hydropower projects is inadequate for fish and wildlife needs, and some projects, such as Hells Canyon, Pelton/Round Butte, and Mayfield/Mossyrock still block fish from their historical habitat.

A number of nonfederal hydropower projects have taken steps to mitigate their adverse fish and wildlife effects. For example, the Vernita Bar agreement addresses flows through the Hanford Reach, and has been very successful in rebuilding Hanford Reach populations of upriver bright fall chinook (not listed under ESA). Further revisions of this beneficial agreement are under evaluation. At Wells Dam, juvenile fish passage under the terms of a FERC settlement is the best of any dam on the mainstem river – approximately 98 percent survival using a surface bypass system. Under another settlement, Idaho Power Company provides spawning flows for fall chinook below Hells Canyon Dam. In the upper Columbia, Chelan and Douglas PUDs have been negotiating a Habitat Conservation Plan, including on-site and off-site mitigation and performance standards, with NMFS and the USFWS.

Nevertheless, much improvement at nonfederal hydropower projects remains to be done. In the course of relicensing and ESA consultation, all of these projects will be reviewed and updated to meet current fish and wildlife needs. Under the Council's Fish and Wildlife Program,

(Section 12), specific conditions for new licenses and relicensing are established. In addition, under ESA, consultations with the FERC, the federal dam licensing agency, will result in measures to avoid "jeopardy" to listed fish.
Overall, the Federal Caucus proposes that nonfederal hydropower meet the criteria for relicensing included in the Council's Program, and the ESA requirements for no jeopardy. Key requirements from the Council Program include:

- Consultation with fish and wildlife agencies and tribes and the Council throughout study, design, construction, and operation of the project;
- Specific plans for flows and fish facilities
- The best available means for aiding downstream and upstream migration of salmon and steelhead
- Flows and reservoir levels of sufficient quantity and quality to protect spawning, incubation, rearing, and migration.
- Full compensation for unavoidable fish losses or fish habitat losses through habitat restoration or replacement, appropriate propagation, or similar measures
- Assurance that the project will not degrade fish habitat or reduce numbers of fish in such a way that the exercise of treaty rights will be diminished.

The Federal Caucus will work together to accomplish this result through settlement agreements wherever possible. For specific projects, the Federal Caucus has the following recommendations:

- the implementation of the Mid Columbia HCP for the five PUD dams,
- continued implementation (and revision) of the Vernita Bar Agreement for Hanford Reach flows.
- Completion of a Hanford Reach management plan to ensure long term protection of fish, wildlife, and cultural resources in that area.
- Re-evaluation of all mitigation and hatchery programs as part of relicensing and ESA consultation.

NMFS and USFWS will use section seven authority under the Endangered Species Act to consult with the Federal Energy Regulatory Commission to ensure that the needs of anadromous and resident fish are met adequately through the re-licensing process.

5. Biological Background and Recovery Planning

Existing Conditions

Physical Setting

The Columbia River Basin covers about 250,000 square miles in seven western states and British Columbia and is defined by unique geologic and water features. The states in the Pacific Northwest follow, in the most part, the basin's geographic features. An enormous variety of plants and animals occupy the wide array of physical habitats in the Columbia River Basin.

Ocean Conditions

Ocean conditions have major implications for salmon and steelhead productivity. It has been determined through various analytical efforts that ocean conditions generally vary with climatic conditions on both long-term and short-term scales. When conditions are cooler, in general the ocean is more hospitable toward migrating salmon. Cool water temperatures are associated with high nutrient levels and food supplies. The reverse is also true; warmer conditions are associated with lower levels or resources. Ion addition, there is anecdotal evidence that predator abundance may increase off the coast of Oregon and Washington during periods of warmer water. These are not the only characteristics of variant ocean conditions, but they are the primary indicators affecting the ability of salmon and steelhead to thrive once they leave the rivers. In general, ocean conditions have been below average over the past 20 years. From the early 1980s through the mid-1990s, conditions were relatively warm. In contrast, throughout the 1960s and 1970s, conditions were cooler by comparison. These trends generally correspond to fluctuations in adult salmon and steelhead returns. However, it is important to note that ocean oscillations have not been stable, moving up and down within the same basic temperature range. The overall trend has been toward warmer conditions in general. This trend also has major implications for anadromous fish recovery efforts.

The ability of the ocean to nurture salmon and steelhead is dependent on how many migrating juveniles actually make it past the estuary from the spawning areas. In addition, individual populations must have sufficient abundance to survive downturns in ocean conditions. Further monitoring and evaluation over time will reveal more about direct survival and mortality attributable to the ocean. For now, the ocean is but one additional factor that must be accounted for when developing a recovery strategy.

Predation

Consumption of migrating salmon by predators is another important factor affecting the productivity of salmon and steelhead. Migrating juvenile salmon are a targeted food source of

numerous species, including other aquatic species such as northern pikeminnows, bird species such as Caspian terns, pelicans, and cormorants, and marine mammals such as harbor seals and sea lions. Returning adult salmon are targeted primarily by marine mammals. Current studies show that consumption of juvenile salmonids by birds, particularly Caspian terns, is occurring in considerable volume. Likewise, preliminary research is showing marine mammal predation has a measurable effect on returning adults. The overall extent of predation in raw terms on listed species is not clear. Neither are the biological implications clear. Efforts have only recently been undertaken to assess these things. Further research and aggressive monitoring should reveal the trues extent and implications of predation within a relatively short time. In a balanced, properly functioning ecosystem, a certain amount of predation will always occur. It is the genetic predisposition of salmon and steelhead to produce offspring in sufficient numbers to survive and thrive under such circumstances. However, given the perilous state of decline being faced by many salmon and steelhead species, predation control could contribute to recovery efforts along with a suite of other management actions.

Species Status

The Columbia River Basin historically supported many anadromous species, including hundreds of populations of chinook, sockeye, coho, chum and pink salmon, as well as steelhead, coastal cutthroat trout, white and green sturgeon, eulachon, and Pacific lamprey. Fifty-two fishes, both anadromous and resident, are native to the Columbia River Basin, including 13 **endemic** species (McPhail and Lindsey 1986). Changes in the physical, chemical and biological condition of land and water bodies throughout the basin have dramatically affected the status of many of these fish. Dam development blocked, inundated and **segmented habitat** for anadromous and resident fish, and human development and activities have altered or destroyed much of the habitat that remains.

