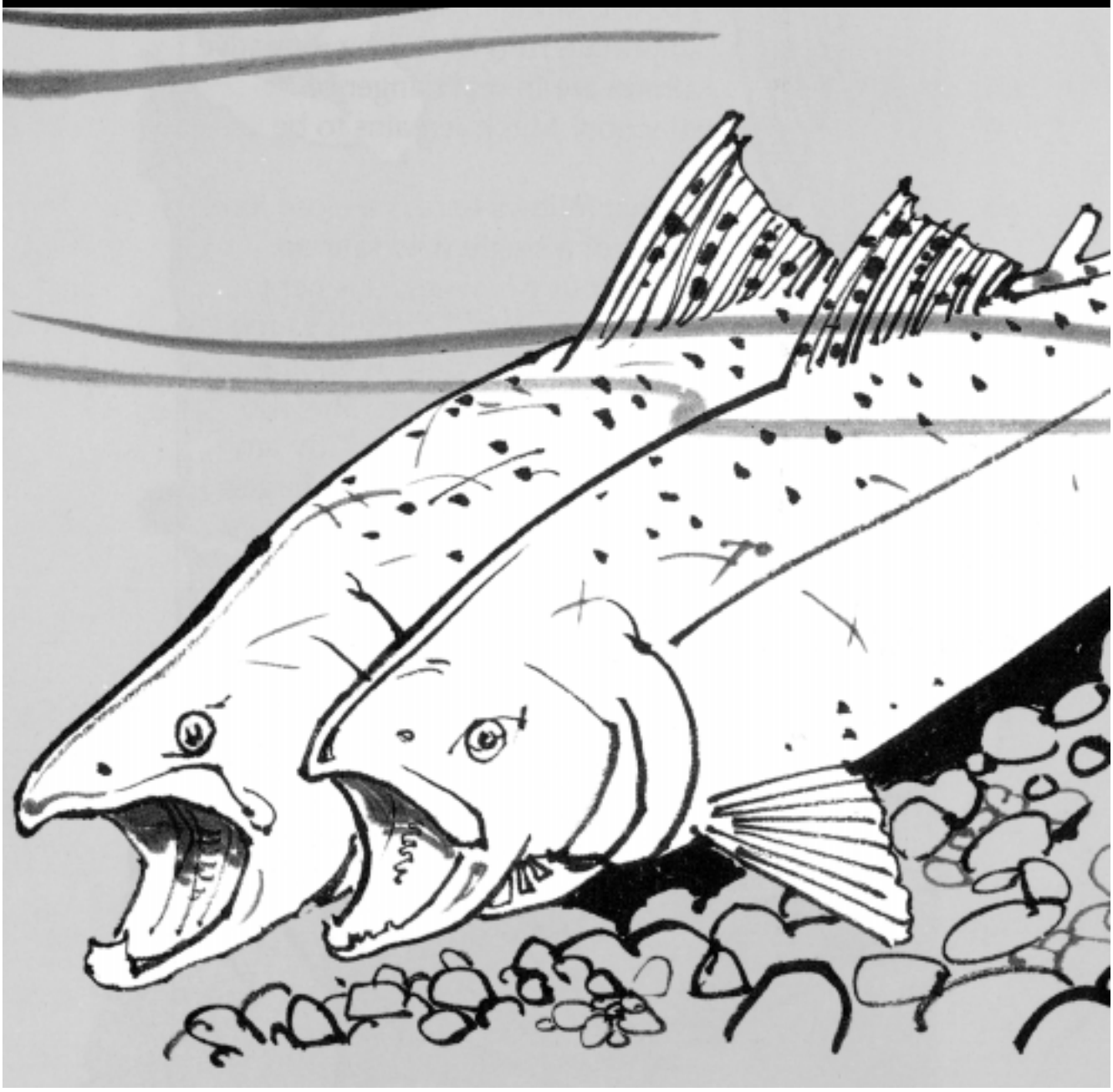
Conservation of Columbia Basin Fish

Final Basinwide Salmon Recovery Strategy

Volume 1

A Publication of the Federal Caucus • December 2000



Conservation of Columbia Basin Fish

Final Basinwide Salmon Recovery Strategy

Volume 1

December 2000

Prepared by:

The Federal Caucus

Army Corps of Engineers
Bonneville Power Administration
Bureau of Indian Affairs
Bureau of Land Management
Bureau of Reclamation
Environmental Protection Agency
Fish and Wildlife Service
Forest Service
National Marine Fisheries Service

For More Information

This document, as well as supporting documents, are available on the Federal Caucus Web site: *www.salmonrecovery.gov*.

You may also request paper copies or a compact disc (CD) of these documents by calling 1-888-921-4886, or by writing to:

Federal Caucus
c/o BPA - P
P.O. Box 3621
Portland, OR 97208

Table of Contents

Volume 1

List of Tables

List of Figures

List of Maps

Volume 2: Technical Information

The following information is found in Volume 2, which is bound separately:

- Habitat Element of the Basinwide Salmon Recovery Strategy
- Harvest Element of the Basinwide Salmon Recovery Strategy
- Hatchery Element of the Basinwide Salmon Recovery Strategy
- Hydropower Element of the Basinwide Salmon Recovery Strategy
- Biological Background and Recovery Planning
- Monitoring and Evaluation
- Implementation

Volume 3: Regional Coordination and Public Involvement

The following information is found in Volume 3, which is bound separately:

- State and Tribal Discussions
- Public Involvement Summary and Responses to Comments

Conservation of Columbia Basin Fish

Final Basinwide Salmon Recovery Strategy

Executive Summary

Introduction

Many salmon and steelhead populations in the Columbia River Basin will be extinct or nearly so by the end of this century, unless the region makes major changes to improve their survival. Federal agencies have a fundamental responsibility under the Endangered Species Act (ESA) to prevent extinction and foster recovery of listed species. This paper presents the federal government's recommendations for actions needed to recover **threatened** and **endangered** salmon and steelhead in the Columbia River Basin. It is designed to complement the recovery plans for resident fish and other aquatic species, and builds on actions already taking place to recover these species. Columbia Basin fish and wildlife will thrive again only if the people and governments of the basin work together; this paper proposes the federal government's role for doing its part to conserve a precious national resource.

Words in bold are defined in the glossary.

In 1994, a federal court rejected the 1993 Columbia River hydropower biological opinion, saying the "system was crying out for a major overhaul." These were the strongest words yet heard from the courts about the urgency of restoring salmon and steelhead runs to the Snake River. They served as a wake-up call for federal agencies, states, and other followers of Columbia Basin recovery efforts. The following year, the federal government initiated that overhaul in a new biological opinion that fundamentally altered the way the federal power system is operated. That opinion placed the needs of fish on equal footing with power generation, flood control, navigation, and irrigation. In the process, it brought changes to the power system that have significantly improved juvenile and adult fish survival.

The intervening 5 years have brought new information and changed circumstances to the issue. Nine more populations of salmon and steelhead have been listed under the Endangered Species Act. Notably, these listings included chinook and steelhead species inhabiting the Upper Columbia, Mid-Columbia, and Lower Columbia regions. The strategies in the 1995 decision focused on the options for rebuilding Snake River stocks alone. The additional listings have broadened the recovery challenge beyond the Snake River to encompass the entire basin.

In addition, new research and analyses have focused increased attention on human impacts on listed fish outside the hydropower system, exposing the extent to which land use, tributary water management, hatchery policies and harvest practices have contributed to the declines. While science generally points to the need to continue improving conditions in the hydropower system for fish, this new research suggests that the greatest opportunities for survival improvements may lie outside the scope of the hydropower corridor. It further suggests that recovery may hinge on efforts to restore health to the tributaries and estuary where these populations spawn and rear.

The federal overhaul begun in 1995 is not yet complete and it must be broader in scope than earlier thought. As a new millennium begins, native salmon and steelhead, and many resident fish species, remain in a state of perilous decline throughout the Columbia River Basin concurrent with rapidly increasing human population growth and even greater pressure on existing natural resources. This Basinwide Salmon Recovery Strategy calls for changes needed to recover salmon and steelhead, including additional improvements to the hydropower system, but also those needed to address human impacts to fish in all life stages. It also tries to account for natural cycles of environmental variation.

Federal agencies can implement much of the Strategy using existing authorities and capabilities. Some recommendations will

require new authorizations and congressional support or action by state, tribal and local governments. The federal agencies cannot solve this problem alone, or by acting unilaterally. Strong action by state and tribal governments, local authorities, and other participants must occur for recovery to succeed. All parties must coordinate efforts to fully realize benefits to species in decline.

The Federal Caucus Strategy places priority on actions with the best chance of being implemented, the best chance of providing solid and predictable biological benefits, and the best chance of benefiting the broadest range of fish species. It calls for a contribution from governments and individuals at all levels, yet it also recognizes and complements the strong efforts already underway throughout the region.

It is important to recognize resources are limited. Congress and the region are most likely to commit resources to actions with immediate, predictable and broad benefits. Recovery efforts will be most effective – and resources most efficiently used – if all of the federal agencies coordinate their respective programs, and if they collectively coordinate with state and tribal programs.

The actions recommended are presented as a Strategy, not a menu. Improving conditions in many life stages – freshwater spawning and rearing, juvenile migration, ocean transition, and upstream migration – is the most risk averse approach to achieve recovery of threatened and endangered salmon and steelhead. The Strategy includes immediate actions aimed at all life stages to prevent extinction, and long-term actions to foster recovery. It is based on a thorough review of the best available scientific information about the **anadromous** fish life cycle, from spawning and rearing, to river migration and overwintering, to hatchery interactions, to predation and ocean conditions. Actions taken to recover anadromous species are also intended to benefit resident fish and other aquatic species.

There are gaps and unavoidable uncertainties associated with the science. Therefore, the Strategy calls for a comprehensive research monitoring and evaluation program to reduce those uncertainties that are critical to future decisions regarding salmon and steelhead recovery, while providing information for needed adjustments to future strategies. The federal agencies will measure progress in the life stages against performance standards for each stage. Performance standards are central to the program because they provide clear objectives, measurable results and accountability.

At the core of the Strategy are actions federal agencies can take now to stabilize populations and show immediate results across all life stages. Habitat actions will protect and restore tributary habitat to improve survival during spawning and rearing. Actions include removing passage barriers, screening diversions, purchasing in-stream flow rights, restoring water quality and acquiring high-quality habitat.

The estuary is an important habitat used by all salmon and steelhead in the basin. Actions in the estuary include the restoration of tidal wetlands, rearing channels and flood plains. Actions in other sectors will help prevent extinction in the near term. These include improving passage through the dams, constraining harvest, reforming existing hatcheries, and intervening with conservation hatcheries on an emergency basis where populations are at risk of imminent extinction.

The Strategy also calls for coordinated **subbasin** assessments, plans, and actions as proposed by the Northwest Power Planning Council. Plans and actions will be organized around subbasins and **watersheds**, and will be developed with states, local governments, tribes, private parties and federal agencies. This effort will require a solid commitment to action and coordination by all parties.

Much of the regional debate has focused on removal of Snake River dams. There is little doubt dam removal would benefit Snake River salmon and steelhead. The National Marine Fisheries Service (NMFS) is not recommending it at this time, however, for several reasons. There is scientific uncertainty about whether breaching dams is necessary to achieve recovery and whether breaching alone can lead to recovery. Only Snake River fish show a benefit from breaching, with no benefit to the other eight listed populations that do not originate in the Snake River Basin. Dam removal is not within the existing authority of the federal agencies, and cannot be implemented in a short time frame. And its high cost could preclude other actions needed

throughout the basin. In short, the option of Snake River drawdown ranks as a lower priority than other available options because of narrow benefits, high uncertainties and high costs, and on balance does not appear to be warranted at this time.

The aggressive Strategy is designed to provide immediate benefits and lead to salmon and steelhead recovery. This approach leaves breaching four lower Snake River dams on the table as a future option, but challenges hydropower system operators now to meet rigorous survival goals over a discreet period, using continued improvements in flow and **spill** management and structural improvements at dams. System performance will be evaluated against science-based, peer-reviewed performance standards at 3-, 5-, and 8-year intervals. The dam removal question will again be joined if progress is inadequate or the Snake River populations decline, but not prior to testing the actions contained in the overall Strategy. The Strategy also commits the federal hydropower system to fund habitat, harvest and hatchery actions to **mitigate** for unavoidable mortality in the federal hydropower system.

Background

The decline of the Columbia's once-numerous fish runs is well documented. Human activities that have caused changes in habitat, and created harvest, hatcheries, and hydropower (the Hs) have caused the decline of these fish. In December 1999, the nine agencies that make up the Federal Caucus released a draft Conceptual Recovery Plan outlining the difficult choices the region faces in recovering listed species. A revised draft was submitted to states and tribes on July 27, 2000 for technical review and comment.

In 15 public hearings, the Federal Caucus heard from more than 9,000 Northwest citizens. Over 60,000 written comments were received on the Plan and the Army Corps of Engineers' Lower Snake River Juvenile Salmon Migration Feasibility Study and Draft Environmental Impact Statement. The Federal Caucus also met with the region's Indian tribes and state officials. The tribes have a special interest in the natural and cultural resources of the basin, especially its fish and wildlife. Many tribes also have treaty-guaranteed access to fish and wildlife. The messages are clear. The people and governments of the region will make sacrifices to save the fish, but they want the burden to be shared, actions that will work, and respect for cultural resources.

This Strategy reflects those comments and updated scientific information. Federal agencies will use this Strategy as a blueprint to guide federal actions and interactions with state and local governments and tribes. The National Marine Fisheries Service and the U.S. Fish and Wildlife Service (USFWS) will use it to guide their decision-making through biological opinions issued under the Endangered Species Act. The Bureau of Indian Affairs (BIA) will work to ensure that harvest reductions do not unfairly restrict treaty harvest.

Program Goals

The Federal Caucus has seven goals for this Basinwide Salmon Recovery Strategy:

- *Conserve Species.* Avoid extinction and foster long-term survival and recovery of Columbia Basin salmon and steelhead and other aquatic species.
- *Conserve Ecosystems.* Conserve the ecosystems upon which salmon and steelhead depend, including watershed health.
- *Assure Tribal Fishing Rights and Provide Non-Tribal Fishing Opportunities.* Restore salmon and steelhead populations over time to a level that provides a sustainable harvest sufficient to allow for the meaningful exercise of tribal fishing rights and, where possible, provide non-tribal fishing opportunities.
- *Balance the Needs of Other Species.* Ensure that salmon and steelhead conservation measures are balanced with the needs of other native fish and wildlife species and do not unduly impact upriver interests.
- *Minimize Adverse Effects on Humans.* Implement salmon and steelhead conservation measures in ways that minimize their adverse socio-economic and other human effects.
- *Protect Historic Properties.* Consistent with the requirements of the National Historic Preservation Act (NHPA) and other applicable law, assure that effects of recovery measures on historic properties are

identified and addressed in consultation with all interested and affected parties.
- In implementing recovery measures, seek to preserve resources important to maintaining the traditional culture of basin tribes.

The Strategy includes a combination of actions most likely to meet these goals. The actions reflect the best scientific understanding of what is necessary to conserve the species and their ecosystems. The Strategy contemplates maintaining tribal fishing opportunities in the near term, and expanding them over time. The Strategy recognizes the needs of other at-risk fish, wildlife and plant species within the basin. The Strategy seeks to provide a measure of social and economic certainty by seeking maximum benefit from the available resources, with clearly established implementation and monitoring processes.

Biological Considerations

The scientific analyses examined the risks and opportunities facing all salmon and steelhead population groups (known as **Evolutionarily Significant Units**, or ESUs) listed under the ESA. In addition to assessing extinction risks, the analyses looked at how much improvement is needed to achieve survival and recovery. In short, the analyses give a sense of how the fish are performing now, the level at which they need to perform to avert risk, and the areas where improved performance are likely to have the greatest effect. The results are sobering. Generally, fish from the upper Columbia and Snake rivers have the furthest to go to reach recovery. Spring chinook in particular have an extremely high extinction risk in both the upper Columbia and Snake rivers.

The analyses also looked at those life stages where survival improvements would provide the greatest benefit. Generally, these are the life stages where the fish suffer the greatest mortality. The analysis shows that the highest mortality occurs in the first year of life and in the transition from freshwater to saltwater. Although mortality from dam passage is high for ESUs in the upper Columbia and Snake rivers, improving downstream survival, by itself, is unlikely to recover any of the upper basin species. For all ESUs, the analysis concluded that improvements in more than one life stage give the best chance for recovery.

There will always be a high degree of uncertainty about the science, given the sheer number of variables that affect salmon and steelhead performance. However, the agencies are prepared to take some actions in the face of uncertainty, based upon current knowledge. Ongoing uncertainties simply emphasize the importance of accountability, monitoring, and evaluation. It is critical to maintain the ability to adapt the strategy to reflect the latest information as the science evolves.

Recovery Strategies:

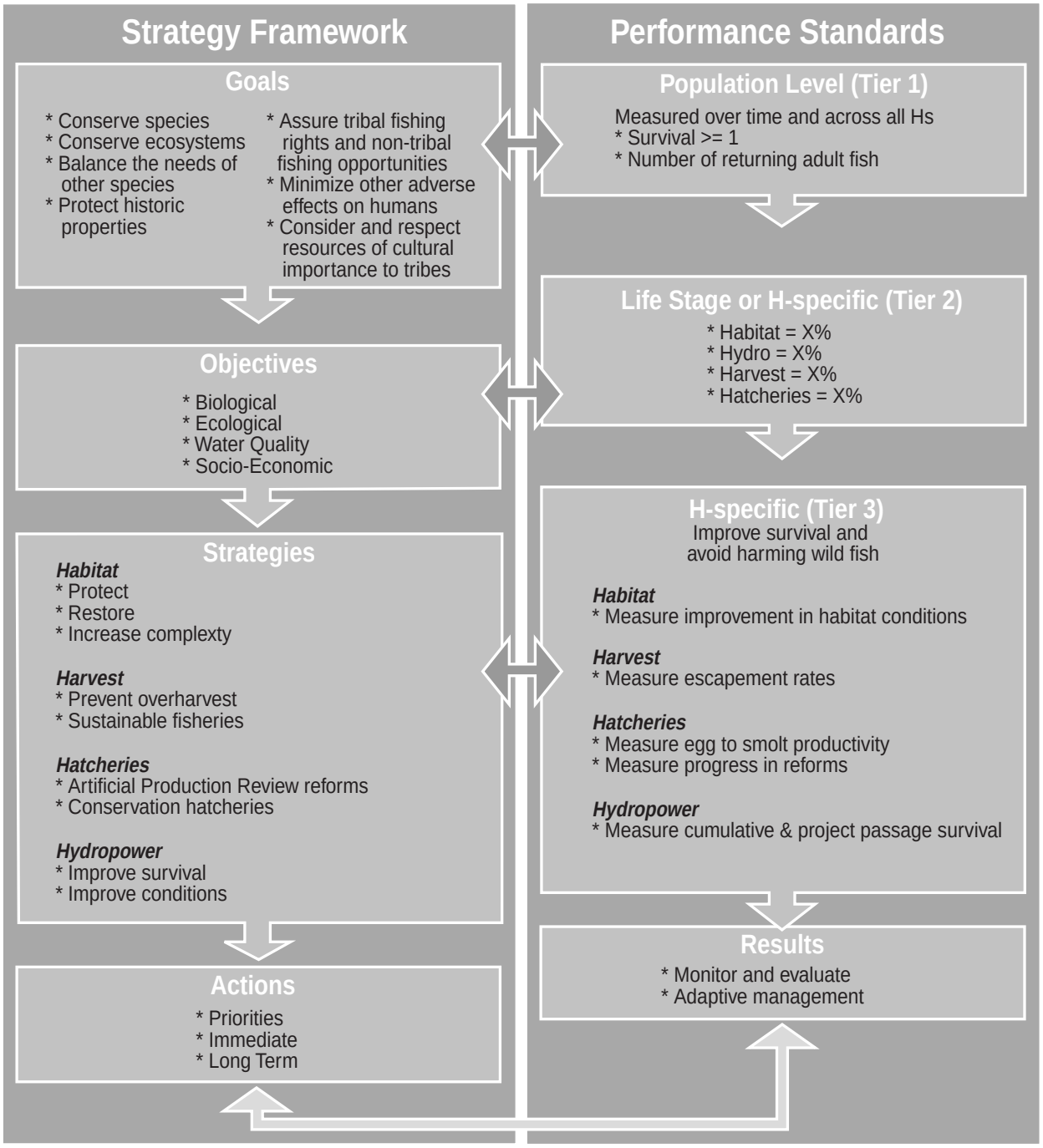
- Habitat: Take immediate actions to restore streamflow, remove passage barriers, protect high quality habitat and screen diversions.
- Habitat: Complete subbasin assessments and plans to prioritize longer-term actions.
- Hydropower: Maximize survival in the hydropower system through flow, spill, passage, and water quality measures and maintain dam breaching as a future option depending on progress in fish recovery.
- Hatcheries: Prevent extinction with safety net projects.
- Hatcheries: Reform hatchery practices to reduce risks to wild fish and contribute to recovery goals.
- Harvest: Constrain harvest levels.
- Harvest: Expand fishing fishing opportunities where possible, including selective fish programs.

Basinwide Salmon Recovery Strategy

The Basinwide Salmon Recovery Strategy identifies immediate actions to prevent extinction and foster recovery by improving survival across all life stages. It emphasizes actions that are currently authorized, that have predictable benefits, and that benefit a broad range of species. It contains strategies and specific actions that will make federal, state and local actions more aggressive and more effective (see Figure 1). For the longer term, it identifies steps to develop recovery plans. Its success is premised on securing contributions to recovery from all governments within the region.

Fixing salmon and steelhead **habitat** is particularly challenging. These fish range through federal and nonfederal land, forests, farms and cities. A vast number of human

Figure 1 Basinwide Salmon Recovery Strategy



activities affect their habitat. In addition, very few studies have been done that quantitatively link management actions with habitat quality, and habitat quality with fish production. Yet there is no doubt fixing habitat is central to any recovery plan. Survival improvements are likely to have the biggest effect in the first year of life (when most of the fish are in the tributaries) and during the transition to salt water (when the fish are in the estuary). Fixing tributary and estuary habitat is key to

Habitat Plan:

- Immediate Actions – Improve in-stream flows, restore water quality, screen diversions, remove passage barriers, secure high quality habitat.
- Manage federal lands to protect fish.
- Protect and improve estuary habitat.
- Protect and improve tributary habitat.
- Improve mainstem habitat.

recovering the fish and is the centerpiece of the Strategy. Actions in the Strategy focus on tributary habitats, both federal and nonfederal; **mainstem** habitat, estuary habitat, and implementation.

For tributary habitats on nonfederal lands, the federal agencies will first fund actions that will have immediate benefits. These include actions aimed at removing passage barriers, screening diversions, increasing in-stream flow, restoring water quality, and protecting high quality habitats through the purchase of land or conservation easements across all lines of land ownership.

For long-term actions, the Basinwide Salmon Recovery Strategy endorses the Northwest Power Planning Council strategy of conducting subbasin assessments and developing subbasin plans. This strategy is reflected in the Council's recent program amendments and will be included in the **Action Agencies'** 1- and 5-year implementation plans. The Caucus agencies worked with the Council to develop an assessment template and a work plan to have a team of professionals complete the assessments. Once the assessments are complete in 2001 and 2002, the federal agencies will participate with state agencies, local governments, tribes and stakeholders to develop subbasin plans. As a complement to subbasin assessments and plans, NMFS has also begun a recovery planning effort that will establish population and ESU goals for abundance, productivity, distribution and diversity. The subbasin and recovery plans will then create the priorities for federal actions and funding.

For tributary habitats on federal land, the federal land managers will protect existing high quality habitat and accelerate restoration in high priority subbasins. In the short term, federal land will be managed under current programs that protect important aquatic habitats. Those programs will be augmented in important subbasins by a targeted restoration effort. After a Record of Decision (ROD) is signed, federal land on the east side of the Cascades will be managed under the Interior Columbia Basin Ecosystem Management Project (ICBEMP), which will rely on subbasin review and watershed assessments, and plans to target further habitat work. On the west side of the Cascades, federal lands are managed under the Northwest Forest Plan.

Federal agencies will assess mainstem habitat and implement experimental programs to create more natural habitat areas along our system of reservoirs. They will also establish a management plan to protect the Hanford Reach, home to a healthy core population of fall chinook.

For the estuary, the Lower Columbia River Estuary Program, a partnership between EPA, the Corps, and state and local governments and citizens, will be the foundation of the recovery effort. As part of this Strategy, federal agencies will work with state, local, tribal, and private partners to acquire or restore thousands of acres of estuary habitat over the next 5-10 years, creating a Lower Columbia River Greenway to benefit migrating fish. Predator control and improved river flows will be prominent features of efforts to improve the estuary.

The salmon's vast geographic range spans literally hundreds of different jurisdictions. Lack of coordination among these jurisdictions can undermine the best-laid habitat protection plans. The Basinwide Salmon Recovery Strategy emphasizes coordination among federal agencies, and between the federal agencies and others. Coordination will occur through a federal Habitat Team, which will also provide a basin-level focus and one-stop shopping for states, local governments, tribes and others working to protect and restore habitat. In addition to coordinating federal funding with the subbasin plans adopted by the Council, the team will provide technical assistance, information on ESA and Clean Water Act compliance, and coordinate federal funding.

Another important aspect of implementation is monitoring and evaluation. The federal agencies have identified critical uncertainties that must be answered to establish an effective habitat program. The Strategy proposes a comprehensive, basinwide monitoring effort that will address these critical uncertainties.

The Basinwide Salmon Recovery Strategy proposes to constrain **harvest** to no more than recently-established current levels (expressed as harvest rates); seeks opportunities to reduce harvest impacts on listed fish where necessary and effective; and seeks additional fishing opportunities in fisheries that reduce effects on **wild fish**, with particular emphasis on the further development and deployment of

appropriate selective fisheries.

Cutting harvest immediately increases spawning escapement and can reduce near-term risks of extinction. However, reductions in harvest rates on natural stocks have been the first response to declining production and ESA listing, and now harvest rates are so low for most stocks that further reductions will not yield major benefits. Most of the harvest impacts remaining on listed fish occur in treaty-protected fisheries, which have been especially hard-hit in recent years.

Harvest Plan:

- In the short term, constrain harvest at currently reduced rates.
- Increase selectivity of harvest and reduce take of listed fish further.
- Provide opportunities for increased harvest

Although further reductions in the already-reduced harvest might provide small additional benefits for listed fish, the Strategy recommends against such action because of the high standing importance of the treaty fishing right and the federal trust obligation.

Federal agencies will, however, seek to reduce impacts from harvest on listed fish where such additional cutbacks are necessary and effective at aiding recovery. They will enable more **selective fishing** opportunities by marking most unlisted hatchery fish, developing and promoting selective fishing techniques and locations to open up or restore opportunities for increased tribal and non-tribal fishing while still protecting the listed stocks, and providing resources to improve management capabilities needed by increased reliance on selective fisheries. They will also provide funds to buy back state-issued commercial fishing licenses when doing so would be effective at reducing fishing.

The Basinwide Salmon Recovery Strategy contains two primary **hatchery** initiatives. The first is to reform all existing production and mitigation hatcheries to eliminate or minimize their harm to wild fish. The second is to implement "safety net" projects using various artificial production techniques such as **supplementation** and **captive broodstock programs** on an interim basis to avoid extinction while other recovery actions take effect.

Protecting and managing for species diversity is a key objective for reforming hatchery operations. Diversity is reflected in the wild fish that are genetically adapted to the areas they inhabit. To protect this diversity, it is critical that hatcheries produce fish that are biologically appropriate for the areas where they interact with **natural fish**. The Strategy requires that any agency operating a hatchery develop a Hatchery and Genetic Management Plan (HGMP) to govern production. These plans will ensure that hatcheries are operated to manage risks to wild fish and to improve the survival rates of the hatchery stocks themselves.

The second part of the hatchery plan is to use conservation techniques at least on an interim basis, to prevent extinction by stabilizing or increasing numbers of listed fish. This will be done by a variety of techniques and projects tailored to the particular circumstances. Some will involve collecting eggs and milt from wild fish, raising the young fish for a period of time in a hatchery or semi-natural environment, then releasing them in natural production areas. The intent is to increase the abundance of natural spawners. Other projects may use captive-brood techniques, where the juvenile fish are raised for an entire generation or two before they are released back in the wild. Still others will employ more conventional supplementation techniques.

Another key element of the hatchery plan will be to establish a research program de-

Hatchery Plan:

- Reform production facilities to minimize harm to wild fish and maximize potential benefits for recovery.
- Use "safety net" projects to avoid extinction.
- Conduct an aggressive research, monitoring, and evaluation program to better determine hatchery impacts, positive and negative, over time.
- Transfer operation of certain hatchery production programs or ownership of certain hatcheries to tribes, subject to approved HGMPs, to facilitate co-management and tribal fisheries.

signed to clarify wild-hatchery fish interactions and quantify the effects of these interactions on wild fish.

Another element of the hatchery plan involves using hatcheries to continue to provide fishing opportunities to fulfill mitigation responsibilities. Mitigation programs need to be operated in such a way as to pose little or no risk to listed fish. A variety of techniques exist to do this, such as producing fish for harvest in **terminal** areas and/or other forms of selective fisheries. This is particularly important to assist tribal fisheries. An example of a terminal area program is the ongoing restoration efforts in the Umatilla Basin, which has resulted in fish returning to the river and both tribal and non-tribal fishing opportunities. Because of this program, fishers do not have to fish where **incidental take** might otherwise occur. In some cases, existing hatcheries will be transferred to or hatchery production programs operated by the tribes for these purposes.

All salmon and steelhead in the basin are affected to some extent by the **hydropower** system. The Basinwide Salmon Recovery Strategy calls for an aggressive program of improvements at existing dams, building on the survival improvements from current efforts. The Strategy does not recommend removal of Snake River dams at this time. Instead, it establishes performance standards for survival of juvenile and adult fish, and a schedule for meeting those standards. Performance standards are to be met through an aggressive program of improvements that includes more flow, more spill, and continued improvements in the dams themselves to pass more fish safely.

Hydropower Plan:

- Improve flows.
- Improve spill and passage at dams.
- Improve water quality.
- Reduce fish trucking.
- Implement measures to protect resident fish.
- Conduct analysis of economic and cultural implications of dam breaching.
- Improve nonfederal hydropower dams.
- Consult with tribes on reservoir operations impacts to cultural resources.

The hydropower plan adds an element that was not in the draft Strategy – **off-site mitigation**. The federal agencies responsible for the hydropower system will use appropriated and ratepayer funds primarily to fix habitat, harvest and hatcheries. Part of the ultimate decision on dam removal will depend on the ability of the hydropower system to compensate for fish losses by improving fish survival through off-site mitigation measures.

The hydropower element includes performance evaluations after 3, 5, and 8 years to determine whether the combination of hydropower improvements and off-site mitigation is meeting performance standards. Failure to meet standards could trigger additional consultations under ESA, more aggressive measures within the hydropower system, such as dam breaching, and/or more aggressive off-site mitigation measures. After 10 years, NMFS will determine whether the hydropower system performance has been sufficient to achieve recovery in combination with other measures, and, if not, whether breaching or other actions will be necessary. NMFS would seek review of these determinations by the Independent Scientific Advisory Board.

Implementation

The success of the Basinwide Salmon Recovery Strategy hinges on active and effective leadership and significantly improved coordination among federal, state, tribal, and local agencies. Meeting these challenges successfully will require a renewed level of commitment and discipline for the governments of the Pacific Northwest. Successfully implementing actions in the habitat, harvest and hatchery sectors will be necessary for salmon recovery, regardless of the ultimate decisions by Congress on the subject of removing or reconfiguring federal dams.

A number of specific actions will make federal implementation of salmon conserva-

Implementation:

- Coordinated federal funding and priorities
- Establishment of priorities
- Three, five- and eight-year reviews
- Use of performance standards

tion measures more effective. Most important is securing a level of funds to implement the Basinwide Salmon Recovery Strategy. Also important is coordinated funding and priorities. Federal agencies will continue to participate in the Federal Caucus, which will oversee implementation by federal agencies. The federal agencies will also establish mechanisms to coordinate federal actions in each H. For hydropower, the agencies will work through an improved Regional Forum process like the one that has existed for several years. Habitat actions will be coordinated through the federal Habitat Team described in the habitat section of this document. Harvest will continue to be coordinated through the existing forums in *U.S. v. Oregon* and the Pacific Salmon Commission. Hatchery actions will be coordinated with the Council's Fish and Wildlife Program funding process. NMFS and USFWS will also ensure coordinated and consistent implementation in all of the Hs through future biological opinions.

The federal government will use these mechanisms to coordinate and engage with governments within the region to take maximum advantage of available resources and authorities. Significant initiatives are already underway within the region, including the Council program, tribal programs, state plans, and community-level watershed efforts and recovery plans. The federal government intends its activities to complement and encourage such efforts, not hinder them with additional and redundant mandates.

The Strategy provides a disciplined structure for salmon and steelhead recovery, with specific goals and objectives. A fundamental part of this approach is establishing biologically-based performance standards for listed species for freshwater habitat, the hydropower corridor, and for estuary and early ocean survival. These performance standards will serve as the yardsticks to measure progress and judge whether dam reconfigurations and other actions must occur to rebuild populations and meet treaty obligations.

Research, Monitoring and Evaluation

Properly designed monitoring programs will provide data for resolving uncertainties critical to future decisions, such as determining population status, establishing causal relationships between habitat (or other) attributes and population response, and assessing the effectiveness of management actions. By resolving critical uncertainties, the monitoring programs will be a cornerstone in identifying alternative actions and refining recovery efforts. The monitoring and evaluation program is therefore not only an integral part of the management actions, but also a critical component of a recovery plan or **adaptive management** and will afford managers the information to maintain or change strategies as necessary.

A complete monitoring program will address the following four major groupings of questions:

- What is the status of **salmonid** populations; does that status change through time?
- What are the conditions in areas of different salmonid abundance; and, are there systematic patterns suggesting that specific natural or **anthropogenic** factors affect salmon population dynamics?
- Is there a cause and effect relationship between salmonid population responses and changes in conditions locally or across the landscape?
- Have management actions been implemented; have they been implemented appropriately and in their entirety?

Conducting monitoring and evaluation effectively will require that both data collection and the implementation of management actions be highly coordinated. Collecting data to address any of these questions will require attention to issues of experimental design, including distribution of monitoring sites, appropriate replication and scale. Management actions must be conducted in the context of an experimental framework that will offer the greatest opportunities for detecting biological responses in the shortest amount of time. Similarly, data collection will be conducted using standardized protocols, and the

data recorded and managed in a regional database. Failure to maintain a scientifically rigorous, coordinated monitoring effort will hinder the ability of agencies to make informed decisions and learn from the results of management actions.

The Northwest Fisheries Science Center, in collaboration with other regional science centers and other federal, state, tribal and local agencies, will develop a monitoring and evaluation program that addresses these major areas. The Federal Caucus will report annually on federal agency progress in carrying out recovery actions, including the availability of resources and the agencies' ability to carry out the Basinwide Salmon Recovery Strategy. These reports would also be geared to support long-term biological monitoring to assess the contribution of improvements in each H to improvements in population growth rates or other biological indicators.

Working with the Region

Through a comprehensive effort that combines separate yet interrelated actions, a better future for the basin can be charted. It is time for citizens, governments and special interests in the Columbia River Basin to collectively take immediate and sustainable actions to rebuild the health of the basin. The federal agencies tender this proposal to decisionmakers, the Northwest Delegation, and state and tribal governments as a launching point for an aggressive, feasible, scientifically-based, balanced path toward basin recovery and rebuilding. Through consultation and collaboration, we hope to refine this proposal so that in its final form, it can serve as a comprehensive, long-term strategic direction for future actions in the basin.

For More Information

Visit: The Federal Caucus Web site: *www.salmonrecovery.gov*.

To request paper copies of documents or an electronic copy of this document and appendices on compact disc (CD):

Call 1-888-921-4886 or Write to
Federal Caucus
c/o BPA-P
PO Box 3621
Portland, Or. 97208

Introduction

In December 1999, the nine agencies that make up the Federal Caucus released a draft Conceptual Recovery Plan that outlined the difficult choices the Pacific Northwest must make to recover listed salmon, resident fish and other aquatic species. The Federal Caucus presented the most current science about listed species and offered options and integrated alternatives for the region to consider for recovery of these species. After discussions and consultations with states and federally-recognized tribes of the Columbia River Basin, and an extensive public comment period, the Federal Caucus has updated the scientific information, considered the comments from the tribes, states and the public about the options and integrated alternatives, and has prepared this Basinwide Salmon Recovery Strategy. The Federal Caucus will use this Strategy, in concert with efforts from tribes, states and local governments and many organizations and individuals, to recover these species.

The comprehensive approach will be implemented directly through biological opinions issued by NMFS and USFWS on the Federal Columbia River Power System (FCRPS) , and through other recovery processes in the region. In the third, fifth, and eighth years following implementation of the Strategy, NMFS will assess whether the Action Agencies have implemented the program of hydropower, habitat and hatchery improvements, and the research, monitoring and evaluation necessary for continuing assessment described in here and in the Federal Columbia River Power System 2000 Biological Opinion. Programmatic performance standards include the actions and the schedule defined in the biological opinion and the annual planning process. Performance is measured by the Action Agencies' success in implementing the actions defined in the annual plans. Critical actions to be evaluated at the 3-, 5- and 8-year reviews are further described in Section 9.5 of the biological opinion. Evaluating progress against these standards will formally occur in NMFS' review of the annual progress reports prepared by the

The Agencies of the Federal Caucus and their Responsibilities *

The nine federal agencies in the Federal Caucus that developed this paper have differing authorities and jurisdictions for salmon recovery:

- National Marine Fisheries Service – Endangered Species Act (ESA) jurisdiction over anadromous fish and activities that affect listed fish. It also has a role in regulating certain fisheries.
- US Fish and Wildlife Service (USFWS) – ESA jurisdiction over plants, wildlife and resident fish and also operates and administers hatchery programs and national wildlife refuges.
- Bonneville Power Administration (BPA) – markets electricity from federal dams; it also has a key role funding fish and wildlife mitigation.
- The Army Corps of Engineers (Corps) – operates federal dams and locks for multiple uses.
- US Bureau of Reclamation (USBR) – operates federal dams for multiple uses.
- Environmental Protection Agency (EPA) – implements and enforces the Clean Water Act.
- US Forest Service (USFS) – manages the national forest system.
- Bureau of Land Management (BLM) – manages public forests and rangeland.
- Bureau of Indian Affairs (BIA) – trustee for tribal and individual Indian lands and resources held in trust.

* All federal agencies bear certain responsibilities as trustees of tribal resources, as determined by treaties, statutes, and executive orders.

Action Agencies, the annual NMFS findings letter, and comprehensive 3-, 5- and 8-year evaluations.

The federal agencies cannot solve this problem alone, or by acting unilaterally. Strong action by state governments, local authorities and other participants must also occur for recovery to succeed.

This Strategy will build on successful actions already taken. After a federal court rejected the 1993 Columbia River hydropower biological opinion, a new biological opinion with options for operating and configuring the federal hydropower system brought major changes to the system to benefit fish. Water flows were increased in the mainstems during fish migration periods, improvements were made to provide multiple passage opportunities for fish at each dam, and more water was spilled over the top of each dam to help fish avoid turbines.

In addition to these changes, an in-season management team was established to tailor system operations to the needs of fish on a weekly basis. This has brought more precision to the agencies' efforts to improve fish survival, particularly for juvenile salmon.

Over the course of the past decade, other activities have been undertaken to benefit at-risk fish species. Salmon and steelhead harvest has been reduced steadily in the ocean and in the rivers. A major effort has been undertaken within the region to reform hatchery practices. Federal forests are managed much more conservatively than in previous decades, particularly to protect rivers and streams. Dozens of community level initiatives have been started throughout the region to improve the quality and quantity of available habitat.

The science of salmon recovery has also improved. In 1996, the Independent Scientific Advisory Board was established to provide scrutiny of fish management decisions at all levels of government, without prejudice. While the existence of the board itself is not tied to salmon management, its presence likely has improved the quality of research, monitoring, and evaluation efforts, as well as agency decision-making in general.

Recent salmon and steelhead returns have increased, possibly as a result of these improvements. While improving climate conditions have undoubtedly benefited migrating salmon, it is also likely that the combined efforts of the region to date has prevented the extinction of some populations, and reduced extinction risks faced by others.

While much progress has been made, to date there has been no discernable trend toward recovery of listed salmon, steelhead, or resident aquatic species. Together, the actions described above provide a foundation for launching a more aggressive regionwide effort to achieve salmon recovery. The strategy has a reasonable chance of being implemented and can reasonably be expected to result in the conservation and survival of the listed stocks in the basin.

Volume 1 of this document presents a summary of the Basinwide Salmon Recovery Strategy. Volume 2 contains a more detailed description of the actions' expected benefits and other technical information. Volume 3 contains summaries of state and tribal discussions and consultations, a summary of public comments received during the public comment period, and general responses to the comments received.

Background

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.

Native salmon and steelhead, and many resident fish and other aquatic species are in decline throughout the Columbia River Basin. All Columbia River Basin salmon stocks are in a state of perilous decline, especially Upper Columbia spring chinook and steelhead throughout its range (see map). Without substantial intervention, there is a greater than 50:50 chance that most of these stocks will be extinct by the next century, some much sooner.

The deterioration of the Columbia's once-numerous fish runs can be traced to the economic development of the basin. Human activities have caused the decline of these fish. Forestry, agriculture, mining, and urbanization have altered or destroyed tributary *habitat.*

Map 1 Columbia Basin ESUs (on page 13) is available in separate document

Fishing, or *harvest,* has reduced the number of adult fish that return to spawn. Some *hatcheries* have introduced inbreeding and competition, may have been a source of disease for **wild fish**, and have in some cases induced fisheries to harvest at rates too high for natural stocks. And *hydropower* dams on the Columbia and Snake rivers have blocked and inundated **mainstem** habitat, altered natural flows, impeded passage of migrating fish, and created a series of pools where fish predators reside. Such land use practices and landscape alterations have also affected tribal cultures and the traditional use of resources. These four areas of human activity are the Hs of this Strategy.

Populations, Stocks and Evolutionarily Significant Units

Populations are generally defined as a group of fish that interbreed when mature, and do not interbreed to a significant degree with other groups of fish. *Evolutionarily Significant Units (ESUs)* are groups of populations designated by NMFS for purposes of implementing the Endangered Species Act. ESUs are distinct groups of populations that typically occupy similar habitats, are genetically similar, and that represent an important component of the evolutionary legacy of the species. *Stocks* of fish are designated by managers generally for purposes of managing fisheries. In some cases, units identified by managers as "stocks" will be similar to populations. In a few cases, a unit identified as a "stock" will also coincide with a unit identified by NMFS as an ESU.

Natural factors, such as ocean conditions and natural predation, also influence the survival of salmon. Ocean conditions vary with climatic conditions on both long and short-term scales. When conditions are cooler, the ocean is generally 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 of resources. 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. These trends generally correspond to fluctuations in adult salmon and steelhead returns. Though ocean conditions are not stable, the general trend has been toward warmer conditions.

Predation of migrating salmon is another important factor affecting the productivity of salmon and steelhead. Migrating juvenile salmon are a targeted food source of many 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. There is some evidence to suggest that ocean conditions off the coasts of Washington and Oregon may influence predator abundance there, with warmer temperatures potentially more conducive to marine fish predators. Returning adult salmon are targeted primarily by marine mammals. Many juveniles and adults are taken by predators, but exact numbers for listed species are unknown. Predation is part of a properly functioning ecosystem, but given the decline of certain populations and the loss of numbers caused by other factors, predation is a factor to consider in the recovery of these species.

Processes for Change-Recovery Planning

Major changes must be made in a wide range of activities that cause harm to listed species if recovery of these species is to be successful. Critical federal and nonfederal decisions affecting Columbia and Snake River basins will be made soon that will determine the kind and magnitude of actions taken in the region. For example, states are developing Clean Water Act compliance measures, tribal governments are developing habitat, supplementation and harvest strategies, the Northwest Power Planning Council has amended its Fish and Wildlife Program, and federal agencies are making decisions about land uses, operational and structural changes at dams, and harvest changes (see box). Making these decisions and implementing them so that listed species recover will require consultation and collaboration from every agency and tribe, and the support of the people of the Pacific Northwest. The federal agencies offer this

Other Related Processes for Species Recovery in the Region

- *Northwest Power Planning Council Fish and Wildlife Program*. The Pacific Northwest Electric Power Power Planning and Conservation Act of 1980 directs the Northwest Power Planning Council to develop a program to "protect, mitigate and enhance fish and wildlife, included related spawning grounds and habitat, on the Columbia River and its tributaries…affected by the development, operation and management of [hydroelectric projects]…." BPA funds the Council's Fish and Wildlife program. In its recent amendments to the Fish and Wildlife Program, the Council committed to developing subbasin plans as context for actions. These subbasin plans will be a crucial program for implementing BPA's Endangered Species Act responsibilities in its funding decisions. The Council's amended Fish and Wildlife Program is included as a key vehicle for implementation of the Basinwide Salmon Recovery Strategy.
- *U.S. Army Corps of Engineers' Lower Snake River Feasibility Study*. In December 1999, the Corps released a Draft Feasibility Report and Environmental Impact Statement that reviewed options for improving juvenile salmon migration in the lower Snake River. Breaching the four lower Snake dams is one of the options studied. The public was invited to comment on the draft report and EIS. Decisionmakers will have an opportunity to consider the Basinwide Salmon Recovery Strategy when making decisions about juvenile migration in the lower Snake River.
- *U.S. Army Corps of Engineers John Day Drawdown Phase I Study*. The study analyzed John Day Dam drawdowns to spillway crest and natural river levels for improved salmon survival. The Corps recommends no further study because of high economic cost and marginal biological benefits. The public comment period ended May 1, 2000.
- *Interior Columbia Basin Ecosystem Management Project (ICBEMP)*. The Bureau of Land Management and the Forest Service released a Supplemental Draft Environmental Impact Statement for the ICBEMP Project in March 2000. The ICBEMP is a massive federal land-use plan that covers 63 million acres of federal lands in Oregon, Idaho, Washington, and Montana. The EIS focuses on the critical broad-scale issues related to: landscape health; aquatic and terrestrial habitats; human needs; and products and services. The aquatic programs outlined in the ICBEMP EIS display the federal habitat contribution available in the basin. The Final EIS was released December 14, 2000. A Record of Decision is expected in early 2001.
- *Draft Biological Assessment on Operation and Configuration of the Federal Columbia River Power System (FCRPS)*. The Biological Assessment jointly prepared by the Corps, Bureau of Reclamation, and BPA was submitted to NMFS on December 21, 1999. It is part of the consultation process, required by the Endangered Species Act, between NMFS and the three federal agencies that operate the FCRPS. The BA provides information regarding the impact of operation of the FCRPS on threatened or endangered species. NMFS will consider this information in the preparation of its Biological Opinion on the effects of the operation of the FCRPS on all listed salmon and steelhead in the basin. NMFS will also use the Basinwide Salmon Recovery Strategy as an overall guide for the Biological Opinion.
- *Columbia River Basin Forum*. Formerly called The Three Sovereigns, the Columbia River Basin Forum is designed to improve the management of fish and wildlife resources in the Columbia River Basin. The process is an effort to create a new forum where the federal government, Northwest states and tribes could better coordinate, discuss and resolve basinwide fish and wildlife issues under the authority of existing laws. The Forum is included as a vehicle for implementation of the Basinwide Salmon Recovery Strategy.
- *Clean Water Act*. Over the next 10 to 12 years, EPA, the states, tribal governments, other federal agencies, and private landowners are investing millions of dollars in watershed and tributary improvements to meet Clean Water Act requirements. Restoration strategies called Total Maximum Daily Loads (TMDLs) are being developed for the Columbia River mainstem and tributaries, based on court orders and negotiated agreements through Clean Water Act litigation. In addition, the federal government has committed to the Clean Water Action Plan, which is a federal partnership to promote and enhance locally based watershed improvements. Millions of dollars will be directed at the watershed level through the Clean Water Action Plan to improve water quality, restore habitat and recover threatened and endangered species.
- *U.S. v. Oregon* is a federal court case addressing treaty fishing rights in the Columbia River Basin. The parties to the case are the United States of America acting through the Department of the Interior and the Department of Commerce; the Nez Perce Tribe; the Confederated Tribes of the Umatilla Indian Reservation; the Confederated Tribes of the Warm Springs Reservation; the Confederated Tribes and Bands of the Yakama Indian Nation; the Shoshone-Bannock Tribe (subject to certain limitations); and the states of Oregon, Idaho and Washington.
- *Fish and Wildlife Implementation Plan Environmental Impact Statement.* BPA is drafting an EIS to examine the impacts that may arise from implementing one of the fish and wildlife directions considered in the other regional processes.
- *Lower Columbia River Estuary Program*. Part of EPA's National Estuary Program; Washington and Oregon released a management plan in 1999.

Basinwide Salmon Recovery Strategy as a starting place for a scientifically-based, balanced path toward recovery and eventual rebuilding of these species.

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. NMFS' formal recovery planning for the upper Willamette and lower Columbia ESUs is well underway and NMFS is initiating formal recovery planning for interior Columbia Basin ESUs as one of the next steps for implementing the Federal Columbia River Power System biological opinion.

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 and lead to recovery.

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, upper Columbia River ESUs will be more affected by hydropower operations than lower Columbia 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 restored.

In its formal recovery planning process in the upper Willamette and lower Columbia region, NMFS has appointed a Technical Recovery Team (TRT) and charged it with completing these technical tasks. NMFS expects the first three tasks (identify the populations, describe characteristics of a viable population, construct different scenarios for recovery) to be completed in 2001 for these ESUs. 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 is committed to conduct subbasin assessments throughout the basin that would accomplish the technical tasks of assessing habitat and characterizing biological and ecological conditions in subbasins. In the likely event that subbasin assessments and plans precede TRT determinations, NMFS hopes that the TRTs will rely and build on the subbasin assessments.

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 is working with the federal agencies, the Council and others to determine how best to accomplish this task.

Completion of these technical tasks for the basin ESUs will provide much of the information needed to develop plans that will lead to recovery. NMFS and the Caucus 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 will 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.

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. USFWS has listed two resident fish and five other aquatic species as threatened or endangered. Volume 2 of this document includes a brief review of the status of the anadromous and resident fish populations remaining in the basin.

Institutional and Regulatory Context

Many laws, treaties and regulations affect anadromous fish and their habitats in the Columbia Basin, governing everything from reclamation projects to artificial propagation. The United States and Canada, nine federal agencies, five states (Oregon, Washington, Idaho, Montana and Alaska) and federally-recognized Indian tribes have different **authorities** over fish or fish habitat. Treaties between the United States and Indian tribes guarantee the region's treaty tribes a right to meaningful fisheries.

Fish habitat extends from small headwater tributaries to the Columbia River estuary, covering federal, state, private and tribal lands. Countless programs exist to maintain current uses of the river, change current uses of the river, exploit natural resources and conserve natural resources. Institutions range from local watershed councils and water districts to basinwide organizations such as the Northwest Power Planning Council and Columbia Basin Fish and Wildlife Authority (CBFWA). Some have observed that the lack of a unified restoration plan and coordination among efforts in the basin is one of the factors preventing the recovery of anadromous fish (Bevan, et al. 1994). The purpose of this document is to help the region develop a recovery plan that results in better regional coordination and a unified regional direction.

Consultations and Discussions with Basin Tribes

There is a unique and long-standing relationship between the U.S. government and federally-recognized Indian tribes (hereafter referred to as "tribes"). The U.S. government has a **trust responsibility** to protect those tribes' trust resources and treaty rights, to respect the sovereignty of tribal governments, and to act consistently with the statutes and the missions of respective agencies.

Throughout development of this Strategy, the Federal Caucus met with the federally-recognized tribes of the Columbia Basin. A summary of these discussions is in Volume 3.

In general, the tribes raised the following concerns:

- Trust and Treaty Responsibility of the Federal Government
- Historic Properties
- Resources of Cultural Importance to Tribes ("culturally important resources")
- Water Quality
- Resident Fish
- Blocked Areas
- Hydropower Operations and Flood Control
- Salmon Rebuilding and Recovery Goals
- Treaty Fisheries
- Hatcheries
- Habitat Measures

Because the Federal Caucus received many written and verbal comments from tribes about cultural resources and treaty fisheries, a short discussion of these concerns follows. Other significant concerns identified by the tribes and listed above are described in more detail in Volume 3.

The federal agencies recognize that natural resources, including anadromous and resident fish, are important to maintaining the traditional culture of the tribes of the Columbia River Basin (hereafter called **culturally important resources**). The federal agencies recognize that some of these culturally important resources may fall outside the scope of the narrower definitions of **historic properties** as defined in the National Historic Preservation Act (NHPA). The federal agencies will consider these culturally important resources along with identified historic properties and will integrate the consideration into the planning and implementation of recovery programs and projects.

In response to this challenge, the full array of federal authorities conveyed by law along with other guidance such as executive orders and agency policy, will be considered in addressing the effects of fish recovery options on other culturally important resources that are not otherwise protected by treaty or under the NHPA. Examples include but are not limited to the Native American Grave Protection and Repatriation Act, Archaeological Resources Protection Act, American Indian Religious Freedom Act, and guidance provided in Executive Order 13007 "Indian Sacred Sites." Agencies will consider the impacts of undertakings on these resources and seek means through established agency programs to address impacts to culturally important resources, consistent with the agencies' authorities and constraints of law.

Full compliance with Section 106 of NHPA will occur in association with implementation of commitments made in the Records of Decision (RODs). Agencies will coordinate with tribal staff and consult with tribal government representatives as early as possible when planning specific implementation actions. The goal is to assure the potential effects of implementation actions on historic properties and on culturally important resources are identified early in the process of planning fish recovery program actions before selecting a preferred action.

For the hydropower elements of the 2000 FCRPS Biological Opinion, the implementing agencies intend to use the existing reservoir cultural resource management cooperating groups as the forum to identify issues and plan processes. For the remaining three Hs (habitat, hatcheries, and harvest), issue identification and planning processes and forums remain to be identified. However, the implementing agencies commit to ensuring that tribes are involved in a manner that will allow identification and consideration of culturally important resources.

Any plan or policies affecting salmon and their harvest must address the issue of tribal fishing. All fisheries, including treaty 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 treaty fisheries. Capping or further reducing harvest rates seriously affects the exercise of treaty fishing rights. Protecting those rights is a constitutionally-based national legal obligation overlying all actions affecting the fishery resource in the Columbia Basin. The federal government's trust obligation to uphold treaties requires that the Strategy directly address this issue.

It will no doubt be the focus of ongoing government-to-government discussions between the tribes and the federal government to sort out whether the approach described here successfully reconciles the near-term recommendation 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. The extent to which they are willing 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 the conservation burden is allocated.

Early and throughout the implementation planning and development processes for future fish recovery programs, the federal agencies are committed to the following:

- Meet with tribal technical staff and consult with tribal government representatives.
- Meet with tribal governments and program representatives to address applicable responsibilities regarding trust and treaty resources and meeting federal trust responsibilities.

Public Involvement

The Federal Caucus developed a public involvement program to provide opportunities for the public to comment on the draft Conceptual Recovery Plan released in December 1999. A complete description of the public involvement program, as well as a summary of comments received and federal responses to the comments, is in Volume 3 and on the salmon recovery Web site (www.salmonrecovery.gov).

The formal public comment period on the draft Plan began December 17, 1999 and continued through March 17, 2000. The Federal Caucus hosted a series of 15 public meetings across five states in February and March 2000. The Federal Caucus received over 60,000 individual comments during the comment period. The comments came in the form of letters, postcards, e-mails, and oral testimony and taped messages at the public meetings. All comments were logged into a database.

Comments and Responses – The Federal Caucus categorized the public comments according to topic. In all, there were 17 categories (see box) with nearly 150 distinct issues raised during the comment period. The comments covered the range of issues addressed in the draft Plan and a number of other topics related to Columbia River Basin economics and ecology. There were many compliments and criticisms of the Federal Caucus and its process. To the extent practical, this document has been changed to reflect the comments received during the comment period.

Comment Categories

- Life Cycle Approach
- Conservation Goals, Objectives, Performance Measures and Monitoring and Evaluation
- Hydropower
- Habitat
- Hatcheries
- Harvest
- Science
- Range of Alternatives
- Economics
- Institutional and Regulatory Issues
- Relationship to Corps EIS, John Day Study, BPA EIS, ICBEMP
- Biological Opinions
- Public Involvement Process
- Native American Issues
- Implementation Issues
- Issues not fully considered
- Other issues

Page left intentionally blank for printing purposes

1. Supporting Analysis

1.1 Scientific Principles

The Federal Caucus developed these principles from various scientific reviews and recovery planning documents that have been developed for fish and wildlife recovery in the Columbia Basin. These principles were used to shape the Basinwide Salmon Recovery Strategy and will be used for implementation of recommended actions.