In the late 1970s, concern about the protection of fish species led to consideration of Snake River salmon stocks for listing under the ESA. In 1980 Congress passed the Northwest Electric Power Planning and Conservation Act, which created the Northwest Power Planning Council and charged it with developing a fish and wildlife program. Passage of that Act and creation of the Council led NMFS to withhold listing. In 1991, NMFS listed Snake River sockeye as endangered, followed closely by listings of Snake River spring/summer and fall chinook. NMFS has listed 12 Columbia River Basin salmon and steelhead Evolutionarily Significant Units (ESU) as threatened or endangered under the Endangered Species Act. The U.S. Fish and Wildlife Service (USFWS) has listed seven resident fish and other aquatic species as threatened or endangered. This section briefly reviews the status of the anadromous and resident fish populations remaining in the basin.

Anadromous Salmonids

Native salmon and steelhead are in decline throughout the basin. Some believe that 40 salmon stocks from Washington have become extinct during the last 150 years (Nehlsen, et al. 1991). Historically, 10-16 million salmon and steelhead returned each year to spawn, but by the 1960s, that number had dropped to about 5 million. Today, only about a million fish return, and most of

them originate from hatcheries, not from the wild. Of the anadromous salmonid stocks in the Columbia River Basin, about 60 percent are listed as depressed, threatened or endangered. At least 65 native stocks have been extirpated.

Chinook Salmon – Chinook salmon have a relatively widespread distribution throughout the basin, however most populations are seriously depressed. The highest commercial catches occurred in 1883 when nearly 22,000 tons were harvested Fulton (1968). While some healthy chinook populations remain, most are depressed and many have already been extirpated. Four ESUs are listed as threatened (Snake River fall-run, Snake River spring/summer run, Lower Columbia, and Upper Willamette River ESUs); one is endangered (Upper Columbia River spring run ESU).

Coho Salmon - Coho were once widespread and abundant in the Columbia Basin, but are now considered extinct in upper Columbia and Snake River drainages, and in serious decline in the remaining range in the lower Columbia River. Commercial catches in the 1920s peaked at greater than 700,000 fish landed (Fulton 1970). NMFS has tentatively identified a coho ESU that includes populations in southwest Washington and the lower Columbia River. This ESU is a candidate for ESA listing, however, it is unclear whether native, naturally reproducing coho still occur in the Columbia Basin.

Chum Salmon – Historically, this species may have spawned as far upstream as the Walla Walla River, but today chum salmon are found in a handful of tributaries and stream reaches downstream of Bonneville Dam. The spawning areas lost (primarily due to hydropower development) are not extensive and represent only a small portion of the available habitat (Fulton 1970). The Columbia River had an abundant chum population that supported annual harvests numbering in the hundreds of thousands. Current abundance is probably less than 1 percent of historic levels. NMFS has identified all Columbia River chum populations as a single ESU and listed them as threatened under the ESA.

Sockeye Salmon - This species is dependent on lake spawning habitats principally located in the Snake and Upper Columbia River Basins. Historically, commercial catches in the Columbia River may have reached nearly 1.3 million fish in the 1890s (Fulton 1970), but current returns are probably in the tens of thousands of fish. Counts of Snake River sockeye spawners have not exceeded 8 fish during the past decade and the ESU is kept alive only through a captive-breeding program. Although sockeye salmon in the Upper Columbia Basin are not listed, their numbers are depressed. There are at least three sockeye ESUs in the Columbia Basin, and one of these - the Snake River ESU - has been protected under the ESA since 1991.

Steelhead - Like chinook, steelhead spawning populations are still relatively widespread in the basin, however they too have undergone dramatic declines and local extinctions. Minimum run size estimates for Columbia Basin steelhead indicate that 150,000-450,000 adults returned during 1938-1967 (Fulton 1970). Current production estimates are in the tens of thousands, with the bulk of production coming from tributaries to the middle Columbia. NMFS has listed all five Columbia River ESUs as threatened or endangered under the ESA.

Coastal Cutthroat Trout - Commonly referred to as sea-run cutthroat, this species has a complex suite of life history types that include anadromous and resident types, as well as a freshwater migratory form. NMFS has identified one ESU that includes Columbia Basin populations (a southwest Washington/Columbia River ESU) and has proposed it for listing as a threatened species under the ESA.

Pink Salmon - Pink salmon are rarely encountered in the basin (Emmett, et al. 1991). NMFS has identified two ESUs in the lower 48 states, both in Puget Sound and the Strait of Juan de Fuca.

Resident Fish and Aquatic Species

Bull Trout – Bull trout in the Columbia Basin were listed as a threatened species under authority of the Endangered Species Act of 1973, as amended (ACT) on June 10, 1998. The decline of bull trout is primarily due to habitat degradation and fragmentation, blockage of migratory corridors, poor water quality, past fisheries management practices, and the introduction of non-native species.

Bull trout have more specific habitat requirements compared to other salmonids. Habitat components that appear to influence bull trout distribution and abundance include water temperature, cover, channel form and stability, valley form, spawning and rearing substrates, and migratory corridors. Bull trout are found primarily in colder streams; water temperature above 15 degrees C is believed to limit bull trout distribution. All life history stages are associated with complex forms of cover including large woody debris, undercut banks, boulders, and pools. Preferred spawning habitat consists of low gradient streams with loose, clean gravel and water temperatures of 5 to 9 degrees C in late summer to early fall.

Bull trout exhibit resident and migratory life-history strategies through much of the current range. Resident bull trout complete their entire life cycle in the tributary (or nearby) streams in which they spawn and rear. Migratory bull trout spawn in tributary streams where juvenile fish rear from one to four years before migrating to either a lake, river, or in certain coastal areas to saltwater. Migratory corridors link seasonal habitats for all bull trout life-history forms.

Recovery planning is currently underway and will focus on maintaining stronghold/core populations and restoring habitat connectivity and characteristics that have been destroyed or degraded. State and tribal representatives will incorporate information already compiled by previous state efforts to the extent possible in developing the overall recovery plan.

Redband Trout – Redband trout (*Oncorhynchus mykiss*) are a rainbow trout that are found in a number of areas of the inland West. In physical appearance they resemble both rainbow and cutthroat trout and for the most part are restricted to small streams in arid regions. However, Behnke (1992) considers nearly all rainbow trout east of the Cascade Mountains to be of the redband subspecies. Some apparent rainbow trout in certain streams in the Kootenai River

drainage have been recognized by Montana as redband trout and are considered a Species of Special Concern in that state and in Idaho. In March 2000, the Fish and Wildlife Service determined after it was petitioned for listing that the Great Basin redband trout, a fish that lives in parts of Oregon, California and Nevada, did not need protection under the Endangered Species Act.