- Conservation of Columbia Basin fish and aquatic species must address all aspects of the ecosystem and the species' lifecycle.
- Conservation requires a network of diverse, high quality, interconnected habitats and high water quality. Natural systems functioning properly are necessary to restore salmon and steelhead.
- Conservation requires preservation of life history diversity, **genetic diversity** and **metapopulation** organization. These characteristics affect the response of anadromous and resident fish populations to both demographic variation and variation in climate and environment.
- Conservation requires re-establishment of the nutrient cycle provided by decaying fish carcasses to effectively cycle nutrients from ocean to freshwater.
- Because human activity, development and population growth will continue, conservation depends on managing human impacts to achieve suitable ecosystem conditions.
- Technology and research can be used to complement natural functions but cannot replace them.
- **Viability** (or status) of salmon and steelhead populations can be evaluated based on abundance, productivity, population structure and genetic diversity.

1.2 Scientific Tools

Several ongoing technical efforts are currently assessing the impact of human-induced factors on declining salmonid populations, the conditions necessary for recovery, and potential effects of recovery efforts on those populations. The Strategy is based on information from these and other studies to assess the risk of extinction for salmon and other species, and to determine the potential beneficial and adverse impacts of proposed changes in each of the Hs. These efforts are conducted at different scales, and address different types of questions; these differences between the analytical efforts must be considered when interpreting (and applying) their results.

1.2.1 Population-based Tools

The **Cumulative Risk Initiative** (CRI), an ongoing effort of the NMFS' Northwest Fisheries Science Center, assesses population trends and the impact of various actions on those trends. The CRI approach has been to estimate population growth rates, and use this measure to assess the risk of extinction or of serious decrease in abundance. These estimates allow the determination of needed improvements to mitigate those risks. For species with sufficient data, CRI has constructed population computer models using the most current estimates of survival rates for each life-stage of a species. These models can identify the times or stages at which changing survival rates will yield the largest impact on population growth rates, and can be used to assess the impact of changes in survival at a particular life stage on overall population growth rate. Follow-up work entails examining whether such changes in survival are biologically feasible and what management options will yield the best results. Finally, as conservation actions are implemented, NMFS,

in collaboration with other regional scientists, will be engaging in ecological experiments to test hypotheses about the relationships between management actions in the Hs and salmon populations.

The Strategy relies heavily on the CRI's estimates of population growth rates and projections of the risk that an ESU will reach extinction within 24 and 100 years. (Extinction is defined as one fish or fewer in a generation.) This is a useful tool for assessing the risk of not acting quickly to improve survivals, but this type of projection comes with some caveats:

- The extinction threshold may not be sufficiently conservative.
- The projections become less certain the farther out in time they go. Projections of extinction risk over 100 years are highly uncertain.

The Strategy also relies on the CRI's analysis of how much survival improvements in different life stages might contribute to population growth rate. This is a useful tool for focusing regional efforts on management actions most likely to yield significant benefits, as well as the magnitude of change needed at each life stage. However, at this stage the CRI has only performed numerical experiments based on theoretical survival improvements. Some actions are more certain to lead to survival improvements than others (for example, harvest reductions versus hatchery reforms). More work needs to be done to determine whether it is biologically feasible to achieve some of these theoretical improvements. The CRI has estimated the risk of extinction of over 100 stocks within 11 of the 12 listed salmon and steelhead ESUs in the Columbia Basin, as well as the risk of serious decline in both the short and long term. (Snake River sockeye cannot be analyzed because they are currently maintained in a captive **broodstock** program.)

The **Plan for Analyzing and Testing Hypotheses** (PATH) is a joint effort of several federal, state and tribal agencies designed to predict future salmon populations under a variety of hydropower system and other management actions. This model simulates salmon population trajectories under a wide range of "assumption sets." These assumptions correspond to a rate, or a parameter in the model, for which there are different hypotheses concerning the effect that a variety of factors have on survival. Evaluating the likely effects of management actions on salmon populations entails running 240 to 1,920 different sets of assumptions. The likelihood of a particular management action achieving survival or recovery standards is then evaluated. PATH analyses show which actions are most robust (least risky) due to uncertainties in the model.

The **Viable Salmonid Population** (VSP) effort is another ongoing project of the Northwest Fisheries Science Center. This work defines characteristics of salmonid populations that can be considered viable, or self-sustaining over the long-term (at least 100 years). It provides guidelines for defining populations as well as qualitative and quantitative rules of thumb for identifying those populations that can be considered viable. Finally, it offers guidelines for the number and distribution of populations within an ESU necessary for an ESU to be considered viable. These rules of thumb consider genetic and life history diversity, spatial structure, as well as population size and trends in productivity. The guidelines and rules of thumb provided for viability will be used by Technical Recovery Teams in establishing recovery goals for listed ESUs.

The **Quantitative Analytical Report** (QAR) is a report NMFS and other federal agencies, state fisheries agencies, tribes, and the Mid-Columbia Public Utility Districts agreed to develop to analyze the effects of a proposed **Habitat Conservation Plan** (HCP) on upper Columbia spring chinook and steelhead. The effort includes a workgroup that is setting recovery goals, and another that is analyzing present risks of extinction and the likelihood of achieving recovery goals under the actions proposed in the plan. The workgroup is conducting extinction analyses using different population models. It will use the same models to project the likelihood that populations will reach the recovery goal.

1.2.2 Habitat-based Tools

The **Ecosystem Diagnosis and Treatment** (EDT) analysis is an *expert system*, developed by the Northwest Power Planning

Council's Framework process, that organizes available information concerning the impact of habitat attributes on salmonid populations. With this approach, small, hydrologically-defined areas are described using habitat attributes. Knowledgeable experts, using available information, define *rules* describing the effect of each of these attributes on salmonid survival at all life stages. Using these rules, the EDT analysis defines the productivity and capacity of a landscape. Analyzing management scenarios involves changing the appropriate habitat attributes in the appropriate areas, and engaging the expert-defined rules to assess the predicted productivity and capacity of the changed landscape.

The **Interior Columbia Basin Ecosystem Management Project** (ICBEMP) has also constructed an expert system. ICBEMP uses spatially-explicit habitat and population status databases to evaluate spatially-explicit predicted status of a population, elements and capacity of aquatic habitat, and the **biological potential** of a population. Predictions include influences on **population dynamics** that are not a direct effect of the habitat, such as genetic factors or migration rates from other populations. Computer models have been used to project habitat capacity and population status across the interior Columbia Basin from various habitat management scenarios. The models are specifically designed to inform decisions about risks to habitat, options for managing risks to habitat, and spatial priorities for habitat restoration efforts. The models do not predict population size. ICBEMP analyses will be a primary tool for evaluating management actions on federal lands in the Columbia River Basin.

Finally, the **Watershed Processes Program** of the Northwest Fisheries Science Center is conducting analyses designed to associate habitat characteristics at the watershed or **subwatershed** level with salmonid productivity (these analyses are also known as SWAM – Salmonid Watershed Assessment Model). This effort examines physical attributes of subwatersheds, such as topography, geology, and distribution of channel types, as well as land use characteristics, such as the proportion of the area that is forested or urbanized, or the condition of riparian zones. These habitat characteristics are then associated with salmonid production information to identify the characteristics of habitats that are most productive. The SWAM analyses can be used both to identify subwatersheds that are currently important in maintaining current populations (and therefore may have a high priority for conservation), and to identify those subwatersheds for which restoration efforts may have the greatest potential to yield large results.

1.2.3 Other Tools

Several analytical methods with a smaller scope than those outlined above have also been used to address particular risks salmonids face during their life cycle. In particular, SIMPASS was used to model the effects of different hydropower system **configurations** on downstream survival. SIMPASS assumes no delayed mortality occurs as a result of transporting fish past dams. In addition, several models for evaluating the effects of harvest, including those devised by the Technical Advisory Committee to the *U.S. v. Oregon* process, and a number of models developed or used by Pacific Salmon Commission technical committees were used to identify the impact of levels of harvest on different stocks.

In the near term, qualitative evaluations will be the primary tool used to evaluate impacts and expected outcomes of proposed actions for listed resident fish and aquatic species. Quantitative data are limited for these species and models have not been developed to evaluate impacts and assess outcomes of actions.

1.3 Rationale

This Basinwide Salmon Recovery Strategy recommends a program that places priority on actions that can be implemented quickly, that are likely to provide solid and predictable biological benefits, and that will benefit the broadest range of species. The Strategy is built on biological objectives, and seeks to establish priorities based on sound scientific principles, while recognizing that there is a limit to the resources available for the job and to the authority of federal agencies. The important questions to ask of the recovery plan are: does this plan as a whole have a reasonable chance of being implemented, and if so, can it reasonably be expected to result in the conservation and survival of the listed

stocks in the basin as a whole? NMFS concludes that the answer to both questions is yes. This conclusion is based on the biological requirements of the species, the substantive elements of the Strategy itself, and the best science available for evaluating the effects of this Strategy. It is also based on the implementation measures provided and the robust monitoring and evaluation commitments, both of which will enable agencies to make needed adjustments in the effort over time to stay on course for recovery.

The Cumulative Risk Initiative (Kareiva, September 2000), shows the status of each listed species is poor, and likely to get worse unless conditions improve. Long-term extinction risks for most Columbia Basin populations are unacceptably high. Risk of a 90 percent decline in abundance, even in the next 24 years, is also high throughout the basin, especially for steelhead. In general, Snake River spring/summer chinook, upper Columbia River spring chinook, and steelhead throughout the basin have the greatest overall risk and require the greatest productivity improvements to avoid extinction and achieve recovery.

Given the near-term biological risks, the Strategy places a premium on actions that can be taken immediately and that will yield benefits to these species quickly. The Strategy emphasizes actions within the authority of the federal agencies and about which there is considerable regional agreement, such as conservation hatchery interventions, production hatchery reforms, harvest constraints, improvements on federal lands, and improving passage at dams and reservoirs. It also emphasizes and embraces actions that state and local governments are planning or already undertaking, such as the Northwest Power Planning Council subbasin planning proposal, achieving water quality compliance for surface waters across the region, and increasing the productivity of the Columbia River estuary. In the habitat arena, where some actions can take decades to show benefits, the Strategy emphasizes those measures that can be taken quickly, with longer term actions to be taken later based on subbasin assessments and plans.

The Caucus agencies also recognize that, even while the region has devoted considerable resources to restoring Columbia Basin fish, there are limits to those resources. The combination of near-term biological risks and resource limitations led the agencies to focus on actions that give the greatest "bang for the buck" – that have predictable benefits and that will benefit the greatest number of species. Getting the biggest bang for the buck can mean focusing on those life stages where improvements will yield the biggest survival increase, or on those actions that are more certain to result in improvements, regardless of the life stage. For example, CRI analysis suggests that improving survivals during the first 2 years of life, when the greatest mortality occurs, will give the greatest benefit. Because there are limits to improving survival at any life stage, it is likely that improvements in all life stages will have a greater effect on overall ESU productivity than focusing improvements on just one life stage. Getting the biggest bang for the buck can also mean focusing on actions that benefit a large number of ESUs. For example, improvements in dam passage in the lower Columbia River would benefit all upriver ESUs, and improvements in the estuary benefit all 12 ESUs to varying degrees.

Federal agencies also considered tribal treaty and trust responsibilities in developing this package. For some ESUs, such as Snake River fall chinook, eliminating harvest would substantially reduce the risks of extinction. Dramatically reducing hatchery production basinwide might also benefit nearly all ESUs to some degree, although it is impossible to quantify the benefit at this time. The Strategy does not recommend these actions, however, because of the importance of maintaining some level of tribal harvest and improving it over time. The appropriate Caucus agencies will discuss with tribes the use of more selective harvest techniques and consult if warranted.

Much of the regional debate has focused on removal of Snake River dams. There is little doubt dam removal would benefit Snake River salmon and steelhead. NMFS is not recommending it at this time, however, for several reasons. There is continuing significant scientific uncertainty about whether breaching dams is necessary to achieve recovery and whether breaching alone can lead to recovery. Snake River fish would receive most of the benefits from breaching; other listed populations may receive some long-term benefits from improvements in water quality in the lower Columbia River. Dam removal would

require explicit congressional authorization, and, once authorized, cannot be implemented on a short time frame. And its high cost could preclude other actions needed throughout the basin. The option of Snake River drawdown ranks as a lower priority than other available options because of the likely long time to implement, narrow benefits, biological uncertainties and high costs.

The Basinwide Salmon Recovery Strategy is designed to provide immediate benefits and, in combination with nonfederal actions throughout the basin, lead to salmon and steelhead recovery. This approach leaves breaching on the table as a future option, but challenges hydropower system operators now to meet rigorous survival goals over a discrete period, using continued improvements in flow and spill management and structural improvements at dams. System performance will be evaluated against scientifically grounded, peer reviewed performance standards at 3-, 5-, 8-, and 10-year intervals. Dam removal is reserved as a contingency in the event progress toward these goals is inadequate, or if shown to be necessary by new scientific information about the Snake River stocks.

The Strategy also commits the agencies responsible for the federal hydropower system to fund habitat, harvest and hatchery actions to mitigate for unavoidable mortality in the hydropower system, and to an aggressive monitoring and evaluation program to test assumptions, measure performance and reduce uncertainties over time.

1.3.1 Will the Strategy Recover Listed Salmon and Steelhead ESUs?

This section describes the basis upon which the agencies have concluded that if implemented, this Strategy is likely to allow for the long-term conservation and recovery of listed salmonids and other fish and wildlife resources of the Columbia and Snake basins. Issues of implementation are addressed in Section 2.2.

The CRI analyzed the sensitivity of some of the ESUs to improvements in different life stages (Kareiva, September 2000). In general, the survival of analyzed ESUs is most sensitive to changes in the first and second years of life, where most of the mortality occurs. Survival in these life stages is affected by several human activities including hatchery operations, habitat degradation, and hydropower development. For most ESUs, the first year of life is spent in the tributaries. The period of transition from fresh water to salt water also represents a period of high mortality for most ESUs. Harvest mortality occurs in the adult life stage. Despite recent reductions for a large number of the listed stocks, ocean and river harvests remain a significant source of mortality for Snake River fall chinook. In-river fisheries also impose some level of harvest mortality on most steelhead ESUs. Because improvements in the first year of life and during ocean transition provide the greatest overall benefit, the Strategy emphasizes habitat and hatchery actions – those actions aimed at improving survival in the tributaries and estuary. Notwithstanding this emphasis, all of these stocks are at a high risk of extinction, therefore improvements across all life stages are necessary and important for their conservation and survival.

Table 1, based on CRI modeling, shows the level of survival improvement needed for Columbia Basin ESUs to survive and recover. NMFS believes implementation of the overall Strategy across all life stages will move listed populations to recovery levels over the long term. The best available science indicates that the particular mix of actions called for by this Strategy are ones that will most likely achieve recovery.

The CRI models project risks of extinction *if all factors remain the same as they were for fish returning in 1980-99.* NMFS recognizes that many actions have been taken to improve the survival of these ESUs even since 1994, and also recognizes that the base period arguably represents a particularly bad time for ocean survival of some ESUs. NMFS has taken into account the survival improvements that have resulted from hydropower measures and harvest reductions since 1994, as well as the potential benefits from improved ocean conditions of the past few years. This analysis, explained in detail in the December 2000 FCRPS Biological Opinion, estimates additional improvements in population growth rates needed to achieve a 5 percent or lower likelihood of extinction in 24 and 100 years and at least a 50 percent chance of reaching a numerical abundance goal in 48 and 100 years, under best and worst case assumptions. Best

Table 1 Minimum Risk Estimates at the ESU Level

ESU	Annual Rate of Population Change	Probability of a 90% Decline in Abundance in 100 years (percent)	Needed Percent Improvement in Annual Rate of Population Change to Prevent Severe Decline
Lower Columbia River Chinook	0.96	72	12
Upper Columbia River Chinook	0.85	100	21
Snake River Spring/Summer Chinook	0.91	100	11
Snake River Fall Chinook	0.92	100	11.5
Upper Willamette Chinook	0.82	100	31
Columbia River Chum	1.04	0	0
Lower Columbia River Steelhead	0.91	100	8
Middle Columbia Steelhead	0.84	100	17
Upper Columbia River Steelhead	0.83	100	21.5
Snake River A+B Runs Steelhead	0.83	100	18.5
Upper Willamette Steelhead	0.92	99	11.5

Note: An annual rate of change less than one indicates that the ESU is declining; greater than one indicates that it is increasing. All estimates assume that hatchery fish on the spawning grounds have a reproductive success one-fifth (20 percent) that of wild spawners. If hatchery fish have greater reproductive success, the annual population growth rate of the wild population will be lower than that presented here and the risk of decline correspondingly higher. Annual population growth rate, risk of decline and needed changes will all vary between populations within an ESU. The full range of risk estimates are described in the 2000 FCRPS Biological Opinion.

and worst case assumptions include assumptions about the reproductive effectiveness of hatchery fish spawning in the wild, and about future conditions in the hydropower system.

The uncertainties inherent in that science also make research, monitoring and evaluation necessary to ensure that this Strategy stays on course to achieve its objectives. Accordingly, adaptive management is important to the Strategy. The federal agencies believe that immediate actions structured as management experiments have a high probability of both improving population performance and identifying and quantifying the causal relationships between human activities and salmon survival and productivity, particularly in salmon spawning and rearing habitat.

Survival improvements in spawning and rearing habitat in the tributaries and in estuary habitat are a centerpiece of this Strategy because the science indicates that the greatest opportunity for achieving significant survival improvements is in these habitat types. Although very few studies have been done that quantitatively link management actions with habitat quality, and habitat quality with fish production, the available information tends to confirm the expectation that an effective habitat program could significantly improve tributary habitat productivity over the long term for all ESUs except Snake River fall chinook.

The Northwest Power Planning Council's subbasin planning data developed in the late 1980s offers an example of information that provides guidance on where productive – or potentially productive – habitat exists. The analysis of the subbasin planning data shows that potential tributary habitat capacity in the basin could provide for population increases within the range of what would be necessary to support recovery of listed ESUs, provided the habitat strategy is implemented and there are sufficient adults to spawn. This data will be updated during the subbasin assessment process. The Habitat Element section of Volume 2 of this Strategy shows how management actions can affect salmon and steelhead abundance. This analysis shows, for example, that the presence of water diversions and

grazing activities correspond to lower fish abundance in the Salmon River Basin, tributary to the Snake River. The Salmon River data, in particular, illustrates how productive habitat strategies can be identified.

Although direct estimates of increased salmon productivity in response to increase in-stream 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 in-stream flow conflicts in Alturas Creek were resolved. Increases in summer base stream flows of 50 percent have been estimated to increase effective pool and riffle area by 30 percent 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. Together, this information provides the basis for the habitat program, enabling the agencies to prioritize actions and locations to achieve the greatest effects.

The federal agencies believe the habitat element of the Basinwide Salmon Recovery Strategy will have significant measurable benefits for listed anadromous and resident fish in the tributaries by protecting existing high quality habitat and restoring degraded habitat on a priority basis. The Strategy prioritizes tributary subbasins for short-term habitat work based on potential for improvement in habitat capacity, degree of federal ownership (an anchor for restoration efforts), and number of water diversions (where addressing flow, passage and screening problems could produce short-term benefits). (See Kratz, July 18, 2000.) When implemented as expected, the Strategy should result in improving habitat conditions in priority subbasins over the course of 10 years. In addition, other immediate measures should improve tributary flows, water quality and riparian conditions in a broader range of subbasins with a mix of federal and nonfederal ownership. According to the available habitat analysis, the effects of this action would increase salmon and steelhead abundance to levels that are within the range of what would be necessary to support recovery.

A critical aspect of this conclusion is the emphasis the Strategy places on the Northwest Power Planning Council subbasin assessment and planning process, which should lay the foundation for formal recovery planning for the Columbia and Snake rivers ESUs. Every subbasin in the Columbia-Snake system will be assessed over the next 2 years using a template jointly developed by members of the Columbia Basin Fish and Wildlife Authority. The Council adopted the template in October 2000 as part of its amended Fish and Wildlife Program (NPPC, November 9, 2000). The assessments will form the analytical foundation for tailoring subbasin plans and for developing formal recovery plans to meet the needs of each ESU. Ultimately, subbasin plans and recovery plans will be based on the data and analyses, and should be fully linked. In turn, these plans will form linkages between state and local efforts already underway or being planned to address habitat issues on a localized basis.

The Columbia River Estuary is also an area of focus for this Strategy. That habitat plays an important role in the life cycle of all listed anadromous stocks of the basin each of which pass through the estuary on their way to and from the ocean. As discussed in Volume 2, Habitat Element, studies indicate that the estuary has the potential to provide significant survival improvements for each of the listed stocks. One study looked at the value of improvements in the estuary for the Skagit River in Washington (Beamer, et al. 1999). 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.

The Strategy recommends that harvest on listed fish be constrained to current levels (subject to *U.S. v. Oregon* processes) in the ocean and in freshwater, including tribal, commercial, and recreational fisheries. The productivity rates identified by CRI as necessary to achieve survival and recovery account for harvest impacts at current levels. Strong steps have already been taken over the past

20 years to end chronic overfishing practices. Mixed stock fisheries are now generally managed for abundance, and the needs of natural fish are given priority over hatchery fish when determining appropriate harvest rates. Since the listing of many species under the ESA, harvest has been reduced even further in all fisheries affecting listed stocks. Given that these reductions have already occurred, it is unlikely that further reductions are going to yield significant additional benefits to listed species. However, continuing constraints on harvest at or near these now-reduced levels will remain an important part of the recovery effort during the rebuilding period. The Harvest Element, Volume 2, discusses management actions taken over the past few years to reduce – and in most cases eliminate – the effects of harvest on listed populations. Nevertheless, the Strategy contemplates further negotiated reductions in harvest impacts based on increasing selectivity in fishing practices, but these potential future reductions are not assumed in the analysis. If they were achieved, they would benefit productivity and further reduce extinction risks for affected ESUs, thus enhancing the overall recovery effort.

NMFS and the other Caucus agencies are confident of the potential to reduce risks and improve survivals associated with ongoing and new hatchery efforts, and therefore propose an extensive program of hatchery reforms. The ability to quantify those improvements, however, is limited, further dictating the need for aggressive monitoring of these reforms. The Strategy recommends major and extensive reforms at existing mitigation hatcheries that are designed to eliminate or minimize the adverse effects of past propagation practices. As discussed further in the Hatchery Element, Volume 2, 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.

For example, the fitness of certain indigenous, listed populations may be substantially improved over time by eliminating or substantially reducing the risks mentioned above. The studies cited in Volume 2, Hatchery Element, 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 hatchery and natural-origin fish. Although it is impossible to quantify the potential benefits from these reforms, a table in the Hatchery Element, Volume 2, provides a qualitative estimate of the degree of benefit likely to accrue from hatchery reforms for each ESU.

The Strategy anticipates that supplementation of natural populations with hatchery fish will be used under certain controlled circumstances, subject to the development of hatchery and genetic management plans, to reduce the risks of extinction, protect genetic diversity, and contribute to recovery. This approach is referred to as “safety net supplementation” for these reasons.

Supplementation research to date has demonstrated that high egg-to-smolt survivals can be achieved using artificial propagation, generally resulting in adult-to-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.

The Strategy expects a combination of aggressive improvements to increase survival for salmonids migrating through the hydropower corridor plus an off-site mitigation program of actions taken by the hydropower operators outside the hydropower corridor to further improve survivals for listed stocks. The FCRPS Biological Opinion (December 2000) describes a set of specific, aggressive 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. 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 off-site mitigation program sponsored and funded by the hydropower Action Agencies will consist of habitat, hatchery and harvest measures that would not reasonably be certain to otherwise occur. In particular, the hydropower action agencies will emphasize non-hydropower actions likely to have immediate survival benefits for listed stocks. This program will be adaptively managed to take advantage of a targeted research, monitoring and evaluation component designed to verify and quantify the survival benefits that are expected to result from the program. Progress will be formally evaluated after 3, 5 and 8 years to determine whether performance standards are being achieved. The FCRPS Biological Opinion prescribes contingencies to follow in the event they are not.

For nonfederal dams on the mainstem Columbia, the Strategy expects the implementation of the provisions and performance standards of the Mid-Columbia Habitat Conservation Plan to address additional improvement in juvenile and adult survival. The HCP, also subject to ESA Section 7(a)(2), must assure a high likelihood of survival and a moderate-to-high likelihood of recovery over time, taking into account actions in the other Hs.

Finally, with respect to other federal actions affecting the listed stocks, this Strategy expects that applying the **jeopardy** standard of ESA Section 7(a)(2) will ensure that all such actions will provide additional survival protections and improvements that will complement the actions specifically identified here.

1.3.2 Conclusions

The Basinwide Salmon Recovery Strategy presents a suite of actions that can be implemented immediately and in the long term that will have significant benefits for a broad range of species (see Table 2 and Map 2). Because of the limits in the available data, it is impossible to quantify with precision the potential cumulative overall benefit that will result from implementing the Strategy. Nevertheless, it is possible to predict the benefits likely to result from this Strategy based on data and information currently available. On this basis, NMFS concludes that the Strategy will lead to the long-term conservation and recovery of the listed salmonid stocks throughout the Columbia and Snake basins. While this conclusion is made in the face of considerable uncertainty, NMFS has relied on the best available information in making this assessment. This includes a combination of quantitative data and analyses; best professional judgment based upon available data; and reasonable hypotheses, recognizing that adequate data is not yet available to provide greater certainty. The other federal agencies of the Caucus support and will participate in the implementation of the actions identified in the Strategy.

As described in Table 1, substantial increases in fish survival are necessary. Even after full implementation of expected hydropower improvements, substantial improvement needs remain. NMFS has concluded that jeopardy can be avoided through the implementation of the hydropower measures in the FCRPS Biological Opinion, the off-site mitigation program and the implementation of feasible measures identified in the Basinwide Salmon Recovery Strategy.

The off-site mitigation portion of the biological opinion assures that many measures identified in the Strategy will be implemented by or with the support of the BPA, Corps, and USBR. NMFS has concluded measures expected to be implemented by other agencies and parties, combined with the off- site measures in the biological opinion, are reasonably calculated to meet survival improvement needs identified in Table 1.

Because uncertainties about the science remain, the Federal Caucus planned for the possibility that these conclusions will need to be reconsidered and revised. The entire Strategy is based upon a rigorous monitoring and evaluation system that will continually assess species status and measure the results of management actions. In addition, the Caucus agencies will provide a conservation hatchery safety net to prevent extinction of the most at-risk native populations on an interim basis. The Strategy provides regular procedural checkpoints in 3, 5, 8 and 10 years to determine whether prescribed actions are being implemented, and if they are generating the anticipated results. These tools provide the agencies with the flexibility necessary to respond if the populations of listed species continue to decline. Finally, the Strategy contemplates rigorous independent peer review of its scientific foundation and its monitoring and evaluation activities.

Table 2 Expected Benefits from Actions by ESU

	Lower Columbia ESUs Chum, Steelhead & Chinook Upper Willamette Steelhead & Chinook	Snake River ESUs Spring/summer Chinook, Steelhead, Fall Chinook & Sockeye	Mid-Columbia ESU Steelhead	Upper Columbia ESUs Spring Chinook & Steelhead
HYDROPOWER				
Operational Improvements				
Additional Canadian flows	X	X	X	X
Additional Snake flows	X	X	X	X
Flood control review	Most likely benefit would be changes to estuary flow, particularly in years of moderate runoff; would have little effect in years of low or high flow			
Elimination of trucking	n/a	X	Dependent on resumption of spring transportation from McNary	
Improved spill passage	n/a	X	X	X
Resolution of delayed mortality	n/a	X	Dependent on resumption of spring transportation from McNary	
Water quality improvements	X	X	X	X
Capital Improvements at Dams				
Aggressive passage measures	n/a	X	X	X
Water quality improvements		X	X	X
Economic mitigation for breach	Multi-faceted mitigation for various impacts of dam breaching on river users, regional infrastructure, etc.			
Nonfederal				
Mid-Columbia HCP	n/a	n/a	n/a	X
IPC relicensing, incl. SRWRA	Projects block migration; benefit to Snake River ESUs primarily result of water management; benefit to other ESUs limited to potential water management effects in estuary			
Other relicencing	Projects generally block passage or are in blocked areas; benefit would be primarily to listed resident fish and potential benefits of improved water management or habitat improvements			

	Lower Columbia ESUs Chum, Steelhead & Chinook Upper Willamette Steelhead & Chinook	Snake River ESUs Spring/summer Chinook, Steelhead, Fall Chinook & Sockeye	Mid-Columbia ESU Steelhead	Upper Columbia ESUs Spring Chinook & Steelhead
HATCHERIES				
Safety net and conservation				
ESA captive broodstock	Last resort, most intrusive form of intervention to prevent loss of genetics of wild fish; currently in place for Snake River Sockeye and several spring/summer Chinook populations			
Conservation hatchery actions	Varying levels and types of artificial production intervention (e.g., supplementation) to protect severely depressed stocks and/or aid recovery			
Aggressive R, M, & E	Aggressive research, monitoring and evaluation to reduce critical uncertainties relating to interaction between artificially produced fish and wild fish			
General Reform				
Hatchery Genetic Management Plans (HGMPs); Implementation of HGMP plans	Comprehensive review, program by program, facility by facility, to clarify goals and objectives, reform of hatchery practices to reduce risk of adverse impacts to wild stocks and maximize potential benefits of artificial production. Implementation of operational, facility (including capital), and program changes necessary to implement HGMPs			
Marking of hatchery production	Necessary to better determine status of natural populations; useful for enabling certain selective fisheries			
HABITAT				
Federal				
Northwest Forest Plan	X	n/a	X	X
ICBEMP	n/a	X	X	X
Off-site Mitigation, Nonfederal Lands	X	X	X	X
Council Plan (BPA-funded)	X	X	X	X
Mainstem & estuary	X	X	X	X
Nonfederal				
State/city/local plans	X	X	X	X
TMDL/water quality plans	X	X	X	X
HARVEST				
Constrain harvest to recently-established, lowered rates	X	X	X	X
Weak stock management	X	X	X	X
Selective fisheries (potential)	X	X	X	X
Ocean fishery easements (potential for benefit)	only for some chinook	only for Snake River fall chinook	n/a	n/a
Enhanced opportunity				
Terminal fisheries	Site and circumstance - specific			
Value-added	Enhanced value products to increase economic value of harvested fish; potential for all species			
IMPLEMENTATION & ACCOUNTABILITY	Formal, comprehensive coordination among federal agencies, state fish & wildlife agencies, Tribes, Columbia Basin Forum, Northwest Power Planning Council (and others) to ensure adequate staffing, budgets, consistency, and execution with comprehensive M&E to assess progress and to make necessary adjustments in implementation			

Map 2 Actions by ESU (on page 32) is available in separate document

2. Basinwide Salmon Recovery Strategy

2.1 Goals and Objectives

The Federal Caucus used these goals and objectives, modified based on comments from tribal governments and the public, to develop the Basinwide Salmon Recovery Strategy.

Goals

- *Conserve Species.* Avoid extinction and foster long-term survival and recovery of Columbia Basin salmon and steelhead and other aquatic species.
- *Conserve Ecosystems.* Conserve the ecosystems upon which salmon and steelhead depend, including watershed health.
- *Assure Tribal Fishing Rights and Provide Non-Tribal Fishing Opportunities.* Restore salmon and steelhead populations over time to a level that provides a sustainable harvest sufficient to provide for the meaningful exercise of tribal fishing rights and, where possible, provide non-tribal fishing opportunities.
- *Balance the Needs of Other Species.* Ensure that salmon and steelhead conservation measures are balanced with the needs of other native fish and wildlife species.
- *Minimize Adverse Effects on Humans.* Implement salmon and steelhead conservation measures in ways that minimize their adverse socio-economic and other human effects.
- *Protect Historic Properties.* Consistent with the requirements of the National Historic Preservation Act and other applicable law, assure that effects of recovery measures on historic properties are identified and addressed in consultation with all interested and affected parties.
- *Consider Resources of Cultural Importance to Tribes.* In implementing recovery measures, seek to preserve resources important to maintaining the traditional culture of basin tribes.

Biological Objectives

- Maintain and improve upon the current distribution of fish and aquatic species, and halt declining population trends within 5-10 years.
- Establish increasing trends in naturally-sustained fish populations in each subregion accessible to the fish and for each ESU within 25 years.
- Restore distribution of fish and other aquatic species within their native range within 25 years (where feasible).
- Conserve genetic diversity and allow natural patterns of **genetic exchange** to persist.

Ecological Objectives

- Prevent further degradation of tributary, mainstem and estuary habitat conditions and water quality.
- Protect existing high quality habitats.
- Restore habitats on a priority basis.

Water Quality Objective

- In the long term, attain state and tribal water quality standards in all **critical habitats** in the Columbia River and Snake River basins.

Socio-Economic Objectives

- Select actions to restore and enhance fish and their habitat that achieve the biological and ecological objectives at the least cost.
- Mitigate for significant social and economic impacts and explore creative alternatives for achieving these objectives.

- Seek adequate funding and implementation for strategies and actions.
- Coordinate restoration efforts to avoid inefficiency and unnecessary costs.
- Restore salmon and steelhead to population levels that will support treaty and non-treaty harvest.
- Select actions that consider or take into account tribal socio-economic or cultural concerns.

The agencies believe their recommendations are the combinations most likely to meet these goals and objectives. The actions reflect the best scientific understanding of what is necessary to conserve the species and their ecosystems. The Strategy contemplates maintaining tribal fishing opportunities in the near term, and expanding them over time. The Strategy recognizes the needs of other at-risk fish, wildlife and plant species within the basin. The Strategy seeks to provide a measure of social and economic certainty by seeking maximum benefit from the available resources, with clearly established implementation and monitoring processes.

2.2 Implementation

To be successful, this recovery Strategy requires federal agencies to coordinate their respective programs with one another and with state, tribal and local programs. This section describes how the federal agencies intend to accomplish that coordination.

- Continue the Federal Caucus.
- Establish a Memorandum of Understanding Among Federal Agencies.
- Continue the Regional Forum.
- Establish a Habitat Team.
- Coordinate Harvest and Hatchery Activities with Habitat and Hydropower Activities.
- Coordinate with other Regional Entities.
- Collaborate with Others on Science.
- Initiate Recovery Planning.
- Use Performance Standards.
- Coordinate Federal Budgets.
- Monitor and Evaluate Progress.

2.2.1 Continue the Federal Caucus

In December 1998, nine federal agencies with fish and wildlife management and implementation responsibilities in the Columbia River Basin formed a Federal Caucus to prepare for a long-term decision on operation and configuration of the Federal Columbia River Power System. The agencies participating in the Caucus are listed at the front of this document. The Federal Caucus is comprised of senior policy staff representatives from each of the nine agencies. A federal MOU commits the original nine agencies to continue coordinating through the Federal Caucus. Other federal agencies may also join and sign the MOU later.

Each of the Caucus agencies has a key role to play in implementing and funding programs and applying regulations in the Columbia Basin that are the subject of the Strategy. The Federal Caucus provides an effective structure to harmonize agency policies and coordinate implementation of the Strategy. Maintaining the Federal Caucus will also allow the federal agencies to coordinate more effectively with regional forums such as the Council and the Columbia River Basin Forum. To further enhance regional coordination and participation, the Federal Caucus will regularly hold meetings that are open to the public.

The federal executives of the Caucus agencies provide policy guidance to and resolve disagreements within the Caucus. The federal agencies are accountable for achieving performance standards across the Hs and measuring the effectiveness of the Strategy.

2.2.2 Federal Agency Memorandum of Understanding

The federal agencies have entered into an MOU to formalize their commitment to coordinate their implementation, funding and monitoring of the Strategy and to ensure common approaches and priorities for the recovery of listed fish. (See Implementation, Volume 2.) Specifically the MOU commits federal agencies to:

- Establish an expanded Federal Caucus;
- Establish a Habitat Team;
- Consistent application of ESA, CWA, other relevant statutes and tribal trust and treaty responsibilities as they relate to the conservation of Columbia Basin fish;
- Establish priorities for implementation;

- Coordinate budget development and expenditures;
- Coordinate with related efforts of state, tribal and local governments;
- Work with the states, tribes and the Northwest Power Planning Council to develop a comprehensive basinwide monitoring program.

2.2.3 Continue the Regional Forum as the Hydropower Team

The federal agencies will continue to coordinate operation and configuration of the FCRPS through a Hydropower Team (begun in 1995 and known as the NMFS Regional Implementation Team). Federal agencies participating in the Hydropower Team will include the **Operating Agencies** (Corps, USBR and BPA), NMFS, USFWS and EPA. As with the NMFS Forum, participation in the Hydropower Team, and all subgroups operating under the Team's guidance, will be open to representatives from the states, tribes, and federal agencies.

The Hydropower Team will develop annual and 5-year plans to implement the operational and structural measures outlined in the biological opinions issued by NMFS and USFWS on operation and configuration of the FCRPS. The operating agencies will coordinate annual implementation, prioritization of actions, review, and modification of measures outlined in the biological opinions through the Team.

Technical groups working under the direction of the Hydropower Team will address specific areas of hydropower implementation. These groups include the Technical Management Team (TMT); the System Configuration Team (SCT); and the teams addressing water quality, resident fish, and research, monitoring and evaluation.

The TMT will meet regularly to advise the Operating Agencies on the status of salmon migrations, and to consider dam and reservoir operations to optimize passage conditions for juvenile and adult anadromous fish, and to meet the needs of other listed aquatic species. The SCT will meet regularly to consider the results of scientific and engineering studies and to develop and recommend any necessary FCRPS facility improvements, including their priority, implementation schedule, and budget needs.

All meetings of the Hydropower Team are professionally facilitated and are open to the public. Minutes of the meeting are taken and available to participants and members of the public.

A Water Quality Improvement Team (WQIT) will be formed to implement the Water Quality Plan for the FCRPS to better link CWA and ESA requirements. The intent would be to link and integrate actions undertaken within the annual planning process and the Columbia River Basin Forum, through input and updates on Water Quality Plan implementation, including consideration of the traditional TMDL development and implementation processes to efforts to improve water quality on the mainstem Columbia River.

2.2.4 Establish a Habitat Team

Several Caucus agencies have land management responsibilities or habitat programs, including the U.S. Forest Service, BLM, BPA, NMFS, USFWS, EPA, Corps and USBR. These agencies will dedicate staff to a federal Habitat Team whose job will be to coordinate among federal programs, and between federal and state and tribal programs. Other federal agencies with land management responsibilities, such as the Natural Resource Conservation Service and the Farm Services Administration, may also be invited to participate on the federal Habitat Team.

The Habitat Team will perform the following coordination and management functions.

Among federal agency habitat programs – The Habitat Team will improve coordination among federal habitat programs in several ways:

- Policy coordination: Coordinate federal agency policies and guidance consistent with this Strategy.
- Budget coordination: Coordinate agency budgets to ensure efficiency, eliminate overlap, and focus resources where they can best achieve the goals of this Strategy.
- Technical Coordination: Ensure federal agencies use and support complementary watershed and subbasin assessment and planning protocols.
- Recovery Planning Coordination: Ensure NMFS' and USFWS' recovery planning processes are supported by the federal

agencies and are well-connected to other federal programs and actions.

Between federal agencies and others – Important salmon habitat is on nonfederal land. Recovery of the fish will only be successful if states, tribes, local governments and private parties address key water quantity, water quality, riparian, and other issues. The federal agencies will encourage voluntary and incentive-based efforts, using federal funds to leverage local resources and efforts. The Habitat Team will improve linkages between federal and nonfederal initiatives in several ways:

- Support local watershed efforts: Work with states and regional organizations to assist local watershed groups in obtaining funding and technical support from appropriate federal programs and agencies.
- Support common habitat assessment tools: Work with states, tribes, the Council and others to develop, support and use common watershed and subbasin assessment protocols.
- Support data quality control and data sharing: Work with states, tribes, the Council and others to develop and implement a basinwide monitoring strategy that includes a comprehensive monitoring plan, standardized data collection, and standardized data reporting.
- Comprehensive monitoring and evaluation: The Federal Caucus will report annually on federal agency progress in carrying out habitat initiatives and coordinate with state and tribal governments. Reports will relate to the performance standards for habitat in the Strategy.

2.2.5 Coordinate Harvest and Hatchery Activities with Habitat and Hydropower Activities

Management of in-river harvest occurs under the auspices of the federal court in *U.S. v. Oregon*. Regulation of ocean harvest occurs pursuant to the Magnuson-Stevens Fisheries Management and Conservation Act and the Pacific Salmon Treaty. In addition, any harvest of ESA-listed fish must be authorized by NMFS or USFWS through ESA processes. NMFS and USFWS will use the Federal Caucus to keep other federal agencies apprised of harvest regulations and issues and to assure that harvest and hatchery activities are complementary and consistent with the overall recovery effort.

The Federal Caucus will coordinate plans for implementation, budget development and schedule for those hatcheries receiving federal funding from BPA, Corps, USBR, Lower Snake River Compensation Program, the Mitchell Act and other sources consistent with existing programs and responsibilities. The primary tool for achieving such coordination will be Hatchery Genetic Management Plans (HGMPs). HGMPs will improve budget planning for hatcheries, help set budget priorities (such as funding and construction schedules for upgrading hatcheries to meet necessary hatchery reforms), improve the level of certainty associated with planning and funding hatcheries, and ensure the proper data collection, monitoring, and evaluation procedures are in place. Coordinated planning should produce a more responsive, methodical, and cost-effective approach to urgently needed programs for species recovery and for meeting fisheries needs. Close coordination with the Council will be critical to assuring that the region has a unified approach to the use and management of hatcheries within the basin.

2.2.6 Regional Coordination

Coordination of federal decision-making and funding with that of states, tribes and local governments is essential to the success of federal recovery efforts in the Columbia River Basin. One opportunity for coordination is through the Columbia River Basin Forum, which was formed in 1998 and has been chartered by the states of Idaho, Washington, Oregon and Montana, the federal government and several of the region's tribal governments. Four representatives each from tribal, state and federal governments form the Forum. The Forum is designed to improve the management of fish and wildlife resources in the Columbia River Basin without changes to existing laws. It provides a valuable forum for coordination and discussion of decisions being made by each of the government entities that affect fish and wildlife in the basin. Meetings of the Forum are open to the public. Representatives

of agencies in the Federal Caucus intend to continue participating in the Forum.

Coordination with the Northwest Power Planning Council will play a crucial role in guiding the recovery of fish and wildlife resources in the Columbia River Basin. The Council is a product of the Northwest Power Planning and Conservation Act of 1980 and is charged with developing a Fish and Wildlife Program to protect, mitigate and enhance fish and wildlife in the Columbia Basin. The Council makes final funding recommendations on fish and wildlife measures to BPA after extensive input from fish and wildlife managers, independent scientists and the public. The Council recently amended the Fish and Wildlife Program with a framework concept, which the amendment states, "is intended to bring together as closely as possible, Endangered Species Act requirements, the broader requirements of the Northwest Power Act and the policies of the states and Indian tribes of the Columbia River Basin into a comprehensive program that has a solid scientific foundation…" BPA intends to rely on the Council's program as its primary implementation tool for the 2000 FCRPS Biological Opinion off-site mitigation requirements.

The federal agencies have a legal responsibility to consult and confer with Indian Tribes. This communication takes place through various regional forums (such as the Columbia Basin Fish and Wildlife Authority and the Columbia River Basin Forum) and through government-to-government consultations.

Coordination with the states and tribes on Total Maximum Daily Load (TMDL) implementation is critical. A TMDL is a strategy for bringing a polluted river, lake or bay in compliance with water quality standards to support fish, drinking and swimming. The states working with EPA and the tribes are developing thousands of TMDLs for the Columbia Basin over the next 10 years and this work will be coordinated with recovery efforts.

2.2.7 Science Collaboration

Critical uncertainties remain about several aspects of the salmon life cycle, including the role of ocean conditions, the magnitude of delayed mortality, hatchery-wild fish interactions, genetic adaptability, and the timeframe over which habitat improvements will lead to population growth. Everyone involved in or affected by the policies that guide salmon and steelhead recovery wants to know what works, what doesn't work, what is being accomplished for the investment of public funds, and how to narrow the uncertainty of achieving recovery.

Comprehensive monitoring and evaluation focused on uncertainties that are critical to future recovery decisions will be applied to determine whether underlying assumptions are accurate, whether the Strategy is working and to identify needed adjustments. Data must be gathered, processed and reported in a standardized and timely way, and must be readily available to all involved in salmon recovery.

A major opportunity for science collaboration could occur via the recovery planning process. NMFS will establish a Technical Recovery Team to develop the science foundation for recovery plans for ESA-listed species of salmon and steelhead in the Columbia River Basin. The process NMFS has initiated to develop these plans involves two phases, with the involvement of regional technical and policy expertise in each of the relevant phases. To summarize, the first phase is largely a scientific exercise culminating in the establishment of delisting criteria goals, development of potential scenarios or options for recovery, and identification of potential early actions for recovery. The second phase is a policy exercise in which the options for recovery would be carefully weighed and a final suite of actions would be identified on an ESU-specific basis. Both the technical phase and policy phase would involve qualified individuals from regional agencies, states, tribes, academia and interest groups. The goal would be to bring together a broadly representative group of the best scientific minds in the region, and perhaps nationally, to tackle these issues.

The TRT for interior Columbia Basin ESUs could include three sub-groups, one each focusing on Mid-Columbia, Snake River, and Upper Columbia ESUs. This process has already begun in Puget Sound and the lower Columbia and Willamette rivers. It will take place in the open, subject to review by all, and will lead to publication and scrutiny of the final products in recognized scientific journals. NMFS, in consultation with other federal agencies, intends to initiate recovery planning

in the interior Columbia River Basin beginning in January 2001. Before formally establishing a TRT for the interior Columbia Basin, NMFS would work in advance to ensure that all interested parties within the region have an opportunity to understand the role of a TRT and the options for participation. The TRT concept was described to states and tribes during technical and policy discussions.

2.2.8 Initiate Recovery Planning

This Strategy provides goals, objectives and actions at the scale of the entire basin. More specific recovery goals and measures need to be determined at smaller scales, applying local data and expertise and addressing local ecological and social issues. NMFS has initiated recovery planning for salmon and steelhead ESUs in the Upper Willamette and Lower Columbia rivers and expects to initiate recovery planning promptly for ESUs in the interior Columbia Basin. USFWS has initiated recovery planning for Columbia River bull trout and conceptual plans for Kootenai River white sturgeon and Snake River snails. The agencies expect these recovery plans to provide specific numeric and qualitative criteria for de-listing, and to provide for site-specific actions to achieve the de-listing criteria.

A related effort is the Council's subbasin planning process that will be implemented through the Northwest Power Act. The Council organizes the Columbia Basin into 53 subbasins, all with unique ecological and social issues. The Council is calling for the development of goals, objectives and management measures that will comprise a subbasin plan for each of the subbasins. Like recovery planning, the Council expects subbasin plans to provide numeric and qualitative goals and objectives and specific management measures. The purpose of these subbasin plans is to provide context and scientific foundation for implementing the Columbia Basin Fish and Wildlife Program (described in Volume 2). The Council has expressed its commitment to integrating the Fish and Wildlife Program with other federal, state and tribal subbasin and watershed programs.

The NMFS and USFWS will strive to integrate recovery planning with the Council's subbasin planning and other state and tribal recovery initiatives. This integration is critical to ensure that the collective efforts in a geographic area such as a subbasin or recovery plan unit can be added up for their progress in achieving de-listing criteria. This integration will happen first through shared science assessment processes and then through fully-coordinated planning forums. The federal agencies will support, facilitate and help integrate these planning efforts to the greatest extent practicable.

2.2.9 Performance Standards

Performance standards are population, life stage, environmental, or implementation "measures of success." The following summary presents the agencies' current thinking about performance standards at various levels – population level, allocation among the life stages, and specific metrics for each H. These are only preliminary in nature, and will be updated over time as knowledge of actual performance becomes more refined through the monitoring and evaluation program.

Performance standards are central to this Strategy (see box). They are the means for establishing the level of survival improvement in each stage of the salmon and steelhead lifecycle that are necessary for survival and recovery. Performance standards create clear objectives and provide flexibility to define the most efficient means of achieving the objectives.

The performance standards are divided into three tiers, which are described below. Over time, compliance with these standards will be assessed through monitoring and evaluation. If progress toward meeting performance standards is insufficient, adjustments will be made, either in the actions implemented or in the allocation of survival improvements across the Hs.

Tier 1: Population Level Performance Standards

Tier 1 performance standards are intended to provide long-term measures of success. They are measured over time, and across all Hs. The Tier 1 standards are:

- Survival Rates of Better than 1 to 1
- Numbers of Returning Adult Fish

Performance Measures and Standards

Performance measures and standards have been developed for each H. A *performance measure* describes a population, life-history stage specific, or human activity-specific biological condition. A *performance standard* is a value of a performance measure that has been identified as a management goal. For example, the parties to the proposed Mid-Columbia Habitat Conservation Plan have suggested the "survival of smolts passing a dam" as a useful and informative performance measure and have set an associated standard of 95 percent. The Mid-Columbia public utility districts, which operate these projects, have proposed to implement a suite of actions that they believe will improve dam-passage survival up to the level of the performance standard within a short time frame. The success of these activities will be gauged through monitoring and evaluation.

Performance measures have been divided into three tiers. The first tier is the population/ESU level. Here, measures and standards (goals) can be stated in terms of spawner abundance, diversity of life-history types, the number and geographic distribution of spawning populations, or secondarily-derived statistics such as population growth rate and the probability of recovery or extinction. Population-level performance measures and their associated standards reflect the cumulative effects of survival throughout the life cycle, and management actions often affect survival or fish condition at the level of a specific life-history stage.

The second tier is life-stage specific. There are nine life-history stages (e.g., spawning to emergence, emergence to parr, parr to smolt, etc.). Within each life-history stage, management actions can affect fish survival or condition in each of the Hs.

The third tier is H specific. If only one source of human-caused mortality affects a particular life stage, the third tier performance measure for that life stage should be equal to the second tier performance measure.

Over time, compliance with these standards can be assessed through monitoring and evaluation. If progress toward meeting performance standards is not sufficient, adjustments can be made – either in the actions implemented or in the allocation of survival improvements across the Hs.

The ultimate performance standards for the hydropower system and other human activities, taken together, are based on improvements in generational survivals. *From one generation to the next, adult-to-adult survival of better than 1 to 1 must be achieved to avoid extinction*. The agencies will use CRI to provide this assessment of progress in all Hs – hydropower, harvest, hatcheries, and habitat – on an ongoing basis.

Another overall measure of success at the population level is numbers of returning adults. *Over time, the numbers of returning adults for each listed population must be increasing toward recovery levels.* Like survival rates, this performance standard must be met by all Hs, taken together, not by hydropower alone.

Tier 2: Life Stage or H-Specific Performance Standards

Tier 2 performance standards are simply the allocation of Tier 1 standards across the life stages (some Hs affect more than one life stage). They are actually met through the more specific performance standards in Tier 3. The estimated benefits of improvements in each life stage will vary depending on ESU.

For tributary and estuary habitat, the agencies will estimate the survival improvements likely to result from protecting and restoring habitat characteristics described in Section 3. Recent analyses indicate that reducing mortality at early life stages holds great potential for increasing salmonid population growth rates; maintaining and restoring tributary and estuarine habitat is one approach to reducing that mortality – case studies suggest that substantial improvements are feasible.

For hatcheries, the agencies' estimates of survival improvements will be based on expected benefits from reduction of adverse hatchery-wild fish interaction, hatchery reforms, and use of supplementation as a conservation measure for weak populations.

For harvest, no additional improvement in survival relative to that already achieved as a result of recently-developed harvest constraints is assumed, although harvest rates on certain upriver steelhead ESUs may need further reductions as a result of additional analyses. However, survival improvements that may be achieved through programs that lead to more selective fisheries will be incorporated as appropriate.

For hydropower, improvements in survival through the federal hydropower system will be estimated for juveniles and adults. Additional survival increases can be expected from flow and passage improvements made at the many nonfederal dams in the basin.

For more information on these estimates, see the analyses of each Tier 2 life stage strategy included in Volume 2.

Tier 3: Performance Standards for each H

Tier 3 performance standards are specific, measurable goals for each H. Some are immediate or short term in nature, while some are long term. They vary by each H, depending on the features that are relevant and measurable.

Tier 3 performance standards should target improved survival and reduction of harm to wild salmon and steelhead runs. Through the combination of these standards, real improvements throughout the fishes' lifecycle are possible. Responsibility for salmon and steelhead recovery is allocated among all Hs in an equitable manner, so that each sector does its fair share.

For ease in understanding, program objectives and performance standards for each H are summarized below. This information is also displayed in Table 3.

Table 3 Performance Standards and Measures

Performance Standards	Performance Measures
• improve survival rate • eliminate practices harmful to wild fish	
Hydrosystem • improve survival through the hydrosystem • improve instream and reservoir environmental conditions	• Juvenile survival rate of X% at each project • Cumulative juvenile in-river system survival rate of X% • Adult survival rate of X% per project and X% systemwide • Cumulative system adult and juvenile survival rate of X%
Habitat • prevent habitat degradation • restore high quality habitat • restore/increase habitat complexity	• Increased stream miles meeting water quality standards (temperature and sediments) • Increased stream miles with adequate instream flows • Increased stream miles opened to fish access • Increased number of diversion areas screened • Increased acres and/or stream miles of habitat protected or restored
Harvest • prevent overharvest • provide sustainable fishery	• Constrain harvest rates of listed fish • Increase escapement rates
Hatchery • reduce hatchery operations potentially harmful to wild fish • conservation hatchery actions	• Improve egg-to-smolt survival • Increase number of biologically-appropriate naturally-spawning adults • Improve fish health and fitness • Improve hatchery facilities, operation, and management and reduce potential harm to listed fish

Strategies for Habitat:

- Protection: To prevent further degradation of habitat conditions and water quality for all life stages.
- Restoration: To increase the amount of high quality habitat and high water quality for spawning, rearing, and migration.
- Complexity: To restore the complexity and range of habitat conditions for all life stages.

Performance Standards for Habitat:

- Estimated Benefits:
  - Use Ecosystem Diagnosis and Treatment Methodology and subbasin assessments
- Overall Productivity Standards:
  - Egg-to-smolt productivity improvement
  - Fish fitness (size and weight)
- Ecological Standards:
  - Water Quality: Increase in areas where water quality standards met: temperature (summer high temperature) and sediment.
  - Instream Flows: Increase in areas where instream flow needs are met (summer low flow).
  - Fish Access: Increase in areas where fish access is restored.
  - Screening: Increase in areas where diversions are screened.
  - Protection: Numbers of acres/stream miles of habitat protected or restored.

The ultimate performance standard to gauge habitat improvements is salmon productivity, a measure of how many salmon a particular river is capable of producing. The best long-term indicator of habitat productivity at this time is egg-to-smolt survival. This information, as well as its relationship to habitat characteristics, will have to be developed over a period of years. Egg-to-smolt productivity in representative habitat areas will be an essential part of our ongoing monitoring and evaluation program to provide this base. Nevertheless, this information will not be useful to guide decisionmaking in the short term.

For the short term, the agencies propose (1) to estimate potential benefits from habitat action using the Ecosystem Diagnosis and Treatment model and subbasin planning, in collaboration with the Northwest Power Planning Council; and (2) to gauge success with habitat improvements using a scientifically rigorous and focused monitoring and evaluation program. Based on available science, the agencies believe that there is a direct relationship between survival and the amount of habitat that is improved in the basin, and will test this hypothesis with the focused monitoring and evaluation program.

The proposed ecological criteria would be assessed at the basin and subbasin level, and over time, at the watershed and/or stream level. Subbasin assessments will define the level of habitat changes required based on the best available information on recovery/extinction thresholds for each ESU. In addition, actual implementation of related management actions to meet the ecological standards will be tracked. The Strategy emphasizes rehabilitation of ecological processes and functions, not artificial creation of habitat.

Strategies for Harvest:

- Fishery Management: Manage fisheries in a manner that prevents overharvest, does not thwart recovery efforts, and contributes to meeting federal obligations to provide meaningful treaty harvest.
- Sustainable Fisheries: To provide sustainable fisheries for the meaningful exercise of tribal fishing rights and non-tribal fishing opportunities consistent with the recovery effort.