Kootenai River White Sturgeon – The Kootenai River white sturgeon was listed as endangered on September 6, 1994. Modification of the Kootenai River white sturgeon's habitat by human activities has changed the natural hydrograph of the Kootenai River, altering white sturgeon spawning, egg incubation, and rearing habitats; and reducing overall biological productivity. These factors have contributed to a general lack of recruitment in the white sturgeon population since the mid-1960s. Short-term recovery objectives identified in the Recovery Plan completed in September 1999 are to re-establish successful natural recruitment and prevent extinction through use of conservation aquaculture. The long-term objective is to downlist and then delist the fish when the population becomes self-sustaining.

The operation of Libby Dam to provide sufficient flow at proper temperatures for successful white sturgeon spawning and recruitment of young is a critical factor in sturgeon recovery. Reservoir storage and salmon augmentation flows are just two of the factors that must be considered and integrated into an operational plan for Libby dam in arriving at sturgeon releases. The rate of change in discharge from Libby Dam also is an important consideration.

Snake River Snails – Five species of aquatic snails in the Snake River were listed as endangered (Idaho springsnail, Banbury Springs lanx, Utah valvata, Snake River physa) and threatened (Bliss Rapids snail). The species currently occur mainly in the remaining free-flowing reaches and spring alcove habitats of the Snake River between American Falls reservoir and C. J. Strike Dam. Habitat requirements generally include cold, clean, well-oxygenated flowing water of low turbidity. Threats to the species include diversion of water from the river and springs for agriculture, aquaculture, and hydroelectric power generation; return flows that are high in nutrients and sediment and may contain pesticides; rapid fluctuation in flows at and below hydroelectric generating facilities; and invasion of non-native species.

Recovery efforts for the snails will need to focus on reducing diversions or maintaining minimum flows, avoiding rapid changes in flows due to hydropower operations or providing salmon augmentation water, and improving water quality.

BIOLOGICAL REQUIREMENTS

Salmon and Steelhead

NMFS has defined the geographic boundaries of major stock groups or ESUs of Pacific Salmon throughout the West Coast that are genetically and demographically distinct from each other. Nineteen ESUs in the Columbia River Basin occupy four interconnected regions: (1) Snake

River Basin, (2) upper Columbia River Basin, (3) middle Columbia River Basin, and (4) lower Columbia River/Willamette River Basin.

Life-history traits, such as run-timing, vary among and within ESUs due to selection imposed by a variety of factors, including differing times of peak stream flow, seasonal barriers to passage (e.g., waterfalls), and differing migration distances. This diversity of life history traits has been important in maintaining the historic abundance of salmon in the basin.

Like all organisms, salmon have individual maintenance requirements. In fresh water, these include adequate water quality (including temperature and dissolved oxygen requirements), sufficient water quantity, adequate food supply, and appropriate spawning and rearing habitat. Different species and different life-history types vary in their specific requirements. For example, chum salmon require low-gradient tributary habitats near tidal areas in the lower basin for spawning, while sockeye salmon spawn in beach gravels in lakes in the interior basin. The degree to which the biological requirements of individuals are met will affect the viability of the entire population or ESU, by affecting the size, stability, spatial structure and diversity of the population.

Survival in the ocean also affects salmonid populations. Shifts in ocean conditions, brought about by shifts in climate, have produced abrupt differences in salmon survival in the ocean (Francis and Hare 1994). Although the mechanisms affecting ocean survival are largely unknown, they are presumed to be the result of annual and decadal variation in nutrient availability (and thus, in an upward cascade, algal and zooplankton production) (e.g., Hare et al. 1999). Recent modeling suggests that climate changes due to doubled levels of atmospheric carbon dioxide would significantly alter coastal productivity, potentially affecting the growth, survival and distribution of salmon populations (Hinch et al. 1995, Welch et al. 1998).

1.5.2 Resident Fish and Other Aquatic Species

Resident fish and other aquatic species in the Columbia River Basin have similar biological requirements as Pacific salmon (e.g., good water quality, access to habitat/cover and food, and opportunities to breed) and will benefit from many actions to improve habitat for salmon. However, specific biological requirements vary by species.

Bull Trout – Bull trout display a high degree of sensitivity at all life stages to environmental disturbances and have more specific habitat requirements than many other salmonids (Fraley and Shepard 1989, Howell and Buchanan 1992, Rieman and McIntyre 1993). Length and timing of incubation to emergence (200 days or more during winter and early spring), the strong association of juvenile fish with stream channel substrates, and a fall spawning period make bull trout particularly vulnerable to altered flow patterns and associated channel instability. Successful bull trout spawning and development of embryos and juveniles requires very cold water temperatures. Extensive migrations are characteristic of the species and migratory bull

trout facilitate the interchange of genetic material between populations, ensuring sufficient variability within populations.

Kootenai Rive White Sturgeon – White sturgeon are broadcast spawners, releasing their eggs and sperm in fast water. Based on recent studies, Kootenai River white sturgeon spawn during the period of historical peak stream flows from May through July (Apperson and Anders 1991; Marcuson 1994). Spawning at peak flows with high water velocities disperses and prevents clumping of the adhesive eggs. Following fertilization, eggs adhere to the river substrate and hatch after a relatively brief incubation period of 8 to 15 days, depending on water temperature (Brannon et al. 1984).

Snake River Snails - Ecologically, the five listed species of Snake River snails share many characteristics, and in some locations two or more can be found sharing the same habitat. Their habitat requirements generally include cold, clean, well-oxygenated, flowing water of low **turbidity**. With the exception of the Utah valvata and possibly the Idaho springsnail, the listed snails prefer gravel-to-boulder size substrate. Despite these affinities, each of the five species has slightly different habitat preferences. The Idaho springsnail and Snake River physa are found only in the free-flowing mainstem of the Snake River. The Bliss Rapids snail and Utah valvata occur in both cold water springs or mainstem habitats, while the Banbury Springs lanx only occurs in cold-water springs.

Recovery Planning

Salmon and Steelhead

The Basinwide Salmon Recovery Strategy covers all ESUs of salmon and steelhead in the basin. It provides an overview of the issues and actions individual recovery plans are likely to specifically address, and will inform the planning process accordingly.