Performance Standards for Harvest:

- Estimated Benefits:
  - Maintain minimum escapement rates
  - Provide time for other recovery efforts to take effect
- Adult Fish Improvement Criteria:
  - Maintenance or reductions in harvest rates of listed species.
  - Resultant stabilization and/or increases in escapement.

Rationale for Harvest Performance Standards

Measurement of harvest rates and escapement are straightforward, and are well developed by the parties involved in harvest management in the river and in the ocean. However, a mechanism must also be provided for attributing survival benefits to specific elements of voluntary or funded harvest reductions provided through greater selectivity of fisheries. That mechanism should explicitly recognize that greater selectivity in a given fishery can be used in part for either or both of two objectives: reduce take on listed stocks while sustaining current harvest, or increasing harvest. The agencies propose to measure these improvements based on reductions of harvest impacts on listed fish and resulting increases in escapement of fish to spawn.

Strategies for Hatcheries

- Hatchery Reform: Reduce potentially harmful hatchery practices.
- Conservation Hatchery Actions: Use safety net program on an interim basis to avoid extinction while other recovery actions take place; use hatcheries in a variety of ways and places to aid recovery.

Performance Standards for Hatcheries:

- Estimated Benefits:
  - Reduce or eliminate adverse hatchery effects; achieve corresponding productivity improvements in wild fish; preserve genetic diversity.
- Fish Improvements:
  - egg-to-smolt survival benefits
  - increase in number of biologically-appropriate naturally-spawning adults
  - improved fish health and fitness
  - improvements in hatchery facilities, operation, and management and reduced potential harm to listed fish.

Temporary **conservation hatchery programs** designed to contribute towards recovery of ESA-listed populations currently at critically low levels can yield immediate benefits for early life-history stages by dramatically increasing egg-to-smolt survival. Measurement of success can be documented at a minimum through the number and quality of smolts produced for each population, eventually manifest in the number of returning adults.

Strategies for Hydropower:

- Improve Survival: To provide adequate survival and maintain healthy adult and juvenile fish migrating through the hydropower system.
- Improve Conditions: To provide instream and reservoir environmental conditions necessary to produce recruits and provide adequate survival of resident fish and other aquatic species.

Performance Standards for Hydropower:

- Biological:
  - Migrating Adults
  - Juveniles: transported and in-river migrants
  - System: cumulative survival, including direct and indirect mortality

For direct actions taken in the hydrosystem, such as improvements for adult or juvenile passage, benefits can best be measured and documented based on changes to juvenile or adult survival. Both non-hydrosystem effects that are manifested within the hydrosystem as well as hydrosystem effects manifested outside the hydrosystem (i.e., indirect mortality) are also considered to provide an adequate basis for actions that can contribute to improvements.

A system survival standard would be the main measure of juvenile fish survival. System survival may be broken down into minimum survival levels per project, but these would not be considered hard limits. Rather, project-specific actions will be contemplated based on the relative "priority" of needed improvements in relation to its contribution to system survival, the ESU stocks affected, and alternative actions at other projects that may be more effective. Through this approach, investment choices will be made to ensure the greatest biological benefits for the various ESUs and their individual requirements.

- Programmatic:

Programmatic performance standards are the actions and the schedule for those actions that are defined in the annual planning process, the Biological Opinion, and this Strategy. In essence, the measure of performance is the success of the Action Agencies in implementation of actions defined in the Annual Plan. Evaluation of progress relative to this standard will be formalized through NMFS' review of annual progress reports prepared by the Action Agencies, the annual NMFS findings letter, and the 3-, 5- and 8-year mid-point evaluations.

- Physical:

Physical performance standards supplement and, in some cases, serve as surrogates for biological performance standards. In the case of hydropower actions, for example, there are some physical targets or objectives directed at measures such as mainstem flow objectives and water quality that are intended to guide water management decisions.

2.2.10 Funding

Funding for staff and other resources is needed to implement this Strategy. The Federal Caucus does not expect that resources will be available to do everything simultaneously, even if such an effort could otherwise be organized and staffed. With this in mind, the Caucus agencies will coordinate funding requirements and proposals that will be submitted and determined through normal federal budget and appropriations processes, and report on the availability of resources and implications for the agencies' ability to carry out this strategy.

Coordinating the budget proposals will ensure efficiency, eliminate overlap and omissions, and focus resources where they can best achieve targets. The Federal Caucus will submit the coordinated plan and budget to the Regional Executives for approval. It will then be the responsibility of each agency to include its share of the Strategy and related funding requirements in its budget submission.

2.2.11 Monitoring and Evaluation

Monitoring and evaluation is not merely the periodic collection of data. Rather, properly designed monitoring programs will provide data for resolving a wide range of uncertainties that are critical to future decisions, such as determining population status, establishing causal relationships between habitat (or other) attributes and population response, and assessing the effectiveness of management actions. The information gained through monitoring programs will be a cornerstone in identifying alternative actions and refining recovery efforts. The focused monitoring and evaluation programs will be an integral part of any management action, and a critical component of a recovery plan or adaptive management, and will afford managers the information to maintain or change strategies as necessary.

A complete monitoring program will address the following four major groupings of questions for listed salmonids:

- **Compliance monitoring. Have management actions been implemented; have they been implemented appropriately and in their entirety?** 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. In addition, the monitoring program should be used to assess and improve the quality of regional databases, particularly those that describe habitat attributes throughout the Columbia River Basin.
- **Population Status Monitoring. What is the status of salmonid populations; does that status change through time?** A primary concern will be determining the level of risk populations face, including the current range, trends and abundance of populations, and whether those trends change.
- **Environmental Status Monitoring. What are environmental conditions in areas of different salmonid abundance or trend; and, are there systematic**

patterns suggesting that specific natural or anthropogenic factors affect salmon population dynamics? This set of questions is primarily aimed at determining the status of factors thought to affect salmon populations, and using that assessment to suggest appropriate management actions and experiments.

- **Effectiveness monitoring. Is there a cause and effect relationship between management actions and salmonid population responses locally or across the landscape?** In many cases this will be a multi-tiered set of questions: did a management action cause the anticipated change in a condition (habitat attribute, or abundance of hatchery fish, for instance)? Then, did the change in conditions cause a response in salmonid populations? How large was the response?

The core of the monitoring program to address these issues for anadromous salmonids will be a hierarchical sampling scheme (Table 4). Specifically, data will be collected at three tiers of increasing detail. Tier 1 is the most general level. The data collected at Tier 1 sites will establish the current range of anadromous fish (and future changes to that range). It will also provide the broadest picture of environmental conditions. Data collected during Tier 2 sampling will allow a more detailed picture of both salmon population status (abundance and trend) and environmental conditions. Tier 3 sampling is the most detailed, and is designed primarily to determine the effectiveness of management actions. Other Tier 3 sites will be used to determine the reproductive success of naturally-spawning hatchery fish (this information is extremely

Table 4 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.

important to determining the status of wild stocks).

In addition to this hierarchical system, two additional components will be necessary for a complete monitoring program. First, a compliance monitoring program will be developed by the federal Habitat Team. Second, a regular program of landscape-level assessment (e.g., aerial or satellite imagery) to document current and changing land use/land cover patterns will be an important component of assessing patterns between environmental characteristics and salmonid population status. Further details of this program are provided in Volume 2.

Monitoring and evaluation will also be important for resident fish and other aquatic species. It will provide critical information on bull trout population trends, distribution, timing and usage of FCRPS fish ladders, fish bypass, and smolt monitoring facilities and reservoir systems, and assess entrainment of bull trout through FCRPS dams. For Kootenai River white sturgeon, current levels of monitoring and evaluation will be maintained that are associated with all life stages of natural recruitment, and the preservation stocking program.

Conducting monitoring and evaluation effectively will require that both data collection and the implementation of management actions be highly coordinated. Collecting data to address any of these questions for any listed species will require attention to issues of experimental design, including distribution of monitoring sites, appropriate replication and scale. Management actions must be conducted in the context of an experimental framework that will offer the greatest opportunities for detecting responses in the shortest amount of time. Similarly, it will be imperative that data collection be conducted in a standardized manner and that data is reported and managed in a regional database. Failure to maintain a scientifically rigorous, coordinated effort will not only render any monitoring program useless, but will also undercut the importance of the management actions themselves, since they will no longer contribute to our understanding of salmonid population responses.

The Northwest Fisheries Science Center, in collaboration with regional scientists and other federal, state, tribal and local agencies, will develop a monitoring and evaluation program that addresses these major areas. Specifically, by September 2001, the following will be completed:

- A comprehensive framework for a monitoring and evaluation plan. The framework will refine the monitoring scheme proposed here, evaluate formally the necessary temporal and spatial replication, and identify specific localities at which the monitoring program will take place.
- Standards for collecting, synthesizing and reporting data;
- A mechanism for reporting data.

The federal agencies anticipate that many of these elements could ultimately be incorporated in the Council's Fish and Wildlife Program. NMFS' Biological Opinion on operation and configuration of the FCRPS, which accompanies this Strategy, identifies key research and monitoring that must be done to validate the assumptions in the **Reasonable and Prudent Alternative**. To the extent practicable, the Caucus agencies will work with states, tribes and the Council to ensure these required activities are well integrated into the more broadly-based regional program.

2.2.12 Progress Reports

The Federal Caucus will report on agency progress in carrying out recovery actions, including the availability of resources and the agencies' ability to carry out the Strategy. These reports would also be geared to support long-term biological monitoring to assess the contribution of improvements in each H to improvements in population growth rates or other biological indicators. In addition, the Federal Caucus will work with the states, tribes, Council and others to develop:

- A process for ensuring the scientific credibility of the monitoring framework that includes review by the Independent Science Advisory Board;
- A prioritized budget for research and monitoring to resolve critical uncertainties.

In 2003, 2005, and 2008, the Caucus will report on overall progress to date in implementing the federal actions, as modified and or updated, presented in Section 3 as action checklists for each H.

3. Specific Actions and Benefits for Each H

3.1 Habitat Actions

Fixing salmon and steelhead habitat is particularly challenging. These fish range through federal and nonfederal land, forests, farms and cities. A vast number of human activities affect their habitat. In addition, very few studies have been done that quantitatively link management actions with habitat quality, and habitat quality with fish production. Yet there is no doubt fixing habitat is central to any recovery plan. Survival improvements are likely to have the biggest effect in the first year of life (when most of the fish are in the tributaries) and during the transition to salt water (when the fish are in the estuary). Fixing tributary and estuary habitat is key to recovering the fish and is the centerpiece of the Strategy. Actions in the Strategy focus on tributary habitats, both federal and nonfederal; mainstem habitat, estuary habitat, and implementation.

For tributary habitats on nonfederal lands in priority subbasins, the federal agencies will implement, as available funds permit, actions that will have immediate benefits. These include actions aimed at removing passage barriers, screening diversions, increasing in-stream flow, restoring water quality and protecting high quality habitats through the purchase of land or conservation easements across all lines of land ownership.

For long-term actions, the Strategy endorses the Northwest Power Planning Council strategy of conducting subbasin assessments and developing subbasin plans and prioritizing actions based on those plans. The federal agencies have worked with the Council to develop an assessment template and a work plan to have a team of professionals complete the assessments. Once the assessments are complete sometime in 2001, the federal agencies will participate with state agencies, local governments, tribes and stakeholders to develop subbasin plans. As a complement to subbasin assessments and plans, NMFS has also begun a recovery planning effort that will establish population and ESU goals for abundance, productivity, distribution and diversity. The subbasin and recovery plans will then create the priorities for federal actions and funding.

For tributary habitats on federal land, the federal land managers will protect existing high quality habitat and accelerate restoration in high priority subbasins. In the short term, federal land will be managed under current programs that protect important aquatic habitats. That program will be augmented in important subbasins by a targeted restoration effort. In the longer term, federal land on the east side of the Cascades will be managed under the Interior Columbia Basin Ecosystem Management Project (ICBEMP) preferred alternative, which will rely on subbasin and watershed assessments and plans to target further habitat work. These assessments will integrate information and findings from the Northwest Power Planning Council's program. If for some reason ICBEMP is not finalized as currently planned, the interim guidelines, PACFISH and INFISH, will remain in effect, ensuring adequate protection on federal lands for listed fish. On the west side of the Cascades, federal lands are managed under the Northwest Forest Plan.

Federal agencies will assess mainstem habitat and implement experimental programs to create more natural habitat areas along the system of reservoirs. They will also establish a management plan to protect the Hanford Reach, home to a healthy core population of fall chinook.

For the estuary, the Lower Columbia River Estuary Program, a partnership between EPA, the Corps, and state and local governments, will be the foundation of the recovery effort. As part of this program, federal agencies will work with state, local, tribal, and

private partners to acquire or restore thousands of acres of estuary habitat over the next 5-10 years, creating a Lower Columbia River Greenway to benefit migrating fish. Predator control and improved river flows will be prominent features of efforts to improve the estuary.

The salmon's vast geographic range spans literally hundreds of different jurisdictions (see Map 3). Lack of coordination among these jurisdictions can undermine the best-laid habitat protection plans. The Basinwide Salmon Recovery Strategy emphasizes coordination among federal agencies, and between the federal agencies and others. Coordination will occur through a federal Habitat Team, which will also provide a basin-level focus and one-stop shopping for states, local governments, tribes and others working to protect and restore habitat. In addition to coordinating federal funding with the subbasin plans adopted by the Council, the team will provide technical assistance, information on ESA and Clean Water Act compliance, and coordinate federal funding.

Another important aspect of implementation is monitoring and evaluation. The federal agencies have identified critical uncertainties that must be answered to establish an effective habitat program. The Strategy proposes a comprehensive, basinwide monitoring effort that will address these critical uncertainties. More detail about the recommended actions is in Table 5.

One key to achieving these benefits is collaboration, which is intrinsic to the proposed strategy. The Federal Caucus believes the Council's subbasin initiative provides the best opportunity for multiple jurisdictions to reach agreement on implementing the actions. If collaboration fails, and the recommended actions do not take place, federal agencies have authority to pursue the necessary survival improvements as suggested by Option 3 of the draft Plan.

3.1.1 Performance Standards

The ultimate performance standard for habitat is fish productivity. However, this will be difficult to establish for habitat because salmon survival improvements from habitat actions cannot be measured in the short term. Even in the long term, measuring progress toward a biologically-based standard will be challenging and expensive. Based on our current understanding of the associations between ecosystem processes and salmonid populations, four habitat factors will influence performance measures throughout the basin:

- In-stream flows;
- amount and timing of sediment inputs to streams;
- riparian conditions that determine water temperature, bank integrity, wood input, and maintain channel complexity; and
- habitat access.

The federal agencies will develop an initial set of performance measures based on these four factors for use in midpoint evaluations in 2003, 2005, and 2008.

3.1.2 Immediate Actions

Although some of the recommended actions will take three or more years to put in place, the Federal Caucus also supports fast-track habitat actions in high-priority subbasins, gauged to maximize benefit in the short term. The Strategy also establishes criteria for other immediate actions. A key criterion for determining what constitutes an appropriate immediate action will be whether it results in an immediate benefit to listed species. Federal agencies are working with the Council, tribes, and states to develop and implement high-priority habitat improvements of this kind.

3.2 Benefits from Habitat Actions

By protecting existing high quality habitat and restoring degraded habitat on a priority basis, the Caucus agencies believe the habitat element of the Basinwide Salmon Recovery Strategy will have significant measurable benefits for listed anadromous and resident fish. For each ESU, the Strategy prioritizes subbasins for short-term habitat work based on potential for improvement in habitat capacity, degree of federal ownership (an anchor for restoration efforts), and number of water diversions (where addressing flow, passage and screening problems could produce short-term benefits). If implemented, the Strategy should result in improving habitat conditions in priority subbasins over the

Map 3 Land Management (on page 49) is available in separate document

Table 5 List of Habitat Actions

Goal	Habitat Actions to Meet Goal*	Timeframe		
■ = Basinwide Salmon Recovery Strategy Action ●= RPA Action ❖ = Conservation Recommendation		**Year 1**	**Years 2-5**	**Years 6-10**
Federal				
Develop Recovery Plans	Establish recovery objectives, de-listing criteria and recovery measures for the Upper Willamette, Lower Columbia, and Interior Columbia. (NMFS)	■	■	
Manage Federal Lands to Protect Fish	Through ICBEMP's and the Northwest Forest Plan's aquatic strategies, provide a base for habitat protection (USFS, BLM).	■	■	■
	Implement seven watershed restoration initiatives targeting core populations most at risk (USFS, BLM).	■	■	
	Implement multiple-scale assessments and data management systems (USFS, BLM)	■	■	■
	Accelerate land acquisition, using LWCF funds prioritizing fish habitat (USFS, BLM).	■	■	■
	Protect existing high quality habitat and accelerate restoration in high priority subbasins	■	■	■
Restore Estuary Habitat	Facilitate Lower Columbia River Estuary Program implementation (LCREP, EPA).	● ■	● ■	● ■
	Improve predator control (including developing a sea bird management plan) (COE, NMFS, FWS).	■	■	
	Secure additional Columbia and Snake flows (BPA, USBR).	● ■	● ■	
	Conduct habitat mapping inventory in early 2001; develop and implement modeling and restoration criteria beginning early 2001 (BPA, Corps, LCREP)	● ■		
	Prioritize habitats for protection and restoration (2001)(LCREP).	● ■		
	Seek authorization for Lower Columbia River Greenway Program (DOI/DOA); Establish Greenway Habitat Protection Fund to protect 10,000 acres of wetlands; 3,000 acres of upland.	● ■		
	Authorize and fund expanded Corps of Engineers Restoration Program.	● ■	● ■	
	Implement monitoring and evaluation program.	● ■	● ■	● ■
	Develop conceptual model of estuary conditions and fish population structure and resilience.	● ■		
	Authorize and fund FEMA buybacks of floodplain structures in priority habitats.	■	■	■

Goal	Habitat Actions to Meet Goal*	Timeframe		
■ = Basinwide Salmon Recovery Strategy Action ●= RPA Action ❖ = Conservation Recommendation		**Year 1**	**Years 2-5**	**Years 6-10**
Restore Tributary Habitat	Work with states to secure and protect minimum flows w/federal nexus (FS, BLM).	■	■	■
	With the Northwest Power Planning Council, develop subbasin and watershed assessments and plans; ensure that assessments and plans are coordinated across nonfederal and federal ownerships and programs.	● ■	● ■	● ■
	Fund technical support for 2001-2006 plan implementation; identify in annual and 5-year implementation plan appropriate habitat actions and implement them.	●	●	●
	Fix flow, screening and passage problems in priority subbasins, beginning in 2001 in the Methow, Upper John Day and Lemhi.	● ■	● ■	● ■
	Fund and evaluate innovative approaches to flow restoration (BPA).	● ■	● ■	
	Provide technical assistance to state instream flow work (USGS, USBR).	■	■	
	Support TMDL development and implementation (BPA).	■	■	
	Fund land acquisitions and conservation easements (BPA).	● ■	● ■	● ■
	Provide permanent protection for riparian areas in agricultural areas by supplementing agricultural incentive programs (BPA, with FSA and NRCS).	●	●	●
Improve Mainstem Habitat	Assess opportunities for mainstem habitat improvements (BPA).	● ■		
	Implement restoration programs (BPA)	● ■	● ■	
	Evaluate opportunities to improve spawning habitat in the Ives Island area.	● ■		
	Protect Hanford Reach (FWS, DOE).	■		
	Provide adequate spawning and rearing flows under Vernita Bar Agreement (FERC)	■	■	
Comprehensive Monitoring and Evaluation	Implement a comprehensive basinwide monitoring effort that addresses critical uncertainties.	■	■	■
States				
Protect & Restore Tributary Habitat	Develop and implement TMDLs for anadromous fish tributaries within five years.	■	■	
	Establish in-stream flows for anadromous fish tributaries within five years.	■	■	
	Continue IPC flows for fall chinook chum spawning (COE, USBR).	■	■	■
	Support water acquisitions using federal funding.	■	■	■
	Coordinate TMDL and Water Quantity planning assessments with NPPC program.	■	■	■

Goal	Habitat Actions to Meet Goal*	Timeframe		
■ = Basinwide Salmon Recovery Strategy Action ●= RPA Action ❖ = Conservation Recommendation		**Year 1**	**Years 2-5**	**Years 6-10**
	Reform and enforce land use statutes governing growth management, forestry practices, and agricultural practices (WA Forest & Fish model).	■	■	
	Establish programs to screen all pumps and restore passage at problematic diversions and obstructions.	■	■	
Restore estuary habitat	Facilitate implementation of Lower Columbia River Estuary Program.	■	■	
Congress				
Estuary Habitat	Immediately authorize expanded predator controls (MMPA)	■		
	Strengthen Lower Columbia River Estuary Program authority.	■		
	Estuarine Program support (EPA).	■	■	■
	Implement the Lower Columbia Greenway Project - Habitat mapping and priorities for protection or restoration - Habitat acquisition/protection - COE habitat restoration - Monitoring - Public education and outreach	■	■	
	Immediately authorize expanded COE estuarine restoration project	■		
Tributary Habitat Funding	FS/BLM restoration initiatives.	■	■	■
	Implementation of ICBEMP, Nortwest Forest Plan or interim guidelines.	■	■	■
	Comprehensive flow, passage and diversion (COE, DOI, BPA)	■	■	
	Clean Water Act/Endangered Species Act compliance (EPA).	■	■	■
	TMDL technical assistance to states.	■	■	■
	Non-governmental participation in planning and implementation of watershed solutions (Federal Habitat Team, NRCS).	■	■	■
	Expand on agricultural incentive programs.	●	●	
	Support Federal Habitat Team (NMFS)	● ■	● ■	● ■
Tribes	To be determined			

*Note: Most recommended actions will require consultation with USFWS and NMFS; these agencies are not listed separately under individual actions.

course of 10 years. In addition, other immediate measures should improve tributary flows, water quality and riparian conditions in a broader range of subbasins. According to the habitat analysis, the effects of this action would increase salmon and steelhead abundance to levels that are within the range of what would be necessary to support recovery. Short-term gains are expected through the following actions:

- Restoring tributary flows. Sufficient flows allow streams to recover productivity, and may reconnect important spawning and rearing habitats. Compared to habitat actions such as riparian revegetation or upland restoration, which may take decades to have significant effects, restoring flows can quickly improve stream ecology and water quality. It can also reasonably be expected to provide juvenile and adult

passage, as well as juvenile rearing habitat, for listed anadromous and resident fish.

- Screening water diversions. All fish that enter unscreened diversions are likely to die due to stranding, predation, impingement, or adverse water quality. About a third of all legally authorized water diversions in the Columbia River Basin are unscreened; about two-thirds are screened in some fashion; and fewer than 20 percent are screened to NMFS criteria. Screening to NMFS criteria is thought to reduce mortality almost to zero. Screening can therefore immediately reduce mortality of listed populations.
- Addressing passage obstructions. On the mainstem, thermal blocks, sediment, and low flows at the confluence sometimes block tributary access. In the estuary, silted channels, dikes, and high culverts prevent access to spawning, rearing, feeding, and **refugia** habitats. In the tributaries, temporary berms, unladdered water diversion structures, low road crossings, bridge footings, and culverts can impede migrating fish. Temporary berms are a particular problem because they destroy riverbed armor, make stream channels more likely to degrade, and compound sedimentation problems. There is immediate benefit from making habitat more accessible.
- Protecting currently productive habitat and restoring outward. The federal agencies put high priority on protecting habitat that is currently productive, especially if at risk of being degraded. These habitats should serve as anchor points for restoring degraded habitat and reconnecting spawning and rearing areas systematically.
- Increasing the amount of habitat. Mitigating actions such as securing additional riparian, wetland, floodplain, inter-tidal, or shallow water habitats provide immediate benefits by reducing the predicted decline in the quality of nonfederal habitat. Securing habitat ensures critical habitats exist for core ESU populations.
- Improve water quality. Improved water quality is a key in species recovery. There are thousands of impaired streams throughout the Columbia Basin. Improving the water quality of these streams will be critical in this recovery strategy.

3.3 Harvest Actions

The Strategy continues the already-tight restrictions on fishing that have evolved over the last decade and which now are incorporated in the most recently approved ocean and in-river fishery plans and, where necessary and effective, reduce harvest impacts further. This includes full implementation of the 1999 Pacific Salmon Treaty Agreement and management of all fisheries, ocean and freshwater, to comply with harvest rate constraints outlined in the most recent NMFS biological opinions. Additionally, the Caucus proposes an aggressive program to further develop selective fisheries strategies to achieve the twin objectives of enabling the harvest of strong stocks and reducing impacts on listed ESUs.

The Federal Caucus recommends the following actions for harvest:

- Constrain fishery harvest rates on listed species in the short term, subject to *U.S. v. Oregon* processes, at already-reduced levels for most ESUs, and pursue opportunities to reduce them further. Manage fisheries based on annual abundance and the status of natural stocks affected by the fisheries.
- Fairly allocate the overall ESA conservation burden being borne by treaty fisheries.
- Expand, develop and/or apply alternative, more selective fishery techniques to reduce impacts on listed fish and provide alternative harvest opportunities, consistent with court-ordered allocation of harvestable salmon surpluses.
- Develop or restore terminal area fishing opportunities where harvest can occur with minimal or no impact on listed species.
- Develop a menu of options for reducing harvest impacts on listed fish even further, either permanently or temporarily by using concepts such as conservation easements, license buyouts, or alternative fishing gear deployment, test the feasibility and effectiveness of the options, and implement them where appropriate.

More detail about the recommended actions is in Table 6.

The objectives of the harvest strategy are to buy time for other recovery programs and measures to take effect; preserve at least some fishing, particularly for tribal fisheries,

Table 6 List of Harvest Actions

Goal	Harvest Actions to Meet Goal*	Timeframe		
■ = Basinwide Salmon Recovery Strategy Action ●= RPA Action ❖ = Conservation Recommendation		**Year 1**	**Years 2-5**	**Years 6-10**
Federal				
Limit harvest impacts	Constrain harvest impacts on listed ESUs to no more than recently established current levels.	■	■	■
	Manage mixed stock fisheries on the natural stocks and/or stock groups affected by the fishery (not on hatchery stocks). (NMFS)	■	■	■
	Seek opportunities to further reduce fishing impacts on listed fish where necessary and effective by helping the states and tribes develop alternative fishing techniques and/or locations and by enabling more selective fisheries and helping to develop the necessary institutional mechanisms and analytical capabilities to support management of selective fisheries (BPA/NMFS/USFWS)	● ■	● ■	
	Seek opportunities to increase harvest in ways that do not harm listed ESUs (NMFS/USFWS)	● ■	● ■	
States				
Reduce Harvest Impacts	Pursue conservative harvest policies (weak stock management)	■	■	
	Discourage non-selective fisheries and pursue selective fisheries (support mass marking and other tools and take a lead role in developing the necessary analytical capabilities to support management of selective fisheries)	■	■	
Congress				
Funding	Provide sufficient funding for managing fisheries and contributing to the transition to selective fisheries, and for the 1999 Pacific Salmon Treaty Agreement.	●	●	●
Tribes	To be determined			

provided that doing so does not undermine the overall recovery effort; fully implement the 1999 Pacific Salmon Treaty Agreement; and develop a sustainable fishing strategy for the long term, with particular emphasis on selective fisheries. The biological analyses confirm that harvest has ongoing effects on the performance of listed species, in varying amounts depending on the particular ESU. It also confirms that additional harvest reductions or moratoria are unlikely, by themselves, to result in recovery for most ESUs, since harvest impacts already have been greatly reduced to very low levels. Conservative harvest management policies, however, are essential for an interim period while other programs to improve survival are put into effect. Over the long run, harvest constraints cannot be relied on to solve the fundamental problems that cause natural salmon productivity to decline.

Strong steps have been taken over the past 20 years to end chronic overfishing practices. Mixed stock fisheries are now generally managed for abundance, and the needs of natural fish are given priority over hatchery fish when determining appropriate harvest rates. Since the listing of many species under the ESA, harvest has been reduced

even further in all fisheries affecting listed stocks. Given that these reductions have already occurred, it is unlikely that further reductions are going to yield significant additional benefits to listed species. However, continuing constraints on harvest at or near these now-reduced levels will remain an important part of the recovery effort during the rebuilding period.

Therefore, the Federal Caucus recommends constraining harvest rates on listed salmon and steelhead at or, if necessary and effective for survival and recovery, below their currently reduced rates for 10 years or until the status of listed fish can support harvest increases. In addition, for those ESUs where harvest remains a significant source of mortality, further reductions of **incidental take** of listed species will be pursued through additional measures, possibly including but not limited to such measures as license buy-backs, gear changes, additional time and area restrictions, and selective fishing. To offset the economic consequences of capping harvest rates and securing additional reductions, the Federal Caucus recommends fishery managers develop alternative fishing opportunities in places and manners that are benign to listed fish.