Under the Endangered Species Act, NMFS is responsible for developing detailed recovery plans for each ESU. NMFS intends to carry out this task in cooperation with other federal agencies, states, tribes and stakeholders and has already begun formal recovery planning for the upper Willamette and lower Columbia ESUs.

Recovery plans set biological recovery goals (or de-listing criteria) and the specific actions needed to achieve those goals. The ESA also requires that recovery plans include an estimate of the cost of needed actions. NMFS has focused its efforts first on the technical tasks involved in recovery planning for salmon and steelhead. Completion of these tasks will aid planners in identifying and prioritizing actions that will provide the greatest returns.

The first technical task is to identify the populations that make up the ESU and describe the characteristics that would allow us to conclude the populations are viable. The characteristics include abundance, spatial structure and diversity within the population, and minimum trends and productivity. Once populations are identified and described in this way, it is possible to

construct different scenarios for recovery of the ESU in terms of number of populations, in what distribution and what level of abundance and productivity. It is likely that some populations will be identified as core populations, important to preserve regardless of the scenario chosen, while others may be a lower priority for immediate protection.

Another technical task is to identify factors limiting recovery. These factors are likely to differ among ESUs (for example, upriver ESUs will be more affected by hydropower operations than lower river ESUs). They may even differ among populations within an ESU (for example, a dam may block access to habitat for one population in an ESU, while urban development may be limiting the recovery of another). Technical experts can also assess habitat characteristics throughout the range of an ESU and identify those habitats that represent productive strongholds and those that could be strongholds if targeted for restoration.

In its formal recovery planning process in the upper Willamette and lower Columbia region, NMFS has appointed a Technical Recovery Team and charged it with completing these technical tasks. In the upper Columbia, a NMFS-led science team worked with the mid-Columbia Public Utility Districts to begin the first two recovery tasks (identifying populations and abundance recovery goals for them). The Northwest Power Planning Council has proposed to conduct subbasin assessments throughout the Basin, which would accomplish the technical task of assessing habitat.

With these processes in place, the task will still remain to set biological recovery goals for ESUs in the Snake River and for steelhead in the mid-Columbia region. NMFS intends to appoint Technical Recovery Teams for the upper and mid-Columbia River, as well as for the Snake River basin as soon as possible. Those teams will establish biological recovery goals for the ESUs in these areas within three years.

NMFS and the federal agencies recognize there are already a number of state and local processes in place working on local recovery plans. As it moves forward to develop recovery plans using this technical information, NMFS intends to rely on existing processes and institutions. The subbasin assessment and planning process proposed by the Council would include fisheries managers as well as state and local governments and watershed councils. This process may well provide the organization and include the stakeholders in the interior Columbia Basin that would enable NMFS to rely on this process to develop recovery plans. Subbasin plans would need to be "aggregated" to ensure they will provide for the recovery of the entire ESU. NMFS will continue to discuss these issues with all of the affected entities in the Basin. If appropriate, NMFS stands ready to appoint formal recovery teams to develop comprehensive plans for the listed ESUs.

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6. Implementation

Section 2.2 of Volume 1 describes the approach the federal agencies will take in implementing the Basinwide Strategy and coordinating with states, tribes, and other stakeholders within the region. The cornerstone of agency coordination efforts will be a memorandum of understanding (MOU) signed by participating federal agencies. This MOU will formally establish the Federal Caucus as the primary mechanism for the agencies to use in coordinating their efforts with each other, and with other entities within the basin. Its primary purpose is to ensure effective, efficient implementation and coordination of federal activities pursuant to the Recovery Strategy and other related efforts to conserve listed fish species in the Columbia River Basin.

MEMORANDUM OF UNDERSTANDING
AMONG FEDERAL AGENCIES
CONCERNING THE CONSERVATION OF
THREATENED AND ENDANGERED FISH SPECIES
IN THE
COLUMBIA RIVER BASIN

I. PARTIES

This Memorandum of Understanding (MOU) is entered into among the following Federal agencies, acting through the specified regional, state, or other local office of each agency and collectively known as the Federal Caucus:

Northwest Region, National Marine Fisheries Service, Department of Commerce
Bonneville Power Administration, Department of Energy
Region X, Environmental Protection Agency
Northwestern Division, U. S. Army Corps of Engineers, Department of the Army
Regions 1, 4, and 6, Forest Service, Department of Agriculture
Pacific Northwest Region, Bureau of Reclamation, Department of the Interior
Region 1, U.S. Fish and Wildlife Service, Department of the Interior
Northwest Region, Bureau of Indian Affairs, Department of the Interior
Idaho State Office and Oregon/Washington State Office, Bureau of Land Management, Department of the Interior
Oregon State Office, Farm Service Agency

II. BACKGROUND

In the Columbia River Basin, the National Marine Fisheries Service has listed 12 species of anadromous fish and the U.S. Fish and Wildlife Service has listed two species of resident fish as threatened or endangered under the auspices of the Federal Endangered Species Act (ESA). Pursuant to Section 7 of the ESA, Federal agencies, including the agencies of the Federal Caucus, are directed, among other things, to utilize their authorities in furtherance of the purposes of the ESA by carrying out programs for the conservation of Columbia Basin listed species and to insure that any action authorized, funded, or carried out by each agency is not likely to jeopardize the continued existence of any listed species or adversely modify critical habitat.

In December 2000, the Federal Caucus released its report entitled *Conservation of Columbia Basin Fish: Basin-wide Salmon Recovery Strategy* (the Recovery Strategy). Pending the development of formal recovery plan(s) pursuant to section 4(f) of the ESA, the Recovery Strategy will guide the cooperative efforts of the Federal Caucus to take steps to recover listed fish species in the Columbia River Basin. In this regard, the Recovery Strategy broadly identifies the hydropower, habitat, hatchery and harvest actions and activities that may be necessary to address adverse impacts on listed species.

III. PURPOSE

To ensure effective implementation and coordination of Federal activities pursuant to the Recovery Strategy and other related activities concerning the conservation of the listed fish species in the Columbia River Basin, the agencies of the Federal Caucus desire to provide for continued coordination of their efforts, particularly in planning and implementation of necessary actions and activities consistent with the Recovery Strategy, and in coordinating their respective agency efforts within and among the four Hs. To the extent practicable and permissible within the authorities of each agency involved, the Federal Caucus will seek to present unified and consistent points of view in its discussions, negotiations and partnerships with state, tribal, and local agencies. To this end, the agencies of the Federal Caucus agree to:

- Track progress in planning and implementing agency actions across all of the Hs,
- Coordinate the execution of their trust and treaty responsibilities to Native American tribes, and their respective responsibilities under the Endangered Species Act, the Clean Water Act, NEPA, and other applicable laws, as they relate to the conservation of Columbia Basin fish,
- Allocate fairly the conservation burden for listed species among tribal and non-tribal entities,
- Coordinate cost analyses and funding issues,
- Integrate programs to monitor and evaluate progress toward established goals,
- Use the best available scientific information in adaptive management,
- Share information, technology, expertise, and resources as practical,
- Evaluate and adapt existing processes to avoid duplicating efforts,
- Maximize efficient use of funds,
- Coordinate Federal activities related to the conservation of listed Columbia River Basin fish with the related efforts of state, tribal, and local governments and entities, including coordination of the agencies' public involvement and tribal consultation processes, and
- Annually document progress in effecting the Recovery Strategy.

IV. ORGANIZATIONAL STRUCTURE OF THE FEDERAL CAUCUS

A. Regional Executives

The Federal Caucus will undertake the coordination effort defined in this MOU under the direction of the appropriate state and regional directors or administrators of each Federal

Caucus member agency, collectively known as the Regional Executives. The Regional Executives will set the general direction and priorities for the work of the Federal Caucus. The Regional Executives will communicate and coordinate among themselves as needed and will convene to deliberate matters needing their attention.

B. Federal Caucus – Senior Staff

Each signatory agency will designate a senior staff person to represent and speak for that agency. These senior staff will be responsible for overseeing the day-to-day activities needed to effect the purposes of this MOU. The group will report to the Regional Executives on a periodic or as-needed basis and will elevate to the Regional Executives any matter that the members of the Caucus cannot resolve.

Each agency's staff representative will be responsible for communicating to his or her Regional Executive agreements made and actions undertaken by the Federal Caucus. Agency representatives will also be responsible for carrying through on the actions that pertain to and are agreed to by his or her agency.

Each agency will commit as much time of its senior staff representative as is reasonably required for the business of the Federal Caucus, and each agency will bear all costs of its representative's participation. From time to time, as may be required and agreed to by the Regional Executives, one or more Federal Caucus agencies may provide administrative staff and office space to support the work of the Federal Caucus.

The senior staff will develop such procedures and understandings as are required for them to operate effectively and efficiently, including, but not limited to, procedures for setting meeting times and agendas, selecting a chair or facilitator, summarizing meeting results, and attendance of alternative agency representatives.

C. Habitat Team

Each Federal Caucus agency agrees to designate one of its employees to be a member of the Habitat Team. The team will work under the general direction of, and provide information to, the senior staff group. Each agency will commit as much time of such person to the business of the Habitat Team as is reasonably required, and each agency will bear the costs of its representative on the Habitat Team. From time to time, as may be required and agreed to by the Regional executives, one or more Federal Caucus agencies may provide administrative staff and office space to support the work of the Habitat Team.

The Habitat Team will be responsible for effecting the purposes of this MOU insofar as they pertain to the coordination of Federal agency habitat programs and coordination with non-Federal entities on habitat matters including cost analyses and funding issues, data management, program progress and other matters which may be appropriate. To the

extent practicable and permissible, the habitat team will share biological data concerning listed species and base its recommendations on common scientific information.

D. Other Work Groups or Committees

The Federal Caucus may establish other standing or ad hoc work groups, committees, or teams from time to time as they deem appropriate.

V. COORDINATION OF HYDRO SYSTEM, HARVEST, AND HATCHERY WORK

Coordination for the Federal Columbia River Power System operations shall continue through those forums which have been established under the terms of the biological opinions issued by the National Marine Fisheries Service and U.S. Fish and Wildlife Service for that purpose. Agencies that participate in these forums will provide information to the senior staff group and/or Regional Executives as needed or as requested to effect the coordination called for by this MOU.

To effect the coordination called for by this MOU in matters concerning hatcheries and harvest, the Federal Caucus will rely upon the existing processes utilized in the case of U.S. v. Oregon which is under the continuing jurisdiction of the U.S. District Court for Oregon. Agencies that participate in the U.S. v. Oregon forum will provide information to the senior staff group and/or Regional Executives as needed or as requested to effect the coordination called for by this MOU.

VI. MISCELLANEOUS PROVISIONS

The participation by each agency in the actions and activities for which this MOU calls is contingent upon the availability of future appropriations or funding. Furthermore, execution of this MOU does not obligate any specific amount of agency expenditure in furtherance of this MOU, such expenditures being at the discretion of each agency.

This MOU does not delegate any authority or responsibility established by law. Nor does it limit the discretion, alter or affect the statutory and other legal rights of parties, including any rights to legal remedies, or the authorities, responsibilities or obligations of the parties under relevant laws. Also, it does not create any right to any type of administrative review nor create any new right to judicial review or any other right or benefit or trust responsibility, substantive or procedural, enforceable by a party against the United States, its agencies or instrumentalities, its officers or employees, or any other person.

Further, if the processes and procedures of the Federal Caucus would delay the implementation of any actions for which an agency is obligated under law, that agency reserves the right to proceed with fulfilling those obligations in such manner as it deems appropriate or necessary.

Nothing in this Memorandum is intended to affect or impair tribal treaty rights or the trust responsibilities of the signatory federal agencies.

This MOU may be amended only with the agreement of all of the Federal Caucus agencies that have executed it and remain parties thereto at the time of amendment. Additional federal agencies may become party to this Memorandum subsequent to the date of the original agreement.

This MOU will become effective as of the last date upon which it is executed among the agencies which are signatory hereto. This MOU will remain in effect until terminated by the agencies that have executed it. Any agency may unilaterally terminate its participation in this MOU upon 30 days written notice to the other signatory agencies.

Acting Regional Administrator, Region X — Date
Environmental Protection Agency

Administrator — Date
Bonneville Power Administration

Commanding Officer, Northwestern Division — Date
U.S. Army Corps of Engineers

Acting Regional Director, Northwest Region — Date
National Marine Fisheries Service

Regional Director, Region 1 — Date
U.S. Fish and Wildlife Service

Regional Director, Region 1 — Date
U.S. Forest Service

Regional Director, Region 4 — Date
U.S. Forest Service

Regional Director, Region 6 — Date
U.S. Forest Service

Regional Director, Northwest Region — Date
Bureau of Indian Affairs

Director, Idaho State Office Bureau of Land Management	Date
Director, Oregon/Washington State Office Bureau of Land Management	Date
Regional Director, Pacific Northwest Region, Bureau of Reclamation	Date
Oregon State Direction, Farm Service Agency	Date

7. Research, Monitoring and Evaluation

7.1 Introduction

The research, monitoring and evaluation proposal presented here is the first step in a developing program. Rather than a completely field-ready program, this section provides an outline of the data required to develop and assess recovery plans for listed salmonids within a single subbasin.