The Strategy attempts to balance the conservation of at-risk fish with the federal government's trust obligation to provide meaningful treaty 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 analysis supports a strong argument that all harvest should be eliminated (e.g., Snake River spring/summer chinook; upper Columbia spring chinook). Nevertheless, the Strategy recommends an acknowledgment that there is an "irreducible core" of tribal harvest that is so vital to the treaty 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 Strategy again recommends allowing a level of tribal harvest that respects the trust obligation, even though it means accepting some additional risk and slowing the pace of recovery.

Finally, the Strategy also 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. The Strategy also emphasizes that in some situations, tribal catch could be substantially increased if the tribes were to expand their use of selective fishing methods. It also recognizes that if the implementation of combined actions addressing all life stages produces a favorable response in salmon productivity, treaty fishing in general could increase in the future.

3.3.1 Performance Standards

The specific harvest constraints and specific compliance with the fishery plans as described in Volume 2 for each fishery group (ocean and freshwater) comprise the performance measures for harvest. For some listed ESUs, a specific harvest rate target, schedule, or constraint is identified for a particular set of fisheries. For example:

- U.S. fisheries south of Canada 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 that cap impacts on Snake River fall chinook.
- Similarly, biological opinions issued by NMFS cap the in-river fall season fisheries that incidentally harvest Snake River fall chinook and intermingled listed steelhead.
- Fisheries affecting chinook salmon must be managed in compliance with the new Pacific Salmon Treaty regime, which includes a set of calculable harvest constraints that will be routinely monitored over time.
- For both ocean and in-river fisheries, the existing fishery management institutions annually provide reports that contain the harvest metrics necessary to assess performance over time relative to the recommendations contained herein.

3.4 Benefits from Harvest Actions

The Strategy recommends that harvest impacts on listed fish be constrained at or below current levels in the ocean and in freshwater, including tribal, commercial, and recreational fisheries. The changes in growth rates identified by CRI as necessary to achieve survival and recovery assume that harvest impacts will continue at current levels. The Strategy contemplates further negotiated reductions, subject to *U.S. v. Oregon* processes, in harvest impacts based on increasing selectivity in fishing practices, but these potential future reductions are not assumed in the analysis. If they were achieved, they would benefit productivity immediately and likely reduce extinction risks for affected ESUs, thus enhancing the overall recovery effort.

3.5 Hatchery Actions

Although there is considerable debate regarding the extent and nature of the effects that hatchery fish have on natural populations, and thus the appropriate role of hatcheries, it is clear that recovery cannot be achieved simply by releasing more hatchery-produced fish in natural production areas, regardless of their ancestry or how they are produced. Hatcheries cannot provide the productive conditions necessary to restore self-sustaining populations in their natural habitats. Although much progress has been achieved in recent years in reducing the negative effects of hatcheries, some artificial programs and facilities still need substantial reforms to reduce unwanted effects.

The overarching goal of hatchery reforms 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 basinwide objectives for conservation and recovery. The goal still includes providing fishery benefits to achieve mitigation mandates, but now must also include an increased emphasis on conservation and recovery, a mission for which many older hatchery programs were not designed. Reforms of existing hatchery programs and facilities that began several years ago must be accelerated and broadened to encompass a variety of new and improved artificial production techniques that include supplementation, captive broodstock, and other strategies designed to minimize the risk of artificial production and/or maximize its mitigation and 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 called for here 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.

The Federal Caucus recommends the following actions for hatcheries:

- Develop NMFS-approved Hatchery and Genetic Management Plans for all hatcheries within the first 3 years.
- Using funding from BPA, congressional appropriations, and other sources as appropriate, implement needed reforms to hatchery programs, operations, and facilities identified by the HGMP planning process as necessary to reduce deleterious impacts on listed fish, maximize positive benefits for recovery, and fulfill mitigation responsibilities.
- Use conservation hatchery practices and safety net facilities on a selective and temporary basis to augment weak populations and prevent extinctions while other recovery efforts take effect.
- Transfer operation of certain hatchery production programs or ownership of certain hatcheries to tribes, subject to approved HGMPs, to facilitate co-management and tribal objectives.

More detail about the recommended actions is in Table 7.

The hatchery option recommended by the Federal Caucus has two primary components. First is the reduction and/or elimination of the negative impacts caused by traditional production hatcheries on wild stocks. Second is the selective use of conservation hatcheries, using

Table 7 List of Hatchery Actions

Goal	Hatchery Actions to Meet Goal*	Timeframe		
■ = Basinwide Salmon Recovery Strategy Action ●= RPA Action ❖ = Conservation Recommendation		**Year 1**	**Years 2-5**	**Years 6-10**
Federal				
Reform Production Facilities	Develop approved HGMPs for all hatchery facilities in the Columbia Basin.	● ■	● ■	
	Implement HGMPs at federal, state and tribal facilities by making necessary operational improvements and capital changes in programs and facilities.	●	●	●
Protect weak stocks (listed populations)	Expand the safety net program for the most at-risk populations; use a variety of conservation hatchery techniques to aid the recovery effort. (NMFS/BPA/USFWS)	●	●	●
Reduce uncertainties; assess performance	Implement aggressive M&E programs to reduce uncertainties, e.g., hatchery/wild fish interactions, the effectiveness of hatchery spawners, etc., and assess performance of conservation efforts.	■	■	■
Increase tribal co-management.	Implement transfers of facilities or responsibility for operation of certain production programs subject to approved HGMPs for up to four hatcheries.	■	■	
States				
Reduce Hatchery Impacts	Prepare and implement HGMPs for state-run hatcheries.	■	■	
	Support safety net activities.	■	■	■
Congress				
Reform Hatchery Programs	Fund reforms of Mitchell Act and Lower Snake Hatchery programs.	■	■	
Provide safety net	Fund aggressive safety net program.	■	■	■
	Fund aggressive monitoring and evaluation of artificial production effects.	■	■	
Tribes	To be determined			

genetically appropriate broodstock, to stabilize and/or bolster weak populations. Using conservation hatcheries to support weak stocks will provide a hedge against extinction risks in the near term and also may provide recovery benefits to listed populations.

Such reforms will be pursued in the context of Hatchery and Genetic Management Plans. The HGMP is a tool for defining goals and objectives of a particular hatchery, and its relationship to prioritized basin objectives, including harvest opportunities and wild stock performance. Specifically, each HGMP should ensure that genetic broodstock selected is appropriate, that it minimizes the potential for adverse ecological effects on wild populations, and that it is integrated into basinwide strategies to meet objectives of all Hs. Perhaps most importantly, each HGMP will include a rigorous monitoring and evaluation component to ensure facility goals and objectives are being met.

Minimizing adverse genetic and ecological effects of production hatcheries will likely yield a measurable biological benefit to wild stocks, although it will be difficult to demon-

strate the relationship in the near term. By using adaptive management techniques, it will be possible to measure the benefits accruing to wild stocks through reform of production facilities over time.

Subject to approved HGMP's, supplementation of natural populations with hatchery fish will be used under certain controlled circumstances to prevent extinction and contribute to recovery. It is one of several techniques that will be used in the safety net program. In this respect, it will be preferred over captive broodstock programs, which should be used only for the most at-risk populations because of their very high costs and uncertain effectiveness. Supplementation can also be appropriate for re-establishing populations in streams where the indigenous fish were **extirpated**, or where there are no listed stocks and the goal is to enhance treaty and non-treaty fishing opportunities.

Certain hatcheries now operated by others will be transferred to tribal management or co-managed with tribes and will be operated under new supplementation protocols, combined with local habitat efforts. Over time, fishing opportunities provided by these programs, in combination with selective harvest techniques, could take pressure off mixed stock mainstem fisheries.

3.5.1 Performance Standards

Performance standards will be established for hatcheries and will be incorporated in approved HGMPs. Standards will be developed in the following areas and measured over time for results:

- Genetic Introgression: Local, within-ESU broodstock is used in all propagation programs within critical habitat, unless associated with an **isolated program**. Hatchery broodstock 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.
- Hatchery-Origin Fish Straying: For naturally-spawning populations in critical habitats, non-ESU hatchery-origin fish do not exceed 5 percent; ESU hatchery-origin fish do not exceed 5–30 percent, unless specified in an HGMP for a conservation propagation program.
- 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.
- Viable and 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.
- 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.
- 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.
- 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.

3.5.2 Immediate Actions

Certain hatchery reforms and conservation actions must proceed on a priority basis. The Federal Caucus will work with the states, tribes, the Northwest Power Planning Council, the FCRPS Action Agencies, the Office of Management and Budget, and the Congress to prioritize and accelerate funding and implementation of the reform measures identified in hatchery biological opinions and HGMPs to ensure these actions are implemented as expeditiously as possible.

3.6 Benefits from Hatchery Actions

While the actual benefits of hatchery reforms and safety net hatchery actions can only be quantified over time through rigorous monitoring and evaluation, the Caucus agencies are confident that they will contribute significantly to the overall recovery effort. Short-term benefits would include:

- Preserving the genetic legacy of the most at-risk populations by taking advantage of the hatcheries' ability to increase numbers of fish while other factors limiting productivity are addressed.
- Limiting the adverse effects of hatchery practices on ESA-listed populations by instituting prioritized hatchery reforms.
- Reducing critical uncertainties about interactions between hatchery-raised fish and wild fish, status of natural populations, and the effectiveness of hatchery-origin spawners.
- Enabling greater use of selective fisheries to reduce fishery impacts on listed fish while achieving fishery objectives.

3.7 Hydropower Actions

The Federal Caucus recommends the following actions in the hydropower system (see Table 8 and Map 4):

- Improved passage: Implement biological opinion passage improvements, including more effective spill programs and specific passage upgrades for adult and juvenile fish at individual dams.
- Improved Flows: Implement biological opinion flow operations to provide water conditions beneficial to migrating juvenile and adults fish. Potential improvements in Canadian flows with up to 2 million acre feet (MAF) over time. Potential improvements from the Snake River contingent upon ongoing discussions. Flood control study to allow further flow improvements. Implementation of flood control adjustments to further minimize risks to listed resident fish from salmon flows.
- Fish transportation: Continue spread the risk approach; significantly reduce trucking; continue to study **delayed mortality** issue.
- Water Quality: Measures to improve water quality while meeting fish passage objectives, and development of a long-term Water Quality Improvement Plan for dissolved gas and temperature.
- Formally evaluate progress 3, 5, and 8 years after implementation begins.

More detail about the recommendations is in Table 8.

3.7.1 Performance Standards

The ultimate performance standard for the federal hydropower system is survival of juvenile and adult fish through the migration corridor. A survival performance standard must also take into account indirect mortality fish may suffer after leaving the migration corridor as a result of their passage experience. The Strategy establishes survival standards through the hydropower system that the Caucus agencies believe are achievable with the present system in place. Because not all mortality associated with the system can be eliminated, the Strategy also establishes expectations for off-site mitigation. The off-site mitigation goals are described more fully in NMFS' biological opinion on operation and configuration of the system, and are included in Volume 2 of this document. By funding programs and actions that achieve these goals, the federal agencies that operate and market power from the hydropower system will substantially contribute to the actions that need to be taken in the other sectors.

- Achieve system performance survival standards for each ESU in accordance with the 2000 FCRPS Biological Opinion.
- Carry out or fund off-site actions sufficient to mitigate for mortality caused by the hydropower system, or sufficient to achieve survival and recovery of the ESUs, together with the other actions in this Strategy.

With such standards in place, the performance of FCRPS projects will be measured for progress in 2003, 2005, and 2008. If the standards are met, then such projects should continue to operate with the established parameters. If, however, the standards are not met, either through system survival rates or in combination with off-site mitigation, then it

Table 8 List of Hydropower Actions

Goal	Hydropower Actions to Meet Goal*	Timeframe		
■ = Basinwide Salmon Recovery Strategy Action ●= RPA Action ❖ = Conservation Recommendation		**Year 1**	**Years 2-5**	**Years 6-10**
Federal				
Additional Capital Improvements at dams (COE/BPA, EPA)	Implement biological opinion passage improvements, including specific passage upgrades for juvenile fish at individual dams. Improvements vary by location, including relocation of bypass outfalls, refined screens and bypass facilities, development of surface bypass, spillway modifications and more effective spill, improved turbine operations and design, predator management, mainstem and estuarine habitat.	● ■	● ■	
	Conduct advance planning for possible future actions, including dam breaching.	●	●	
Improve operations for fish (BPA, COE, USBR)	Improved Flows: improved flow operations to provide water conditions beneficial to migrating juvenile and adult fish. Improvements in Canadian flows with a potential of up to 2 MAF over time. Flood control study to allow further flow improvements. Implementation of flood control adjustments to reduce risks to listed resident fish from salmon flows.	●	●	
	Fish transportation: Continue "spread the risk" approach; reduce trucking; continue to study delayed mortality issue.	●	●	
	Water Quality: Measures to improve water quality while meeting fish passage objectives, and development of a Water Quality Improvement Plan for dissolved gas and temperature.	●	●	
Improve Nonfederal Hydro (NMFS, FERC)	Complete HCP for Mid-Columbia Dams.		■	
	Use relicensing and ESA consultation to improve flows, passage, etc. at nonfederal dams on the Deschutes, Lewis, Cowlitz, and other basins (FERC).	■	■	■
	Apply anadromous fish priorities to re-licensing for other nonfederal dams.	■	■	■
	Settlement of Snake River adjudication.	■		
	Improve existing habitat and fully evaluate passage opportunities through relicensing and Section 7 consultation for Idaho Power Company dams.		■	■
Performance Reviews	Conduct 5- and 10-year review of performance standards and implementation progress.	● ■	● ■	● ■
Congress				
Reduce Hydropower Impacts	Fund full COE capital and O&M programs.	■	■	■
	Authorize systemwide flood control review.	■		
	Support BPA off-site mitigation strategy.	■	■	■
	Fund NMFS comprehensive monitoring and evaluation program	■	■	■
Tribes	To be determined			

Map 4 Dams in the Columbia River Basin (on page 61) is available in separate document

will be clear the projects in question cannot operate without jeopardizing and preventing recovery of listed ESUs. In this case, the project operator will have to consult on additional actions that could include project reconfiguration.

For purposes of the 5- and 8-year reviews, the biological opinion establishes three separate tests related to the annual population growth rate, and a fourth test related to abundance.

The first test is whether the annual population growth rate for listed ESUs is greater in 2005 and in 2008 than the "base period" value today. This test will compare productivity currently with the same value in 2005, and again in 2008. In each case, the test is "passed" if productivity has increased. If the newer value were lower, then additional reviews and actions would be triggered as described in Section 9.5 of the FCRPS Biological Opinion.

The second test is whether in 2005 and 2008, the annual population growth rate is greater than or equal to the projected growth rate based on actions taken in the 1995 biological opinion, reductions in harvest that occurred after the base period, and the survival standards in the Mid-Columbia Habitat Conservation Plan. This tests whether the positive results assumed in the current biological opinion have been realized. This test will compare "estimated current" species productivity in 2005 and 2008 with actual productivity. If the actual measure is greater, the test is passed. If it is smaller, then additional reviews and actions would be triggered as described in Section 9.5 of the biological opinion.

The third test will compare population growth rates in 2005 and 2008 against the rates needed to achieve the recovery. The projections must meet or exceed the levels necessary to achieve the 48-year recovery criteria. If not, additional review, and possibly additional actions, would be triggered as described in Section 9.5 of the biological opinion.

The fourth test, a true safety net test, will include a simple comparison of stock size ("abundance") against current levels. Specifically, the test will compare the annual adult returns of wild fish for each ESU and population against the present 5-year mean. Two consecutive annual returns below this level will trigger a concern that a critical population threshold may have been crossed. Recovery planning and other scientific information available at the time of the 5-year evaluation will provide a basis for additional reviews and actions as described in Section 9.5 of the biological opinion.

3.7.2 Immediate Actions

Columbia River Measures – To achieve a more normative river, significant amounts of additional water targeted to enhance flows during fish migration are needed. Working cooperatively with Canadian officials to find mutually-beneficial arrangements is key. Near-term arrangements could result in additional water to boost summer flows and enhance estuarine conditions. Mid-term (5-year) arrangements are targeted at additional summer **flow augmentation**, which could not only enhance water quality but could also significantly boost the ability to meet July and August flow targets.

Additionally, significant changes will be made to improve in-stream fish passage and water quality by modifying federal dam structures and operations. These changes will vary by project, but may include improvements in both juvenile and adult fish passage facilities, surface bypass, flow deflectors, enhanced spill management, and reduction of adult fallback.

A mainstem habitat program will also be initiated. Using techniques based on watershed assessment and planning, experimental projects to improve reservoir habitat conditions and riverine function will be developed and implemented in the next few years.

Integral to the planning and development of such proposed changes is the need to identify and take into consideration culturally important resources at the affected dams and reservoirs.

Recognizing that additional monitoring and evaluation may point to the need for further changes, further evaluation of configuration modifications at John Day and McNary dams may be necessary if the ESUs do not respond to the Strategy. Because this would require congressional concurrence, NMFS would propose working in advance with the states, tribes, and the Northwest delegation to identify specific performance criteria and protocols to guide the studies.

A review of systemwide flood control requirements will also be conducted to determine whether more flexibility can be secured in managing flow augmentation. A shift in flood control at federal projects, including Libby and Hungry Horse, is proposed. The Federal Caucus agencies will be consulting with tribes and states on these shifts, as well as with Canada.

Finally, while these actions will generally benefit all fish and wildlife species on the Columbia River by enhancing flows, riverine function, water quality and estuarine conditions, careful consideration of reservoir operations is needed. The intent of such an analysis would be to ensure that salmon measures do not disproportionately harm ESA-listed (bull trout, white sturgeon), and non-listed resident species and historic properties.

Flow Augmentation – Since 1993, the USBR has annually supplied 427 kaf of water from its reservoir and other sources to augment streamflows in the Snake and Columbia rivers during the juvenile fall chinook salmon migration season. Through ongoing negotiations with stakeholders in Idaho, the USBR is seeking to increase the supplies of water available for this purpose. Such water sources would increase the probability of being able to deliver 427 kaf each year and could provide additional water, when available from willing sellers. The exact amounts that could be available from these sources for flow augmentation will vary annually with water supply and the level of access that might be acquired through these negotiations. Any future decision to seek congressional authorization to breach the four major federal dams on the lower Snake River will be guided by scientifically-focused performance standards for fish passage and survival. The performance standards and accompanying protocols will guide decisions for interim dam operations and modifications.

Although the Strategy does not include breaching the four lower Snake River dams at this time, the Caucus agencies will prepare for the possibility that breaching could become a necessary contingency. The Departments of Commerce and the Interior will develop, and submit for independent review, an economic and cultural mitigation plan for implementation of the Strategy and possible additional actions to avoid jeopardizing the continued existence of threatened and endangered salmon. In developing this mitigation plan, the Departments of Commerce and Interior may adopt BPA's Fish and Wildlife Implementation Plan EIS to aid their development of the specific social and economic analyses. Using the BPA programmatic EIS process to the maximum extent practicable, the mitigation plan will be developed in coordination with the Action Agencies (including the Corps project management plan to reevaluate more aggressive hydropower-related actions), the NPPC, and relevant federal, state and tribal agencies and the interested public.

These actions will reduce the time needed to seek congressional authorization for breach, and thus reduce the time needed for possible implementation, thereby avoiding risks of delay should breach later become a preferred approach. Finally, the federal agencies will continue to evaluate the fish transportation program in order to determine the significance of delayed mortality.

Nonfederal Hydropower – The Federal Caucus recommends the following actions in the nonfederal hydropower system:

- Nonfederal mainstem Columbia River dams: complete habitat conservation plans under development for Chelan and Douglas, and execute collaborative process with Grant County to lay groundwork for re-licensing of mid-Columbia projects.
- Nonfederal mainstem Snake River dams: pursue collaborative process to prepare for re-licensing of Idaho Power projects.
- Nonfederal tributary hydropower projects: address the needs of listed species (e.g., flows, passage, survival improvements, hatchery reforms) on coordinated basis through customary FERC process and ESA consultation.

For nonfederal dams on the mainstem Columbia, the Federal Caucus proposes to implement the provisions and performance standards of the Mid-Columbia Habitat Conservation Plan to address additional improvement in juvenile and adult survival. The standards must assure a high likelihood of survival and a moderate to high likelihood of recovery over time, taking into account actions in the other Hs. Ideally, meeting standards in all Hs would reduce human-caused hydropower impacts to

the point at which listed ESUs face less than a 5 percent risk of extinction over 100 years.

With respect to the Idaho Power dams on the Snake River, which are currently up for relicensing, a specific mitigation program, which will be subject to ESA consultation, is still under study and development. In addition to these, there is a substantial number of minor nonfederal hydropower projects in the basin that influence the survival and recovery of salmon and steelhead and other aquatic species. Performance improvements for these projects will be sought through ESA consultation on each project's relicensing process. These performance improvements will be based on the nonfederal hydropower project's portion of the population growth rate necessary to achieve survival and recovery. The standards may range from aggressive improvements over the status quo, to levels that reflect the best estimate of survival rates if hydropower impacts were completely eliminated.

If a nonfederal hydropower project or system cannot meet its performance standards, flexibility will be provided for the operator to provide additional mitigation off-site to make up the difference. If the standards are not met, either through direct project survival rates or in combination with off-site mitigation, then it will be clear the projects in question cannot operate without jeopardizing and preventing recovery of listed ESUs. In this case, the project operator will have to consult on additional actions that could include project reconfiguration.

3.8 Benefits from Hydropower Actions

The federal hydropower system will be operated under a set of specific, aggressive hydropower actions that NMFS has determined, on the basis of available scientific information and professional judgment, will achieve hydropower performance standards. Most of the measures are aimed at improving passage survival through federal dams and reservoirs through changes in project operations and improvements in project configuration. 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. These benefits are described on a numerical basis in Volume 2.

In general, immediate benefits are expected through improved flows, improved passage, enhanced spill, steadily increasing the proportion of barged versus trucked summer juvenile migrants, and mainstem habitat improvements. For the long term, the program focuses on understanding and addressing the factors contributing to mortality within the hydropower system.

- Improved flows. In particular, summer flows are lower than desired, and flow targets are not met in many runoff conditions. Near-terms actions, such as additional flows from select reservoirs (Canadian reservoirs and draft of Banks Lake), contribute to greater probability of meeting summer flow objectives.
- Improved spill. Additional spill and refinements to spill patterns provide near-term opportunity to increase juvenile fish survival at some dams. Additional spill provides relief from turbine-related mortality while other actions are developed.
- Transportation. For spring migrants, preliminary data suggests that the in-river survival may be similar to that of transportation during the early spring. If this trend persists, more fish should be left to migrate in-river during April, postponing the start of transportation to May. For summer migrants, most transported juvenile migrants are trucked as opposed to barged. To reduce any uncertainties about potential adverse effects of trucking, greater reliance on barging can be initiated immediately.
- Mainstem habitat improvements. The mainstem migration corridor may have untapped potential for developing more functional habitat attributes associated with fish survival. Further reductions in predation by birds and fishes can be achieved through focused habitat modifications and changes to in-river structures.

4. Glossary and Acronyms

Acronyms

A-FISH	Anadromous Fish Appendix
APR	Artificial Production Review
BA	Biological Assessment
BGS	Behavioral Guidance System
BIA	Bureau of Indian Affairs, U.S. Department of Interior
BLM	Bureau of Land Management, U.S. Department of Interior
BMP	Best Management Practices
BO	Biological Opinion
BPA	Bonneville Power Administration
CBFWA	Columbia Basin Fish and Wildlife Authority
CD	Compact disc
COE	Corps of Engineers
CREP	Conservation Reserve Enhancement Program
CRFMP	Columbia River Fish Management Plan
CRI	Cumulative Risk Initiative
CRISP	Columbia River Salmon Passage (Model)
CRITFC	Columbia River Inter-Tribal Fish Commission
CWT	Coded Wire Tag
D	Differential Delayed Transport Mortality
DOI	U.S. Department of Interior
DREW	Drawdown Regional Economic Workgroup
EDT	Ecosystem Diagnosis and Treatment
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESBS	Extended Length Submersible Barrier Screen
ESU	Evolutionarily Significant Unit
FCRPS	Federal Columbia River Power System
FEMA	Federal Emergency Management Agency
FEMAT	Forest Ecosystem Management Assessment Team
FERC	Federal Energy Regulatory Commission
FGE	Fish Guidance Efficiency
FSA	Farm Services Administration
FOTG	Fish Operations Technical Group
FPE	Fish Passage Efficiency
FWP	Columbia River Basin Fish and Wildlife Program
HCP	Habitat Conservation Plan
HGMP	Hatchery Genetic Management Plan
HMU	Habitat Management Units
HUC	Hydrologic Unit Code
H-VSP	Habitat conditions to support viable salmon populations
ICBEMP	Interior Columbia Basin Ecosystem Management Project
IHOT	Integrated Hatchery Operations Team
INFISH	USFS interim strategies for managing fish-producing watersheds in eastern Oregon and Washington, Idaho, and portions of Nevada.
IPCo	Idaho Power Company
IRC	Integrated Rule Curve
ISAB	Independent Scientific Advisory Board
ISG	Independent Scientific Group (formerly Scientific Review Group)
ISRP	Independent Science Review Panel
JBS	Juvenile Bypass System
kaf	1000 acre feet
Kcfs	1000 cubic feet per second
LSRFS	Lower Snake River Feasibility Study
MAF	Million acre feet
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MPI	Matrix of Pathways and Indicators
M&E	Monitoring and Evaluation
NATURES	Natural Rearing Strategies
NEPA	National Environmental Policy Act

NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NPPC	Northwest Power Planning Council
NRC	National Research Council
NRCS	Natural Resources Conservation Service
PAC	Provincial Advisory Council
PACFISH	USFS and BLM interim strategies for managing anadromous fish-producing watersheds in eastern Oregon and Washington, Idaho, and portions of California.
PATH	Plan for Analyzing and Testing Hypotheses
PFC	Properly Functioning (Habitat) Conditions
PFMC	Pacific Fisheries Management Council
PIT	Passive Induced Transponder
PST	Pacific Salmon Treaty
PUD	Public Utility District
QAR	Quantitative Analysis Report
RAC	Regional Advisory Council
ROD	Record of Decision
RPA	Reasonable and Prudent Alternative
SAR	Smolt-to-Adult Return
SASSI	Salmon and Steelhead Stock Inventory
SBC	Surface Bypass and Collection
SCT	System Configuration Team
SDEIS	Supplemental Draft EIS
SIMPAS2	NMFS Spreadsheet Model
SOR	System Operation Review
SPS	Significant Population Segment
SRBA	Snake River Basin Adjudication
STS	Submersible Traveling Screen
SWAM	Salmonid Watershed Assessment Model
TMDL	Total Maximum Daily Load
TMT	Technical Management Team
TRT	Technical Recovery Team
TSP	Turbine Survival Program
USBR	U.S. Bureau of Reclamation
USDA	U.S. Department of Agriculture
USDI	U.S. Department of Interior
USFS	U.S. Forest Service
USFWS	United States Fish and Wildlife Service
VAR Q	Variable Q
VBS	Vertical Barrier Screen
VSP	Viable Salmonid Population
WDF	Washington Department of Fisheries
WQIT	Water Quality Improvement Team
WSC	Watershed Council

Technical Terms

Action Agencies – The federal agencies that operate or market power from the Federal Columbia River Power System, namely BPA, Corps and USBR.

Adaptive management - Feedback based on knowledge or data generated by monitoring and evaluation actions, of the effects or results of an implemented action. The information and data are purposefully collected and used improve future management plans and actions.

Adfluvial - Possessing a life history trait of migrating between lakes or rivers and streams.

Adult fallback - Adult salmonids that swim or drift back downstream through the powerhouse or spillway of a dam after passing upstream of the facilities and must pass the dam a second time in order to successfully complete their migration.

Alevin - The developmental life stage of young salmonids and trout that are between the egg and fry stage. The alevin has not absorbed its yolk sac and has not emerged from the spawning gravels.

Allocation percentage - Division of the fish resource among harvesters and needs for reproduction.

Anadromous Fish - Fish that hatch and rear in fresh water, migrate to the ocean (salt water) to grow and mature, and migrate back to fresh water to spawn and reproduce.

Anthropogenic – Of, relating to, or resulting from the influence of human beings on nature.