This monitoring and evaluation effort is based on a data collection scheme developed to answer questions fundamental to the management and recovery of anadromous salmonids. These questions arise from fundamental uncertainties in these fishes' population processes, both in trends in abundance as well as the factors that regulate salmonid population dynamics.

The first goal of the question-based monitoring and evaluation scheme outlined here is to identify trends in abundance and productivity in populations of listed anadromous salmonids in the Salmon River Basin. For populations requiring recovery efforts to meet mandated survival and recovery goals, however, monitoring and evaluation will also focus on the efficacy of management actions. Therefore, establishing quantitative, mechanistic links between factors that can be manipulated and population responses is a second, critical goal of this effort. The Columbia Basin monitoring and evaluation program will encompass the following areas in order to address these issues:

a. **Population status monitoring**. What areas are occupied by juvenile salmonids and spawning adults? What is the status of the population (i.e. abundance, trend and variation)? Does that status change through time?
b. **Environmental status monitoring**. What is the status of environmental attributes, including non-native species, potentially affecting salmonid populations? Does it change through time? Are there associations between environmental attributes and salmonid population status?
c. **Effectiveness monitoring**. Are management actions having the intended effects on the aquatic system, and what is the response of salmonid populations to those effects?
d. **Quality of regional databases**. How accurate and complete are currently available databases that represent habitat quality throughout the basin?
e. **Compliance monitoring**. Have management actions been properly implemented and maintained?

7.2 Questions and Approaches

7.2.1 What is the status of salmonid populations; does that status change through time?

A primary concern of salmonid management is determining the level of risk that populations face, including the current trends and abundance of populations, and determining whether those trends change. In addition, accurately determining population status is a vital part of assessing

mechanisms of population regulation (question 7.2.2). A comprehensive monitoring program will thus address the following questions:

- *What are current abundances, and what are the long-term trends in population abundance?* The long-term trend of a population (its rate of change) is one of the most important parameters determining its viability, since a declining population will always reach extinction at some point in the future.

- *What proportion of the naturally spawning population is made up of hatchery-origin fish, and what is the reproductive efficacy of those fish?* The rate of change of the wild component of a population cannot be determined without knowing the contribution of hatchery-origin spawners to subsequent generations.

- *What are life-stage specific survival rates?* Population dynamics of salmonid populations are poorly predicted by the dynamics of terminal life stage spawners. Demographic information for multiple life stages is a far better measure of actual population dynamics and provides an important basis for mechanistic population models.

- *What is the spatial extent of breeding populations?* The distribution of spawners throughout the basin provides an assessment of the total breeding population, and of the temporal variability in utilization of spawning habitat. (Note that in some cases, total spawning population can also be determined by a passage barrier count at the base of the ESU or population.)

- *What is the peak and range of run-timing and time of spawning?* Knowing the temporal pattern of breeding habitat utilization can validate the use of peak counts of index reaches as representative samples of breeding populations.

- *What is the spatial distribution of juvenile fish*? Accurately assessing juvenile abundance (and therefore stage-specific survival rates) will require knowledge of the distribution of those fish.

7.2.2 What are the mechanisms of population regulation?

Even with a very complete knowledge of the status of populations, we need to understand the determinants of population regulation to be able to manage the populations for recovery. This section poses a set of explicit questions asking, which ecological, environmental or genetic factors control population growth? Answering these questions is a two step process: i) assessment of current conditions, identifying patterns suggesting relationships between current conditions and population status, ii) establishing cause-and-effect relationships between changes in conditions and salmonid population responses. Questions that should be addressed in this area include (but are not limited to):

- *Are population status and environmental attributes associated in ways that suggest important management experiments?*

- *Where do hatchery and wild fish interact, and do those interactions result in direct or indirect resource competition as indicated by food and space resource use overlap/competition?*

- What are the ocean conditions that act as determinants of salmon productivity as indicated by correlations in salmonid population numbers (returning spawners?) with ocean condition indices, zooplankton indices, or with direct measurements of ocean survival, fish condition or food supply?

- *Does community structure or primary productivity affect salmonid population status?*
- *How do populations respond to management actions?*

- What are the anthropogenic sources of altered selective regimes, and how might they act to alter the regulation of natural salmonid populations? Salmonids domesticate easily, as illustrated by the success of production hatchery operations, and can be selectively bred, as illustrated by steadily shrinking body size in wild populations; however the extent to which unintentional selective regimes resulting from human activities have altered population processes is unknown.

An Hierarchical System of Monitoring

To meet the challenge of monitoring and evaluation, the region will deploy a monitoring program that involves three tiers of sampling, in ascending detail, in both freshwater systems and the estuary. Table 15 summarizes the entire monitoring scheme. Below, for each of these two areas, the purpose of each tier is described first, then the data that will be collected at each tier in general terms. Following this, specific details for environmental status monitoring and compliance monitoring programs that complete the necessary data collection are provided. Finally, the further analyses and activities that must be completed before a detailed monitoring program can be established are briefly outlined.

Tier 1. Tier 1 sampling is the broadest of the sampling levels, comprising the greatest number of sites, sampled at the lowest frequency. It is designed to give the broadest picture of salmonid population status and the condition of the habitats in which they are found. Tier 1 data will contribute to population status monitoring, environmental status monitoring, the quality of databases and compliance monitoring. It has the potential to contribute to effectiveness monitoring in those situations where the expected population response is range expansion. Specific goals associated with this tier are: a) defining areas currently utilized by adults and juveniles; b) detecting altered status of populations due to range expansion or shrinkage; c) identifying associations between salmon presence and habitat attributes; and d) ground-truthing regional habitat quality data bases.

To achieve these goals, several types of data must be collected. Specifically:

Freshwater systems

a. *Fish.*
- Presence/absence of spawners and/or juveniles.
- Presence/absence of hatchery-origin spawners.

b. *Habitat.* Habitat variables selected for Tier 1 monitoring and database ground-truthing are those that either preliminary statistical analyses link to annual population growth rate or are thought to be important, but are lacking from available databases. These variables are:
- Stream temperature
- Pesticide and heavy metal contamination (water sample)
- Presence/number of diversions or dams
- Qualitative or quantitative assessment of erosion processes
- Channel modification (including placer mining)
- Channel morphology
- Substrate
- Riparian condition
- Categorization of land use in the riparian area
- Categorization of habitat types (e.g. side channels, pools, etc.)
- Presence/absence of non-indigenous fish species or dominant riparian plant species

c. *Compliance monitoring.*
- Checklist of otherwise un-monitored actions in sampling area (e.g., are riparian fences intact?)

Table 15. Outline of proposed monitoring and evaluation sampling design

	Tier 1	Tier 2	Tier 3	Landscape imagery	Compliance logbook
Sampling frequency	Once every 3-4 years	Annually	Frequency dependent upon study; minimum annually	Once every three years	Once every 6 months (action agency); arbitrarily to monthly (regulatory agency)
Relevant to monitoring types*	1,2,3,4,5	1,2,3,4,5	3,5	2	5
Goals[#]	A, B	B, C	C, D	B	
Number of sites	To cover all potentially used areas in a population	To be determined by power analyses	Minimum 3 per ESU; minimum 2 for each major management action	Entire Columbia Basin	All management actions
Data type --salmonid population	Presence/absence	Counts of juveniles and spawners	Dependent on management action; Hatchery spawner reproductive success	None	None
Data type -- habitat	General, qualitative	Qualitative and quantitative	Quantitative, dependent on management action	Landscape-level attributes	None

*Relevant to monitoring types: 1 = population status monitoring, 2 = environmental status monitoring, 3 = effectiveness monitoring, 4 = quality of regional databases, 5 = compliance (implementation) monitoring
Goals: a = establish fish habitat use or range; b = establish associations between environmental characteristics and population status; c = estimate population growth rates or stage-specific survival rates; d = establish mechanistic links between management actions and salmon population response.

Estuary

a. Fish.
- Presence/absence of wild smolts
- Presence/absence of hatchery-origin smolts

b. Habitat. Habitat variables selected for Tier 1 monitoring in the estuary are very general, and will be refined as our understanding of fish utilization of the estuary and plume increases. Preliminary Tier 1 habitat variables are:
- Temperature
- Salinity
- Pesticide and heavy metal contamination (water sample)
- Depth
- Turbidity
- Zooplankton concentration
- Presence/abundance of non-indigenous species

c. Compliance monitoring.
- Checklist of otherwise un-monitored actions in sampling area

Tier 1 sites will be sampled on a 3 to 4 year rotation, with each site being sampled once in that interval. Sites will be distributed to sample the full range of habitats in the area potentially occupied by the population of interest. A seasonal component will be important, particularly for juvenile surveys, to determine habitat use and availability at different times of the year.

Tier 2 sites: The monitoring at Tier 2 sites is designed to give a more detailed picture of population status, allowing, in turn, a more detailed assessment of relationships between environmental characteristics and trends in salmonid populations. Tier 2 data will form the backbone of population status monitoring, as well as environmental status monitoring. It also has the potential to contribute to effectiveness monitoring and compliance monitoring.

Freshwater

For freshwater systems, specific goals associated with this tier are: a) defining population growth rates; b) detecting changes in those growth rates, or changes in relative abundance in a reasonable time; and c) identifying associations between population trends and environmental attributes (particularly with changes in those attributes over time). Data to be collected at this tier are:

a. Fish.
- Spawner or redd counts at spawning sites
- Juvenile counts
- Counts of hatchery fish at spawning sites
- Counts at dams and weirs
- Age of spawners (subset of sites)

b. Habitat. Tier 2 habitat factors will emphasize variables that may be improved by management actions, and that are likely to have a direct impact on salmonid survival. In addition to the Tier 1 variables, the following data will also be collected:

- Aquatic insect diversity and abundance
- Primary production
- Abundance of non-indigenous species

c. Compliance monitoring.

- Checklist of actions in sampling area

Estuary.

Specific goals associated with sampling at this tier in the estuary are: a) estimating relative smolt abundance in the estuary, and survival rates during the estuarine phase; b) detecting changes in relative abundance and survival rates between years; and c) identifying associations between smolt abundance or survival rates and environmental attributes (particularly with changes in those attributes over time). Specific data to be collected are:

a. Fish.

- Number of wild and hatchery-origin smolts
- PIT tag data from all fish caught during sampling

b. Habitat. In addition to the Tier 1 variables, the following data will also be collected:

- Presence/abundance of predator species
- Presence/abundance of non-indigenous species

c. Compliance monitoring.

- Checklist of actions in sampling area

Tier 2 sites will be sampled annually. The number of adult sampling sites within each population will be determined by a power analysis that requires a 75% likelihood of detecting a 5% change in lambda over an eight year period. This means that ESUs made up of populations that fluctuate widely will require more tier 2 sites than ESUs with less variable spawner counts. Sites will be distributed probabilistically within a population, ensuring that both "good" and "bad" sites are appropriately represented. To obtain the maximum benefit from habitat data, it may be important to include some stratification (channel type, for example) in the distribution of sites.

Juvenile counts, coupled with spawner or redd counts, will ultimately provide a measure of egg-to-smolt survival. This will improve estimates of population growth rate, and can serve as a "baseline" usable in other monitoring efforts (see Tier 3).

The number of sites to be sampled in the estuary will also be determined by a power analysis, once sufficient data to conduct that analysis are available.

Tier 3 sites: Tier 3 monitoring is the most detailed of the monitoring levels. The specific goals of this tier are: a) establishing mechanistic links between management actions and fish population response; and b) determining the relative fitness of hatchery fish. The information gathered at this level will address some of the most fundamental questions necessary for

effective management of anadromous salmonids. First, the relative fitness of hatchery fish must be determined before the true status of populations can be known, and therefore before appropriate recovery goals can be established. Second, by establishing causal and quantitative links between management actions and population responses, monitoring at this tier will contribute to our predictive ability, and therefore to a better understanding of which actions are necessary and sufficient for population recovery.