Artificial production - Spawning, incubating, hatching or rearing fish in a hatchery or other facility constructed for fish production.

Artificial Production Review (APR) - The Northwest Power Planning document that recommends how to use of fish hatcheries in the Columbia River Basin.

Artificial propagation - Any assistance provided by man in the reproduction of Pacific salmon. This assistance includes, but is not limited to, spawning and rearing in hatcheries,

stock transfers, creation of spawning habitat, egg bank programs, captive broodstock programs, and cryopreservation of gametes.

Artificial selection - Assistance provided by man in the determination and selection of the **genetic fitness** of an individual of a species for artificial fish production.

At-risk Fish Stocks - Stocks of anadromous salmon and trout that have been identified by professional societies, fish management agencies, and in the scientific literature as being in need of special management consideration because of low or declining populations.

At-risk Populations - Fish, wildlife, and plant populations that have been identified by professional societies, fish management agencies, and in the scientific literature as being in need of special management consideration because of low or declining populations.

Augmentation - The practice of rearing and releasing artificially propagated salmon and steelhead to enhance natural population levels.

Augmentation (of stream flow) - Increasing stream flow under normal conditions, by releasing storage water from reservoirs.

Authorities (tribal government) - The right and power which an officer has in the exercise of a public function to compel obedience to his lawful commands.

Bank configuration – The contour and the functional arrangement of the vegetative and soil materials that form and delimit the stream channel from the surrounding land.

Bank integrity - This generally refers to the structural integrity of a bank or how well a particular bank resists erosion.

Base stream flow(s) - The flow resulting precipitation that percolates to the ground water and slowly moves through the substrate to a channel. In contrast, stormflow is precipitation that reached the channel over a short time frame by surface or underground routes.

Biological Community - A naturally occurring, distinctive group of different organisms which inhabit a common environment, interact with each other, and are relatively independent of other groups.

Biological Potential - The ability for depressed stocks of fish to experience production levels consistent with its available habitat and within the natural variations in survival for the stock.

Broodstock, captive breeding - Adult fish maintained in captivity, used to propagate the subsequent generation of hatchery fish.

Broodstock, wild - Adult fish harvested from indigenous populations used to propagate the subsequent generation of hatchery fish.

Bypass systems - Juvenile salmonid bypass systems consist of screens lowered into turbine intakes to divert fish away from turbines at hydroelectric dams. Bypassed fish are either returned directly to the river below the dam or into barges and trucks for transport to a release site downstream from Bonneville Dam. PIT-tag detectors identify all PIT-tagged fish passing through the bypass systems. In addition, the systems are equipped with subsampling capabilities that allow hands-on enumeration and examination of a portion of the collection for coded-wire tags (CWT), brands, species composition, injuries, etc. Recovery information at bypass systems is used to develop survival estimates, travel time estimates, and run timing; to identify problem areas within the bypass system; and as part of the basis for flow management decisions during the juvenile migrations.

Capacity (landscape) – The upper limit in the number of organisms that an environment can support due to finite amounts of space, food, and other needed resources. Capacity regulates population responses that are dependent of the density of organisms (MB).

Captive-breeding program - A form of artificial propagation involving the collection of individuals (or gametes) from a natural population and the rearing of these individuals to maturity in captivity. For listed species, a captive broodstock is considered part of the evolutionarily significant unit (ESU) from which it is taken.

Carrying Capacity - The maximum number and type of species which a particular habitat or environment can support without detrimental effects.

Channel complexity - The number of physical features (e.g., pool-riffle ratios, size and classes of substrate particles, amount and

type of woody debris, cannel slope, shape, sinuosity, and pattern) contained in a channel. The greater the number of features found in a given length (e.g., two meander lengths) the greater the complexity.

Channel modification - Any change, natural or induced, in the character of a channel.

Channel simplification - Reducing channel complexity by any natural or induced means.

Channel widening - Increasing the width of a channel by natural or induced means.

Cobble (nests) - Substrate particles that range from 2 to 10 inches in diameter at its largest ordinate.

Cohort - Individuals all resulting from the same birth-pulse, and thus all of the same age.

Compliance (monitoring) - Adhering to the protocols of a monitoring and evaluation plan.

Configuration (FCRPS) - Significant structural components or facilities of the FCRPS (also see FCRPS).

Conservation Crisis Levels - Conservation crisis levels are defined as levels similar to the 1999 harvest rates for listed spring/summer chinook (5 to 7 percent), and comparable conservation crisis levels for listed Snake River fall chinook and listed steelhead.

Conservation easement - Acquiring, through lease, purchase, or donation, the right to protect, improve, or maintain habitats or a particular habitat conditions.

Conservation hatchery program - A program that uses artificial propagation to recover Pacific salmon by maintaining the listed species' genetic and ecological integrity

Conservation Status - The relative health of a salmonid population, in particular whether it warrants listing as threatened or endangered under the Endangered Species Act.

Conservation Strategy - A management plan for a species, group of species, or ecosystem that prescribes standards and guidelines that if implemented provide a high likelihood that the species, groups of species, or ecosystem, with its full complement of species and processes, will continue to exist well-distributed throughout a planning area, i.e., a viable population.

Cost-share projects - Projects that are funded by two or more different agencies, groups, or individuals.

Critical habitat - The geographic area occupied by or essential to the species.

Critical (stock) - A stock of fish experiencing production levels that are so low that permanent damage to the stock is likely or has already occurred.

Cultural Resource - A term for which the meaning is largely derived from and limited by Federal law, regulation, and Executive Orders, and Departmental or agency standards or policies. Cultural resources are specific places that may be or are important in the history of the nation and its peoples. These resources include prehistoric or historic period archeological sites; buildings or structures of architectural, engineering, or historical associative value; places of importance in history or tradition; and traditional cultural properties, which are resources important in maintaining the traditional lifeways of a community. Within the broad range of cultural resources are those that have recognized "historical significance." Locations or buildings that retain physical integrity and meet the criteria for listing on the National Register of Historic Places specifically are "historic properties" (see below). A fishing ground or site may be an example of a "cultural resource" (and may even be a historic property if it meets the National Register eligibility criteria).

Culturally Important Resource - Culturally defined sets of relationships exist between a group of people, their culture, and their world. These relationships define and are defined by the values, uses, meanings, and relevance people hold for their natural, cultural, and spiritual world. Some natural or other resources are essential for maintenance of a culture and can be considered "culturally important resources". Culturally important resources must be defined, understood, and treated within the context of the culture that identifies and values them. The fish that are taken at the above fishing site would be an example of a "culturally important resource", as might be special plants used to build or maintain the site and its appurtenances.

Cumulative Risk Initiative (CRI) - Scientific analysis developed by the Northwest Fisheries Science Center of NMFS, to model quasi-extinction projections for salmon and steelhead ESUs. The CRI also examines where in the salmon life cycle opportunities exist to improve survivals and reduce the risk of extinction.

Declining (stock) - A stock experiencing a decline in production levels.

Default Indicator Criteria - indicators of ecosystem condition that are to be used until they are replace with more accurate criteria based on a more site specific analysis. The indicator criteria has been provided to describe the conditions in upland, riparian, and instream areas that function to maintain productive populations of salmonids (NMFS). Also see: properly functioning conditions.

Degradation - This term typically refers to the loss or reduction in one or more characteristics of an environment. It may be as simple as the changes due to erosion or as complex as the loss or reduction of one or more ecosystem functions.

De-listing - Removal of a species or ESU from endangered or threatened status under the ESA.

Density-dependence - A process, such as fecundity, whose value depends on the number of animals in the population per unit area.

Depressed (stock) - The report "1992 Washington State Salmon and Steelhead Stock Inventory" (WDF et al., 1993) defines "depressed" as a stock of fish whose production is below expected levels based on available habitat and natural variations in survival rates, but above the level where permanent damage to the stock is likely.

Descaling - Physical injury to a fish that results in the removal of scales and protective mucus layers.

Dewatering - Removing all the water from an artificial or natural container or channel. Typically refers to the immediate downstream habitat effects associated with a water withdrawal action that diverts the entire flow of a stream or river to another location.

Discharge (into estuary) – The quantity or rate of water entering the Columbia River estuary.

Dissolved gas - The amount of a particular gas or of all gasses dissolved in water. Usually measured in parts per million.

Dissolved oxygen (DO) - The amount of oxygen that is dissolved in particular volume of water. The amount of DO can be an important indicator of the condition of a water body.

Diversion structures - Typically refers to structures that diverts of withdraws water from a stream or river to another location usually for irrigation purposes.

Domestication - The intentional or unintentional process by which wild plant and animals adapted to cultivation, tamed, or loses its ability to survive in the wild.

Drafting (reservoir) - Lowering of the elevation of a reservoir, which would include passing both in-flow and stored water.

Dredge and fill (permits) - Permits required by Section 404 of the Clean Water Act to remove substrate material from a water body or to place or disposed of any material (sand, gravel, rocks, pilings etc) in a body of water.

Ecosystem - The biotic and abiotic characteristics of given area. An ecosystem can be as small as a wetland or as large as a biome (e.g. Great Basin Shrub-steppe Deserts, Tropical Rain Forests of the Lower Amazon Basin, The Columbia River Estuary). They are typically defined by some major habitat characteristic. Each has a unique set of physical, chemical, and climatic characteristics to which the plant and animal life have adapted.

Ecosystem Diagnosis and Treatment (EDT) - An expert opinion and empirical modeling approach to stream and watershed assessments.

Egg Incubation - Egg development of the embryo, influenced by temperature and other environmental factors.

Emergence - The process during which fry leave their gravel spawning nest and enter the water column.

Emigration - Referring to the movement of organisms out of an area.

Endangered (ESA) - A species of plant or animal in danger of extinction throughout all or a significant portion of its range.

Endangered Species Act (ESA) - An act passed by Congress in 1973 intended to protect species and subspecies of plants and animals that are of "aesthetic, ecological, educational, historical, recreational and scientific value." It may also protect the listed species' critical habitat, the geographic area occupied by or essential to the species. The U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) share authority to list endangered species, determine critical habitat and develop recovery plans for listed species.

Endemic (species) - Native to or limited to a specific region.

Environmental baseline condition - This is some pre-project environmental condition. It is the environmental standard that project effects are measured against.

Escapement - The number of salmon and steelhead that return to a specified measuring location after all natural mortality and harvest have occurred. Spawning escapement consist of those fish that survive to spawn.

Estuary, estuarine - The area where the fresh water of a river meets and mixes with the salt water of the ocean.

ESU (evolutionarily significant unit) - A salmon population or group of populations that are substantially reproductively isolated from other conspecific population units, and contributes substantially to ecological/genetic diversity of the biological species as a whole.

Evolutionary response - The adaptations of a species accrued in response to environmental changes over a long period of time.

Exploitation rate - The proportion of a population at the beginning of a given time period that is caught during that time period (usually expressed on a yearly basis). For example, if 720,000 fish were caught during the year from a population of 1 million fish alive at the beginning of the year, the annual exploitation rate would be 0.72.

Extant (populations) - describes types or species of animals that are currently living. Not extinct.

Extinction risk - A component to modeling scenarios involving stocks becoming extinct.

Extirpate - To destroy or remove completely, as a species from a particular area, region, or habitat.

Extra Mortality - Numerous suites of conditions corresponding to a deteriorating situation for the listed species, crucial to the assessment of how well different management options will perform.

Fecundity - The total number of eggs produced by a female fish.

Fisheries (in-river) - Harvest occurring within freshwater areas.

Fisheries (known-stock) – Harvest targeting a specific stock(s).

Fisheries (marine or ocean) - Harvest occurring in marine areas.

Fishery (Indian) - See "Tribal Fishing Rights."

Fishery (non-Indian) - Fisheries conducted by non-tribal members.

Fishery (mixed-stock) - Harvest occurring at such a time or location as to potentially catch fish from multiple stock(s).

Fishery (subsistence) - See "Tribal Fishing Rights."

Fishery, ceremonial - See "Tribal Fishing Rights."

Fishing pressure - The impact of fishing on fish populations.

Flood plains - The area along a stream or river that is subject to flooding.

Flow Augmentation - Increasing river flows during the juvenile out-migration by reducing winter drafts at FCRPS storage reservoirs to provide higher spring flows and a higher probability of reservoir refill; by drafting reservoirs during the out-migration season (April through August); and by acquisition of water from nonfederal sources.

Flow Requirements - Quantity of flow for a given stream reach necessary for fish survival. These requirements may vary by species and life stage.

Flow timing – A water release schedule associated with hydropower facilities or natural flow regime or hydrograph.

Fluvial – Of or pertaining to a river or stream. This includes the slope, shape, and channel, its substrate characteristics, its flow

characteristics, its sediment transport characteristics and geomorphic conditions that contribute to these conditions.

Fry (emergence) - The first free-swimming life stage of a salmonid.

Gas Bubble Disease - Conditions caused when dissolved gas in supersaturated water comes out of solution and equilibrates with atmospheric conditions, forming bubbles within the tissues of aquatic organisms. This condition can kill or harm fish.

Gas Supersaturation - The overabundance of gases in turbulent water, such as at the base of a dam spillway. Can cause fatal condition in fish similar to the bends.

Geneflow - The incorporation of migrant genes into a receiving population.

Genetic Diversity - The array of genetic traits that exists within a population, due to a large number of slightly dissimilar ancestors, which enables it to adapt to changing conditions.

Genetic Exchange - The transfer of genes among individual organisms within a population.

Genetic Fitness - The relative reproductive success of a population (genotype) as measured by fecundity, survival, and other life history parameters.

Genetic Interactions - Outbreeding between genetically differentiated populations. Straying of genetically divergent hatchery produced salmon into a native population.

Genetic Variability - Differences in the frequency of genes and traits among individual organisms within a population.

Geographically Localized (populations, stocks) - Populations restricted to a well defined area set by systems and processes involved in the world's weather, mountains, seas, lakes, etc.

Habitat complexity - The extent and variety of water, soil, geomorphic features and plant species of a given area. The more features the more complex a habitat.

Habitat condition indicator - Some standard (e.g. one pool and one riffle per meander length of a river) that is used to index the suitability of a habitat for some species (e.g. trout).

Habitat conservation plan - Plans to protect, improve, or maintain the status or condition of a given habitat.

Habitat diversity - The number and distribution of physical, chemical and typically plant material in an area. The greater the number of features, the greater the diversity.

Harvest (flat rate) – Harvest occurring at a fixed rate.

Harvest (in-river schedule) - Designated harvest dates and times for in-river fisheries.

Harvest (selective) - Harvest targeted to specific fish or fish runs.

Harvest (sustainable) - A degree of fish harvest that does not deplete fish populations below replacement levels.

Harvest (tribal allocation) - See "Tribal Fishing Rights."

Harvest (tribal) - See "Tribal Fishing Rights."

Harvest management - The process of setting regulations for the commercial, recreational and tribal fish harvest to achieve a specified goal within the fishery.

Harvest pressures - The degree and manner in which harvest efforts (commercial, recreational, and tribal) affect fish populations.

Harvest rate - The proportion of a returning run or total population of salmonids that is taken by fisheries, usually expressed as a catch to escapement ratio.

Harvest selectivity - A harvest strategy that targets a specific species.

Hatchery – A facility where fish are collected, spawned, reared, and (typically) released (see artificial propagation).

Hatchery and Genetic Management Plan (HGMP) - A document detailing the continued operation of an artificial propagation program.

Hatchery intervention – The use of artificial propagation to enhance, conserve, and recover salmonid populations.

Hatchery release - Artificially propagated fish released into the wild for the purpose of mitigating, supplementing, augmenting, and restoring a fish population or a fishery.

Healthy (stock) - A stock of fish experiencing production levels consistent with

its available habitat and within the natural variations in survival for the stock.

Heavy metals - Metallic elements with high atomic weights, e.g., mercury, chromium, cadmium, arsenic, and lead. They can damage living things at low concentrations and tend to accumulate in the food chain.

Historic property or historic resource - As defined in the National Historic Preservation Act, Title III, Section 301 (16 U.S.C. 470w)(5), "any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion on the National Register, including artifacts, records, and material remains related to such a property or resource." The criteria defining eligibility to the National Register are provided in regulations (36 CFR 60.4).

Homing - The ability of a salmon or steelhead to correctly identify and return to their natal stream, following maturation at sea.

Hydraulics - The principles governing mechanical properties of static and moving water (provisions of optimum passage at dams depend on knowledge of fish behavioral response to hydraulics at dams).

Hydroacoustics - The use of sound to estimate the number of fish using a specific passage route.

Hydrograph (river) - A graphic representation of stage, flow, velocity, or other characteristics of water at any given point.

Hydrologic function - The effects of water on the earth's surface, soil and rocks.

Hydropower – Electrical power generation produced by dams.

Impoundment – Any human-made structure for retaining natural flows (e.g., reservoirs).

Inbreeding – The mating of related individuals.

Incidental take – Take of a threatened or endangered species that is incidental to, and not the directed purpose of, the carrying out of an otherwise lawful activity.

Indigenous - Existing, growing, or produced naturally in a region.

Infrastructure - An underlying base or foundation.

Institutional barrier - Impediment or obstruction to achieving institutional goals based on current policies and mandates enacted by other institutions.

Instream flows - The amount of water passing a particular point in a stream or river, usually expressed in cubic-feet per second (cfs). Typically concerned with the minimum flow in a stream needed to protect and maintain aquatic life.

Integrated Rule Curves (IRC) - A set of reservoir operating criteria designed to meet multiple objectives (e.g. flood control, irrigation, recreation, and fish habitat.)

Inter-tidal (marsh) - Marshes located in the zone (usually in an estuary) between mean high tide and mean low tide.

Isolated Program – A program intended to support a terminal fishery where there is little or no possibility of co-mingling with listed wild fish.

Jeopardy - An action places a listed species in jeopardy if the action would bring that species' continued existence into question. If a proposed actions plales a species in jeopardy, it means that species is at risk of no longer being in existence. So, the jeopardy standard is measured in terms of the odds of avoiding jeopardy. It is not defined in statute.

Juvenile Bypass Outfall - The structure and location of the juvenile bypass system discharge.

Lacustrine - Of or pertaining to a lake (e.g., a lake ecosystem).

Landscape-level characteristics - Those characteristics associated with a heterogeneous land area with interacting ecosystems.

Life history strategies/types – Traits and characteristics of a stock that reflect adaptations to a unique environment (e.g., spawn timing).

Life stage - An organisms period of development to adulthood.

Listed fish, species - Species determined to be threatened (any species in danger of becoming endangered in the foreseeable future) or endangered (a species in danger of

extinction throughout all or a significant portion of it's range) as allowed under the ESA.

Local adaptations – Specialized characteristics or traits expressed by geographically distinct populations.

Low-gradient (tributary habitats) - a stream or river with a slope of less than 0.02 percent.

Mainstem - The principle channel of a drainage system into which other smaller streams or rivers flow.

Management prescription – The management practices and intensity selected and scheduled for application to a specific area.

Mark-selective fisheries - A fishery managed to selectively harvest distinctively marked fish.

Mechanical bypass system – See "bypass system."

Metapopulation - A population comprising local populations that are linked by migrants, allowing for recolonization of unoccupied habitat patches after local extinction events.

Migrant blockages – Any of a number of obstructions that prevent movement of fishes up- and down stream.

Minimum Gap Runners (MGR) - Turbine blades that maintain extremely close tolerance (less than 0.25 inches) between the bade, hub, and encasing draftube walls (discharge ring).

Mitigate - Make less severe or more bearable.

Mitigation hatchery fish - Artificially produced fish that are propagated to compensate for loss or reduction of a specific fish population.

Morphology - The structure, form and appearance of an organism.

Multi-scale – A series of graduated spatial geographic areas or temporal periods.

Multi-Species Framework Project – A collaborative project of the Northwest Power Planning Council, the Columbia River Basin's Indian Tribes and the United State Government to create a handful of scientifically based, agreed upon alternatives for determining how best to achieve fish and wildlife recovery in the Columbia River Basin.

Natal (stream) - Stream of birth.

Natural fish - A fish that is produced by parents spawning in a stream or lake bed, as opposed to a controlled environment such as a hatchery.

Natural regenerative processes – Restoration of ecosystem condition based on a series of related physical or biological activities existing in nature.

Naturally spawning fish/populations - Populations of fish that have completed their entire life cycle in the natural environment without human intervention.

Non-endemic stocks - Not native to or limited to a specific region.

Non-indigenous stocks - Not existing naturally in a region, state, country, etc.

Non-point source pollution (program) – Section 319 of the Clean Water Act establishes a Nonpoint Sources Management program. States, Territories, and Indian Tribes receive grant money which supports a wide variety of activities including technical assistance, financial assistance, education, training, technology transfer, and monitoring to assess the success of specific nonpoint source implementation projects.

Nutrient cycling - Circulation or exchange of elements such as nitrogen and carbon between nonliving and living portions of the environment.

Off-channel (areas) – Any relatively calm portion of a stream outside of the main flow.

Off-Channel Water Storage Capacity - Water storage in areas outside the mainstem Columbia.

Off-site Mitigation - Off-site mitigation is an action taken to addresss human-caused mortality of listed species outside the action area (hydrosystem) that would mitigate, in part, for the effects of unavoidable mortality inside the action area. It is credited toward the action agencies because it would not otherwise occur without the direct involvement of the action agencies. This is not defined in statute.

Operating Agencies – The federal agencies that operate federal dams in the Federal Columbia River Power System, namely, the Corps of Engineers and the Bureau of Reclamation.

Operations (FCRPS) - Management of the FCRPS projects as set forth in the 1995 FCRPS and 1998 Steelhead Supplemental Biological Opinions. Along with establishing certain hard constraints at storage reservoirs, the biological opinions established the Regional Forum, which as one of its responsibilities has some flexibility to recommend real-time (i.e., in season) management decision for flow augmentation, spill, and transportation decisions in order to best achieve passage strategies for migrating salmon.

Outbreeding - The interbreeding of distantly related or unrelated individuals.

Outbreeding depression - The loss of local adaptations as a result of interbreeding wild and hatchery fish.

Out-of-stream water use – Any use of stream water that occurs outside the stream channel, such as irrigation.

Pacific Salmon Treaty (PST) - A long-term and comprehensive management plan, negotiated between the United States and Canada, that would govern salmon fisheries in Southeast Alaska, British Columbia, and the Pacific Northwest.

Passive integrated transponder (PIT) tagging - Passive Integrated Transponder tags are used for identifying individual salmon for monitoring and research purposes. This miniaturized tag consists of an integrated microchip that is programmed to include specific fish information. The tag is inserted into the body cavity of the fish and decoded at selected monitoring sites.

Performance measures - Define the contribution that is needed at each life-history stage to achieve the overall biological goals and objectives, and which do so in context with the contributions from other life stages.

Performance-based management - Measures or actions that seek to reach established recovery objectives, and which can be adjusted over time in response to their degree of success in achieving those objectives.

pH - The negative logarithm of the molar concentration of hydrogen ion. It refers more simply to the acidity of a solution.

Plan for Analyzing and Testing Hypotheses (PATH) - The PATH process is a multi-agency/ multi-participant effort to allow a wide community of scientists and managers to analyze hypotheses for salmon decline and examine the outcome of different management options, including drawdown and transportation.

Plume – A downstream or offshore conveyance of water and suspended sediments (e.g., the Columbia River plume extends miles into the Pacific Ocean).

Point source discharges - Pollutants discharged from any identifiable point, including pipes, ditches, channels, sewers, tunnels, and containers of various types.

Polluted – (1) An area that has been contaminated, especially by a waste material that contaminates air, soil, or water. (2) Any solute or cause of change in physical properties that renders water unfit for a given use.

Population(s) - A group of individuals of the same species occupying a defined locality during a given time that exhibit reproductive continuity from generation to generation.

Population dynamic - The aggregate of changes that occur during the life of a population.

Population identification - The process of determining that a set of individuals belong in a population grouping.

Productive capacity - The capacity of a water body or production facility to produce fish.

Progeny - Offspring.

Properly functioning conditions (PFC) – Properly functioning condition is the sustained presence of natural habitat-forming processes in a watershed (e.g., riparian community succession, bedload transport, precipitation runoff pattern, channel migration) that are necessary for the long-term survival of the species through the full range of environmental variation. PFC, then, constitutes the habitat component of a species' biological requirements (Also see: NMFS 1996).

Province – A large geographic area that has similar set of biophysical characteristics and processes due to effects of climate and geology. Provinces are roughly equal to groups of 4th field USGS hydrologic unit codes (averages 1,000,000 hectares).

Push-up dam – An instream water diversion created by pushing streambed or other material into a mound which diverts part of the stream flow out of the channel.

Ramping Rates - The rate of change of discharge from a project, often limited by a specified rate of downstream water surface elevation change.

Reach - A section of stream between two defined points.

Rear - To feed and grow in a natural or artificial environment.

Reasonable and Prudent Alternative – Reasonable and prudent alternatives refer to alternative actions identified during formal consultation that can be implemented in a manner consistent with the intended purpose of the action, that can be implemented consistent with the scope of the federal agency's legal authority and jurisdiction, that is economically and technologically feasible, and that would avoid the likelihood of jeopardizing the continued existence of listed species or resulting in the destruction or adverse modification of critical habitat.

Rebuilding flows – Process of returning water to a stream to approximate historic flow patterns.

Reclamation Project(s) - Projects constructed under the Reclamation Act and operated by the U.S. Bureau of Reclamation, which administers some parts of the federal program for water resource development and use in western states. The Bureau of Reclamation owns and operates a number of dams in the Columbia River Basin, including Grand Coulee Dam.

Recovery - Defined as the point at which a listed species has improved to such an extent that it no longer requires the protection of the ESA.

Recovery goal - The reestablishment of a threatened or endangered species to a self-sustaining level in its natural ecosystem (i.e., to the point where the protective measures of the Endangered Species Act are no longer necessary).

Recovery planning areas - Any geographic area that regulatory agency uses to set the boundaries of a regional recovery plan for salmon it is usually a river basin or subbasin.

Redd - A nest of fish eggs covered with gravel.

Refugia – Locations and habitats that support populations of organisms that are limited to small fragments of their previous geographic range.

Resident fish - Occupying headwater reaches; may disperse locally, but generally considered non-migratory.

Restoration – Reestablishment of pre-disturbance aquatic functions and related physical, chemical, and biological characteristics.

Riparian (zones) - Those terrestrial areas where the vegetation complex and microclimate conditions are products of the combined presence and influence of perennial and /or intermittent water, associated with high water tables, and soils that exhibit some wetness characteristics.

Riprap - Refers to rocks or concrete structures used to stabilize stream or riverbanks from erosion.

River of origin - The river system in which a given salmonid was hatched (see natal stream).

Road treatments – Any of a number of restorative activities conducted to improve drainage, erosion, or stability of a road, such as, ripping and seeding the road surface, planting cut-slopes, removing the road from the landscape by reestablishing the original land contour.

Run (fish) - A group of fish of the same species that migrate together up a stream to spawn, usually associated with the seasons, e.g., fall, spring, summer, and winter runs. Members of a run interbreed, and may be genetically distinguishable from other individuals of the same species.

Run timing - The time of year that the fish return to their rivers of origin to spawn.

Runoff - Water that flows over the ground and reaches a stream as a result of rainfall or snowmelt.

Salinity concentrations - The concentration of salt in a body of water. The salinity of a saltwater wetland changes whenever freshwater is added when it rains, and each time the saltwater is added or removed when tide rises and falls.

Salmonids - Fish of the family Salmonidae, that includes salmon and steelhead.

Scientific protocols - A set of conventions governing data treatment and analysis procedures.

Scour of redds – Dig or remove gravels and eggs from redds by a powerful current of water.

Screens/ladders (fish) - Wire mesh screens placed at the point where water is diverted from a stream, river, and through a turbine at a dam to help keep fish from entering the diversion or passageway. Fish ladders are devices made up of a series of stepped pools, similar to a staircase, that enable adult fish to migrate upstream past dams.

Seasonal Flow Patterns – Natural changes and fluctuations in stream flows occurring over the course of a year.

Secure (habitat) – Reducing or eliminating problems caused by past human activities to prevent further degradation to remaining healthy areas (Doppelt et al. 1993).

Sediment regime(s) (input, storage, transport) - The distribution of sediment input, transport, and storage in a river system through time.

Segmented habitat – Habitat that is cutoff from other portions of the habitat. Refers to habitat wherein free movement of individuals from portion of the habitat to other portions is restricted.

Selective fishery strategy - A fishery management tool that allows selective retention of certain identifiable salmonid stocks (identified by marking, time, area, or gear methods) in order to minimize impacts on listed species.