Sampling at Tier 3 sites used for effectiveness monitoring will be specific to the management action being studied. However, each study must assess age-specific survival appropriate to the management action. In many cases, this may involve several life stages. Sediment reduction, for instance, may affect both egg to fry and fry to smolt survival rates. Whenever possible, PIT tags or other individual marking techniques should be utilized, in order to follow the fates of individual fish as a function of their history. Such individually-based studies are important for identifying the effects of environmental conditions that are realized at later life stages. Size or growth rates, as well as demographic rates may be important parameters in these studies. In addition, both habitat response and population response to the management action should be assessed in order to identify the factors causing any fish population responses. Finally, appropriate control sites must be paired with the treatment sites in order to establish those links unambiguously. Studies conducted under the Tier 1 and 2 monitoring programs will be important for identifying the important variables by which sites should be paired. When possible, these studies should be conducted in the context of a BACI design, which allows environmental impacts, such as ocean cycles to be filtered out. Information from other monitoring tiers (especially Tier 2) will also provide important "controls" against which changes in Tier 3 studies can be assessed.

Specific sites and management activities to be included in Tier 3 monitoring will be rigorously identified. Associations of environmental condition and population status identified through Tier 1 and 2 monitoring will play an important role in prioritizing activities for Tier 3 evaluation. Specific sites for these actions (and for controls for those actions) should be identified, considering important environmental factors (or strata). In some instances, however, pragmatic concerns may play a role in choosing sites. For instance, historically sampled index stocks will be especially valuable contributors to the Tier 3 network because their historical time series offer special opportunities for distinguishing responses to management from chance fluctuations. Or, local groups may plan and fund a management activity that provides an opportunity for detailed effectiveness monitoring.

As a general rule, at least three Tier 3 studies (each necessarily comprising several sites) should be identified within each ESU. In addition, at least two studies in the Columbia River Basin aimed at each major management action (e.g. alteration of grazing practices, compliance with water quality standards, road closures, etc.) must be conducted.

7.2.3 Compliance

In this monitoring scheme, compliance monitoring involves the implementation of management actions (i.e., the work's quality with respect to meeting design tolerances within the required timeframe), and encompasses two questions:

- Are the mandated management actions being implemented appropriately?

- Have they been implemented in their entirety, and maintained, if necessary?

While these questions appear trivial, this component of a monitoring program is very important for two reasons. Scientifically, it is important to know that the management action has been put in place when evaluating its effects (particularly if the effects are measured, in part, away from the management activity, as the effects of hydrosystem or estuarine improvements are likely to be). From a regulatory perspective, this monitoring aspect will ensure that agencies and individuals responsible for mitigation or restoration activities in fact complete their responsibilities.

Some compliance monitoring can be conducted during the three tier system, as described above. However, not all sites will be checked during this program at the appropriate frequency. For the major management actions, compliance monitoring will be part of the tier 3 monitoring sites whose aim is to also quantify the response of fish. However, there will be many small management actions (involving local habitat or stream improvements) that cannot be associated with detailed tier 3 sites. For these many small management actions, the agency or party conducting each action will be responsible for keeping a log book of implementation, which is entered monthly into a web-based data archive. Randomly (and erratically) NMFS will send out field staff to check on the log books and validate their entries.

7.3 Analytical Framework

Collecting data in the absence of an analytical framework is nearly as pointless as collecting data without an underlying question. An analytical framework provides the structure on which to hang both the data as well as the questions that drive the data collection. On a very simple level, the analytical framework that underlies this monitoring and evaluation program is the mechanistic basis for population regulation in Salmon River Basin salmonids. In this case the analytical framework is the link between all of the questions posed by the monitoring and evaluation program. That is to say, the analytical framework is the predictive relationship between all of the data collected, the mechanisms that they imply, and the future condition of the salmonid fishes in the Salmon River Basin.

To be useful the analytical framework must contain sufficient specificity that all mechanistic relationships can be included while simultaneously having sufficient generality that no interactions are impossible. To be analytical a framework must be mathematical, but all mathematical models impose mechanisms through their fundamental equations. Therefore, care must be taken in choosing a model that either has the same underlying mechanism that acts to generates the observations to be analyzed, or has such a general form so as not to imply a mechanism that acts at the same level as the data. If, as in the case with salmonid population regulation, the true mechanism is unknown, only a model of the latter type can be posed.

The best-suited model form for a completely undetermined population dynamic is a matrix model. The only implied mechanism that cannot be avoided with a matrix population model is

the assumption that population trajectories are Markov processes: population sizes at the next instant in time depend only on current conditions. The beauty of matrix population models lies in their generality – all forms of environmental and biological mechanisms that determined transition probabilities between life stages can be included. The only real limit is data, never a way to include it in the framework.

Thus, the analytical framework is the conceptual framework for the entire process of developing, implementing and adapting this monitoring and evaluation program. The framework of a matrix population model guides the questions that structure the monitoring and evaluation program, and a matrix population model is the conceptual framework for data collection and analysis. Since the entire program is framed as a series of questions informing the determination of population dynamical processes, as these relationships are developed their place in the mechanistic framework can be adapted. As we isolate population regulatory mechanisms we can easily refine both the manner in which data is collected and the analysis is structured because we have implemented a general flexible framework with mechanistic question driven data collection - an adaptive monitoring and evaluation program.

7.4 Logistics, Implementation and Coordination

A number of groups, most notably the Forest Service's Pacific NW Forest Science Laboratory, the EPA, and the Oregon Coastal Salmon Restoration Initiative, have developed scientifically rigorous monitoring protocols for aquatic systems. The NWFSC will work in conjunction with these groups and other regional agencies to refine the monitoring scheme proposed here, to evaluate formally the necessary temporal and spatial replication, to identify specific localities at which the monitoring program will take place, and to develop data collection protocols.

Implementing this ambitious monitoring program will require an extraordinary degree of coordination among an enormous number of regional management agencies. Population status data are fundamental not only to risk assessment but also to determining mechanisms of population regulation. Local agencies will necessarily play an important role in acquiring and processing these data. Environmental condition data is important both for identifying patterns between salmonid productivity and natural or anthropogenic factors and in providing the important "Before" component of a BACI experiment. It is anticipated that much of these data will be collected during subbasin assessment programs underway. Additional coordination will be important to ensure that the full complement of environmental factors are assessed during these efforts and that on-going data are collected as needed. Monitoring aimed at determining mechanistic cause-and-effect relationships between environmental conditions or management actions and population responses will be conducted on a case-by-case basis, dependent on the scale of the action. In these cases, agencies implementing actions and the monitoring design team may coordinate with groups or local agencies with specific expertise to apply appropriate data collection protocols.

Because this effort will be conducted on such a large scale, it will be imperative that all data collection and reporting be conducted in a manner that allows the data to be used not only for scientific support of management actions, but also to address more basic or theoretical issues that

have the potential to inform management decisions. In particular, standards for data must encompass data collection, reporting, and access to that data.