Selective fishing gear - Fishing gear that, while targeting the intended species and size groups, allows non-target species to be released with little or no mortality.

Sensitive species - Those species that (1) have appeared in the Federal Register as proposed for classification and are under consideration for official listing as endangered or threatened species or (2) are on an official state list or (3) are recognized by the U.S. Forest Service or other management agency as needing special management to prevent their being placed on federal or state lists.

Sensitivity (population) - The susceptibility of a population to positive or negative inputs.

Sensitivity Analysis (PATH) - In addition to the uncertainties that are explicitly incorporated into the calculation of probabilities of meeting standards, the detailed results presented in the PATH FY98 Report also explored the effects of other assumptions on the overall results. They looked specifically at the sensitivity of results to the four factors: habitat, harvest, bird predation in the Columbia River estuary, and upstream survival rates. (Also see PATH.)

Sluiceway Outfall - The structure and location of the discharge of the surface dam outlet designed to collect and dispose of debris collected at the dam face.

Smolt - Refers to the salmonid or trout developmental life stage between parr and adult, when the juvenile is at least one year old and has adapted to the marine environment.

Smolt Travel Time - The time required for smolt transit a stream reach during downstream migration.

Smoltification - Refers to the physiological changes anadromous salmonids and trout undergo in freshwater while migrating toward saltwater that allow them to live in the ocean.

Spatial and temporal scales - The size/range of place and time used in modeling or data analysis.

Spawn - The act of reproduction of fishes. The mixing of the sperm of a male fish and the eggs of a female fish.

Spawning gravel – Streambed materials in which salmon lay their eggs, usually gravels free of fine sediments.

Species of concern - An unofficial status for a species whose abundance is at low levels.

Spill – Releasing water over a dam's spillways rather than channeling it through the powerhouse.

Spillway flow deflectors (flip lips) - Structures that limit the plunge depth of water over the dam spillway, producing a less forceful, more horizontal spill. These structures reduce the amount of dissolved gas trapped in the spilled water.

Stock - A specific population of fish. When referring to salmon, a specific population of fish spawning in a particular stream during a particular season.

Stock structure - The suite of characteristics (in particular genetic attributes) that distinguish one stock of salmonids from another.

Storage capacity - The active storage capacity (above the dead pool) of all the reservoirs in the Columbia Basin, including those in Canada.

Storage reservoirs - A reservoir primarily used to actively store and draft water. These reservoirs often have a large active storage capacity.

Stranding – Causing fish to be trapped in stream reaches due to insufficient water, especially as a result of water withdrawal.

Straying - A natural phenomena of adult spawners not returning to their natal stream, but entering and spawning in some other stream.

Stream segments – A portion of a stream channel.

Subbasin – A watershed area defined by 4th – field USGS hydrologic unit code the size averages 200,000 hectares.

Substrate - The composition of a streambed, including mineral and organic materials.

Subwatersheds - A watershed area defined by 6th field USGS hydrologic unit code the size ranges from 5 to 15,000 hectares.

Supplementation - Artificial propagation intended to reestablish a natural population or increase its abundance.

Surface Bypass Collection (SBC) - System designed to divert fish at the surface before they have to dive and encounter the existing turbine intake screens. SBC directs the juvenile fish into the forebay, where they are passed downstream either through the dam spillway or via the juvenile fish transportation system of barges and trucks.

Survivorship - A measure of survival tied to each of a species' life stages.

Take (legal/illegal) - Under the Endangered Species Act, take means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect an animal, or to attempt to engage in any such conduct.

Terminal area - rivers of origin.

Terminal fishery - Fisheries near freshwater (usually the mouth of rivers or bays or near a hatchery release site) where the targeted species is returning to spawn.

Threatened (ESA) - A genetic population that is at risk of becoming endangered in the foreseeable future.

TMDL – Total Maximum Daily Load is a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards, and an allocation of that amount to the pollutant's source (EPA).

Transport (juvenile) - Collection and transport via barge and truck of out migrating juvenile salmonids from several FCRPS collection projects to a location downstream from Bonneville Dam, the lowermost dam on the Columbia River.

Trash Shear Boom - A floating device aligned with flow that allows floating debris to be guided to a specific removal point.

Tribal fishing rights - The guaranteed right for Native Americans to fish in their usual and accustomed Places. The right was established in a series of treaties dating from the mid-1850s and it applies to a number of tribes and their various harvesting practices (i.e., commercial and ceremonial and subsistence).

Tributary habitats - Fish habitat provided by a stream that flows into another stream, river, or lake.

Trust obligations/responsibility - Governmental obligations to the tribes under the treaties of 1855.

Turbidity – The cloudiness of water caused by suspended matter that interferes with the passage of light through the water or in which visual depth is restricted.

Value-added commercial enterprises - Any business venture based on taking a product whether raw or partially processed, and processing it further to increase its value to the consumer.

Viability (population) - A population in a state that maintains its vigor and its potential for evolutionary change.

Viable Salmonid Population (VSP) - An independent population of any Pacific salmonid (genus *Oncorhynchus*) that has a negligible risk of extinction over a 100-year time frame.

Water conveyances – Devices used to transfer water from one location to another, usually from a natural water body to the land surface for irrigation, or for an industrial use. Examples include pipes, lined or unlined ditches, and irrigation canals.

Water quality limited - A water body that does not meet the federally approved state water quality standard establish under the provision of the Clean Water Act.

Water table elevation – The elevation at which groundwater will enter a well hole and attain a static level. Groundwater below this level is held in the intergranular pores on the soil or rock, or joints or fractures in the rock. Above the water table is a zone in which the pores of the soil or rock are completely filled with water held up by capillary tension.

Watershed - A watershed area defined by 5th – field USGS hydrologic unit code the size ranges between 20 to 40,000 hectares.

Watershed analysis – A systematic, science-based procedure for characterizing ecosystem conditions, and the state of ecosystem processes and functions.

Watershed assessment – (See watershed analysis). The term assessment rather than analysis often implies that a process with less scientific rigor was used.

Weak (stock) - Listed in the Integrated System Plan's list of stocks of high or highest concern; listed in the American Fisheries Society report as at high or moderate risk of extinction; or stocks the National Marine Fisheries Service has listed. "Weak stock" is an evolving concept; the Council does not purport to establish a fixed definition. Nor does the Council imply that any particular change in management is required because of this definition."

Wetland(s) – Areas that are inundated by surface water or groundwater with a frequency sufficient to support, and under normal circumstances do or would support, a prevalence of vegetative or aquatic life that require saturated or seasonally saturated soil condition for growth and reproduction (Executive Order 1990). Examples of wetlands include swamps, marshes, and bogs.

Wild fish - See "natural fish."

Woody debris input – Refers to the processes that move woody vegetation from land areas to the stream environment. Examples of processes include landslides, debris flows, wind throw, and disease.

5. References

Andrews, J., J. Lloyd, and B. Webster. 1987. Alturas Lake flow augmentation (Final Report). Project Number 83-415, Bonneville Power Administration, Portland, OR.

Apperson, K.A. and P.J. Anders. 1991. Kootenai River white sturgeon investigations and experimental culture. Annual Progress Report FY 1990. Idaho Department of Fish and Game and Bonneville Power Administration. Contract No. DE-AI79-88BP93497. Project No. 88-65. Portland, Oregon 67 pp.

Battelle Pacific Northwest National Laboratory and U.S. Geological Survey Western Fisheries Research Center, *Assessment of the Impacts of Development and Operation of the Columbia River Hydroelectric System on Mainstem Riverine Processes and Salmon Habitats*, July 2000.

Beamer, E.M., R.E.McClure, and B.A. Hayman. 1999. Fiscal year 1999 Skagit River Chinook Restoration Research. Skagit System Cooperative, La Conner, Washington, 24 p.

Bell, M.C. 1986. Fisheries handbook of engineering requirements and biological criteria. U.S. Army Corps of Engineers, Office of the Chief of Engineers, Fish Passage Development and Evaluation Program, Portland, Oregon.

Bevan, D., J. Harville, P. Bergman, T. Bjorn, J. Crutchfield, P. Klingeman, and J. Litchfield. 1994. Snake River recovery team: final recommendations to the National Marine Fisheries Service. National Marine Fisheries Service. Portland, Oregon.

Bjornn, T.C., and D.W. Reiser. 1991. Habitat requirements of salmonids in streams. Pages 83-138 in W.R. Meehan, editor. Influences of forest and rangeland management on salmonid fishes and their habitats. Special Publication 19. American Fisheries Society, Bethesda, Maryland.

Bonneville Power Administration (BPA). 1993. *In*: U.S. Fish and Wildlife Service. Undated. White Sturgeon: Kootenai River Population *Acipenser transmontanus* draft recovery plan. 132 p.

Bonneville Power Administration and U.S. Bureau of Reclamation. 1993. Columbia River Basin, System Operational Review. Irrigation Depletion Estimate. September 10, 1993, prepared for Bonneville Power Administration by A.G. Crook Company.

Botsford, L. W. and J. G. Brittnacher. 1998. Viability of Sacramento winter-run chinook salmon. Conservation Biology 12: 65-79.

Brannon, E.L., C.L. Melby, and S.D. Brewer. 1984. Columbia River white sturgeon enhancement. Final Report to Bonneville Power Administration. Contract No. DEAI79-84BP18952; Project No. 83-316. Portland, Oregon. 43 pp.

Campton, D.E. 1995. Genetic effects of hatchery fish on wild populations of Pacific salmon and steelhead: what do we really know? *American Fisheries Society Symposium*,**15**:337-353.

Chapman, D., A. Giorgi, M. Hill, A. Maule, S. McCutcheon, D. Park, W. Platts, K. Pratt, J. Seeb, L. Seeb, and F. Utter. 1991. Status of the Snake River Chinook salmon. Prepared for the Pacific Northwest Utilities Conference Committee. Don Chapman Consultants, 3180 Airport Way, Boise, ID.

Chapman, D., et al., *Status of Snake River Chinook Salmon*, Report for the Pacific Northwest Utilities Conference Committee, Don Chapman Consultants, Inc., Boise, Idaho, 1991.

Chilcote, M.W., S.L. Leider, and J.J. Loch. 1986. Differential reproductive success of hatchery and wild summer-run steelhead under natural conditions. Trans. Amer. Fish. Soc. 115:726-735.

Columbia Basin Fish and Wildlife Authority, *Report of the Fish Screen Oversight Committee*, 1999.

Columbia River Fish Management Plan (CRFMP). 1988. Entered into pursuant to *United States v. Oregon* (Civ. 68-513. Federal District Court of Oregon, 1969)

Columbia River Inter-Tribal Fish Commission (CRITFC) 1995. *Wy-Kan-Ush-Mi Wa-Kish-Wit:* Spirit of the Salmon. The Columbia River Anadromous Fish Restoration Plan of the Nez Perce, Umatilla, Warm Springs and Yakama Tribes Columbia River Inter-Tribal Fish Commission, Portland, Oregon.

Columbia River System Operation Review, Final Environmental Impact Statement, Appendix F: Irrigation, Municipal and Industrial/Water Supply pp. 2-1, 2-2 (November 1995).

Dayton, P. K. 1979. Ecology: A science and a religion. In: *Ecological Processes in Coastal and Marine Sciences*, (ed.) R.J. Livingston. Plenum Press. pp. 3-18.

DeVore, J.D., B.W. James, and D.R. Gilliland. 1999. Effects of mitigative measures on productivity of white sturgeon populations in the Columbia River downstream from McNary Dam, and determine the status and habitat requirements of white sturgeon populations in the Columbia and Snake rivers upstream from McNary Dam. Annual Progress Report, April, 1997-March, 1998, Report B. Report prepared for Bonneville Power Administration Project 86-50, Contract No. DE-A179-86BP63584. Washington Department of Fish and Wildlife, Vancouver, WA. 38p.

DeVore, J.D., B.W. James, D.R. Gilliland, and B.J. Cady. 1998. Effects of mitigative measures on productivity of white sturgeon populations in the Columbia River downstream from McNary Dam, and determine the status and habitat requirements of white sturgeon populations in the Columbia and Snake rivers upstream from McNary Dam. Annual Progress Report, April, 1996-March, 1997, Report B. Report prepared for Bonneville Power Administration Project 86-50, Contract No. DE-A179-86BP63584. Washington Department of Fish and Wildlife, Vancouver, WA. 36p.

Doppelt, B., M. Scurlock, C. Frissell, and J. Karr. 1993. Entering the watershed: a new approach to save America's river ecosystems. Island Press, Washington D.C.

Dunne, T., and L. B. Leopold. 1978. Water in Environmental Planning. W. H. Freeman and Company. New York.

Emmett, R.L., S.A. Hinton, S.L. Stone, and M.E .Monaco. 1991. Distribution and abundance of fishes and invertebrates in West Coast estuaries, Volume II: species life history summaries. Estuarine Living Marine Resources Program Report No. 8. NOAA/NOS Strategic Environmental Assessments Division, Rockville, Maryland. 329 p.

Environmental Protection Agency. 1999. EPA Web site: epa.gov/owow/tmdl/intro.html.

Everest, F.H., N.B. Armantrout, S.M. Keller, W.D. Parante, J.R. Sedell, T.E. Nickelson, J.M. Johnston, and G.N. Haugen. 1985. Salmonids. Pages 199-230 in E.R. Brown, editor. Management of wildlife and fish habitats in forests of western Oregon and Washington. Publication R6-F&WL-192-1985. U.S. Department of Agriculture, Forest Service, Pacific Northwest Region, Portland, Oregon.

Feist, B.E., E.A. Steel, G.R. Pess, and R.E. Bilby. 2000. A coarse-scale, spatially explicit model for predicting Pacific salmon (Oncorhynchus spp.) abundance as a function of land cover and land use in the Pacific Northwest, United States. *In Prep.* To be submitted to *Conservation Biology*.

Fisher, J. G.. *Downstream Migrant Fish Screens for Irrigation Ditches, Upper Salmon River Basin, Idaho*, report to the Sawtooth National Recreation Area, Idaho, 1977.

Flagg, T.A., and C.E. Nash (eds). 1999. A conceptual framework for conservation hatchery strategies for Pacific salmonids. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-38, 46 p.

Fleming, I.A. and M.R. Gross. 1993. Breeding Success of Hatchery and Wild Coho Salmon (*Oncorhynchus kisutch*) in Competition. Ecological Applications, 3(2), pp. 230-245.

Fleming, I.A., Jonsson, B., Gross, M.R. and A. Lamberg. 1996. An experimental study of the reproductive behavior and success of farmed and wild Atlantic salmon. J. Applied Ecology 33: 893-903

Forest Ecosystem Management Assessment Team. 1993. Forest ecosystem management: an ecological, economic and social assessment. Report of the Forest Ecosystem Management Assessment Team. U.S. Government Printing Office 1993-793-071. U.S. Government Printing Office for the U.S. Department of Agriculture, Forest Service; U.S. Department of the Interior, Fish and Wildlife Service, Bureau of Land Management, National Park Service; U.S. Department of Commerce, National Oceanic and Atmospheric Administration and National Marine Fisheries Service; and U.S. Environmental Protection Agency.

Fraley, J.J., and B.B. Shepard. 1989. Life History, ecology and population status of migratory bull trout (Salvelinus confluentus) in the Flathead Lake and River System, Montana. Northwest Science 63(4):133-143.

Francis, R. C. and Hare. S.R. Decadal-scale regime shifts in the large marine ecosystems of the Northeast Pacific: a case for historical science. Fish. Oceanogr. 1994; 3(4):279-291.

Francis, RC; Hare, SR 1994. Decadal-scale regime shifts in the large marine ecosystems of the Northeast Pacific: A case for historical science. Fisheries Oceanography 3(4):279-291

Frissell, C. A. 1993. A new strategy for watershed restoration and recovery of Pacific salmon in the Pacific Northwest. Prepared for the Pacific Rivers Council, Eugene, Oregon.

Fulton, L.A. 1968. Spawning areas and abundance of chinook salmon (*Oncorhynchus tshawytscha*) in the Columbia River Basin—past and present. U.S. Fish and Wildlife Service Special Scientific Report—Fisheries no. 571. 26 p.

Fulton, L.A. 1970. Spawning areas and abundance of steelhead trout and coho, sockeye, and chum salmon in the Columbia River basin—past and present. U.S. Fish and Wildlife Service Special Scientific Report—Fisheries no. 618. 37 p.

Gebhards, S. V. *The Effects of Irrigation on the Natural Production of Chinook Salmon in the Lemhi River, Idaho.* M. S. Thesis, Utah State University, Logan, Utah, 1959.

Groot, C., and L. Margolis, editors. 1991. Pacific salmon life histories. University of British Columbia Press. Vancouver, British Columbia. 564 p.

Hard, J.J. 1995. Genetic monitoring of life-history characters in salmon supplementation: problems and opportunities. *American Fisheries Society Symposium*, **15**:212-225.

Hare, S. R.; Mantua, N. J., and Francis, R. J. 1999. Inverse production regimes: Alaska and West Coast Pacific Salmon. Fisheries. 24(1):6-15.

Henjum, M. G., J. R. Karr, D. L. Bottom, D. A. Perry, J. C. Bednarz, S. G. Wright, S. A. Beckwitt, and E. Beckwitt. 1994. Interim Protection for late-successional forests, fisheries, and watersheds: national east of the Cascade Crest, Oregon and Washington. The Wildlife Society, Bethesda, Maryland.

Hilborn, R., B.G. Bue, S. Sharr. 1999. Estimating spawning escapements from periodic counts: a comparison of methods. *Can. J. Fish. Aquat. Sci.* **56**:888-896.

Hinch, SG; Healey, MC; Diewert, RE; Thomson, KA; Hourston, R; Henderson, MA; Juanes, F. 1995. Potential effects of climate change on marine growth and survival of Fraser River sockeye salmon. CAN. J. FISH. AQUAT. SCI 52(12):2651-2659

Howell, P. J. and D. V. Buchanan, eds. 1992. Proceedings of the Gearhart Mountain

bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis, Oregon.

Huntington, C.W., W. Nehlsen, and J. Bowers. 1996. A survey of healthy native stocks of anadromous salmonids in the Pacific Northwest and California. Fisheries 21(3):6-14.

Independent Scientific Group (ISG). 1996. *Return to the River*. Northwest Power Planning Council, Portland, Oregon.

Independent Scientific Group, Return to the River: Restoration of Salmonid Fishes in the Columbia River Ecosystem (prepublication copy Sept. 10, 1996).

Integrated Hatchery Operations Team (IHOT). 1994. Policies and Procedures for Columbia Basin Anadromous Salmonid Hatcheries. Bonneville Power Administration, Portland, Oregon.

Kareiva, Peter. September 5, 2000. The Cumulative Risk Initiative (CRI), A Standardized Quantitative Analysis of Risks faced by Salmonids in the Columbia River Basin.

Keely, E.R., P.A. Slaney, and D. Zaldokas. 1996. Estimates of production benefits for salmonid fishes from stream restoration initiatives. Province of British Columbia, Ministry of Environment, Lands, and Parks, and Ministry of Forests. Watershed Restoration Management Report No. 4.

Knudson, K. 1994. Water quality status report, Kootenay (Kootenai) River Basin British Columbia, Montana, and Idaho. Prepared for Kootenai River Network, January, 1994. 57 p.

Koning, C.W., and E.R. Keeley. 1997. Salmonid biostandards for estimating production benefits of fish habitat rehabilitation techniques. In: Fish Habitat Rehabilitation Procedures (P. Slaney and D. Zaldokas, eds). Watershed Restoration Technical Circular No. 9. Ministry of Environment, Lands and Parks. Vancouver, B.C.

Kratz, Kim. July 18, 2000. *Columbia Subbasin Prioritization Model.*

Lower Columbia River Estuary Program. 1998. *Comprehensive Conservation and Management Program*.

Lower Columbia River Estuary Program. 1999. Comprehensive Conservation and Management Plan. Volume 1: June 1999. Lower Columbia River Estuary Program, Portland, Oregon. p. 222.

Marcuson, P. 1994. Kootenai River white sturgeon investigations and experimental culture. Annual Progress Report FY 1990. Idaho Department of Fish and Game and Bonneville Power Administration. Contract No. DE-AI79-88BP93497. Project No. 88-65. Portland, Oregon 67 pp.

Marmorek, D., Parnell I., Peters, C.N. and C. Alexander (eds). 1999. PATH: Scoping of Candidate Research, Monitoring and Experimental Management Actions: Concurrently Reducing Key Uncertainties and Recovering Stocks. Working Draft. ESSA Technologies Ltd., Vancouver, B.C., Canada.

Marmorek, D.R., Peter, C.N. and Parnell I (eds.). 1998. Plan for Analyzing and testing hypotheses (PATH) Final Report for Fiscal Year 1998. Essa Technologies Ltd.

May, B.E. and W.L. Somes. 1981. Comparative effects of sheep and cattle grazing on the Marsh Creek drainage. Transactions Bonneville Chapter American Fisheries Society. 1981:48-62.

McAllister, M.K. and R.M. Peterman. 1992. Experimental design in the management of fisheries: A review. *N. Amer. J. Fish. Manage.* **12**(1):1-18.

McElhany, P., M. Ruckelshaus, M. J. Ford, T. Wainwright and E. Bjorkstedt. 2000. Viable salmonid populations and the recovery of Evolutionarily Significant Units. NOAA-NMFS-NWFSC Draft document. Available at http://research.nwfsc.noaa.gov/

McPhail, J.D., and C.C. Lindsey. 1986. Zoogeography of the freshwater fishes of Cascadia (the Columbia system and rivers north to the Stikine). Pages 615-637 in C.H. Hocutt and E.O. Wiley, editors. The Zoogeography of North American freshwater fishes. Wiley and Sons, New York, New York.

Meehan, W.R., and T.C. Bjornn. 1991. Salmonid distributions and life histories. Pages 47-82 in W.R. Meehan, editor. Influences of forest and rangeland management on salmonid

fishes and their habitats. Special Publication 19. American Fisheries Society, Bethesda, Maryland.

Mobrand Biometrics, Inc. 1999. Unpublished report. The EDT method, August 1999 – Draft (Available from Mobrand Biometrics, Inc. Washington).

Moyle, P. 1994. The decline of anadromous fishes in California. Conservation Biology. Vol. 8:869-870.

National Fish Hatchery Review Panel, 1994. Report of the National Fish Hatchery Review Panel. The Conservation Fund, Arlington, Virginia.

National Marine Fisheries Service. 1996. Making Endangered Species Act determinations of effect for individual or grouped actions at the watershed scale. Guidance document prepared by NMFS Habitat Conservation Division, Portland, Oregon. 31 p.

National Marine Fisheries Service. 1996. Memorandum from William Stelle, Jr., to NMFS/NWR staff, September 4, 1996: Making Endangered Species Act determinations of effects for individual or grouped actions at the watershed scale. (Available from NMFS, Portland, Oregon).

National Marine Fisheries Service. 1997. Description and identification of essential fish habitat, adverse impacts and recommended conservation measures for salmon. Amendment 14 to the Pacific Coast Salmon Plan, Draft Appendix A. January 1999. Pacific Fisheries Management Council Award Number NA87FC008. Portland, Oregon.

National Marine Fisheries Service. 1997. Genetic effects of straying of non-native hatchery fish into natural populations, Proceedings of the workshop, June 1-2, 1995, Seattle, Wash. E.S. Grant, editor. NOAA Technical Memorandum NMFS-NWFSC-30. 130 p.

National Marine Fisheries Service. 1999. ESA Section 7 Consultation: Biological Opinion on Artificial Propagation in the Columbia River Basin. March 29, 1999. Portland, Oregon.

National Marine Fisheries Service, U.S. Fish and Wildlife Service. 1999. Fed-1 Plan for Artificial Propagation: Artificial Production Proposal for CRFMP Negotiations. January 7, 1999. Portland, Oregon.

National Marine Fisheries Service. 1999. Interim standards for the use of captive propagation technology in the recovery of anadromous salmonids listed under the Endangered Species Act. Sustainable Fisheries Div., Hatchery and Inland Fisheries Branch, Portland, OR. Feb. 1999, 18p.

National Marine Fisheries Service. 1999. Recommended Protocols for the Use of Captive Broodstock, Northwest Fisheries Science Center, Seattle, Washington.

National Marine Fisheries Service. 1999. White Paper: Passage of Juvenile and Adult Salmonids Past Columbia and Snake River Dams.

National Marine Fisheries Service. 1999. White Paper: Predation on Salmonids Relative to the Federal Columbia River Power System.

National Marine Fisheries Service. 1999. White Paper: Salmonid Travel Time and Survival Related to Flow Management in the Columbia River Basin.

National Marine Fisheries Service. 1999. White Paper: Summary of Research Related to Transportation of Juvenile Anadromous Salmonids Around Snake and Columbia River Dams.

National Marine Fisheries Service. June 2, 1999. Biological Opinion on the Oregon Conservation Reserve Enhancement Program.

National Marine Fisheries Service. December 16, 1999. Biological Opinion and Conference Report. Columbia River Federal Navigation Channel Deepening.

National Marine Fisheries Service. December 2000. Biological Opinion. Reinitiation of Consultation on Operation of the Federal Columbia River Power System, Including Juvenile Transportation Program, and 19 Bureau of Reclamation Projects in the Columbia Basin.

National Research Council (NRC). 1996. *Upstream:* Salmon and Society in the Pacific Northwest. Committee on

Protection and Management of Pacific Northwest Anadromous Salmonids. National Academy Press, Washington D.C.

Nehlsen, W., J.E. Williams, and J.A. Lichatowich. 1991. Pacific salmon at the crossroads: Stocks at risk from California, Oregon, Idaho, and Washington. Fisheries 16(2):4-21.

NOAA. 1993. Interim Policy on Artificial Propagation of Pacific Salmon Under the Endangered Species Act. *Federal Register* **58**(63):17573-6.

North, J.A., L.C. Burner, and R.A. Farr. 1999. Effects of mitigative measures on productivity of white sturgeon populations in the Columbia River downstream from McNary Dam, and determine the status and habitat requirements of white sturgeon populations in the Columbia and Snake rivers upstream from McNary Dam. Annual Progress Report, April, 1997-March, 1998, Report B. Report prepared for Bonneville Power Administration Project 86-50, Contract No. DE-A179-86BP63584. Oregon Dept. of Fish and Wildlife, Clackamas, OR. 49p.

Northwest Fisheries Science Center (NWFSC). 1999. Anadromous Fish, Appendix A, Draft Report. Prepared for the U.S. Army Corps of Engineers, Walla Walla District, Walla Walla, Washington. Appendix to the Lower Snake River Juvenile Salmon Migration Feasibility Report/Environmental Impact Statement. Dated April 14, 1999.

Northwest Power Planning Council. September 17, 1992. Information on Water Quality and Quantity Contained in the Salmon and Steelhead Subbasin Plans (above Bonneville Dam) (Document 93-8).

Northwest Power Planning Council. 1986. Compilation of Information on Salmon and Steelhead Losses in the Columbia River Basin. Appendix D of the 1987 Columbia River Basin Fish and Wildlife Program. Portland, Oregon.

Northwest Power Planning Council. 1999. Artificial Production Review. Council Document 99-15. October 13, 1999. Portland, Oregon.

Northwest Power Planning Council. November 9, 2000. Phase One Amendments Columbia River Basin Fish and Wildlife Program, Technical Appendix, November 9, 2000.

Oregon Department of Fish and Wildlife (ODFW), Washington Department of Fish and Wildlife (WDFW). 1998. Status Report: Columbia River Fish Runs and Fisheries, 1938-1997. Portland, Oregon.

Oregon Water Resources Department. 1993. Memorandum from T. Kline and B. Fujii, Oregon Water Resources Department, to David Moscowitz, et. al., regarding weak stocks and water supply conflicts (September 17, 1993).

Pacific Fishery Management Council (PFMC). 1999a. Draft Final Pacific Coast Salmon Plan. Conservation Objectives and Management Information. Portland, Oregon.

Pacific Fishery Management Council (PFMC). 1999b. Review of 1998 Ocean Salmon Fisheries. Portland, Oregon.

Pacific Fishery Management Council Salmon (PFMC). 1999c. Preseason Report: Stock Abundance Analysis for 1999 Ocean Salmon Fisheries. Portland, Oregon.

Paragamian, V. 1995. Kootenai River fisheries investigation: Stock status of burbot and rainbow trout and fisheries inventory. Idaho Department of Fish and Game, Annual Progress Report. Report IDFG 96-7 prepared for Bonneville Power Administration Project No. 88-65, Contract No. DE-B179-88BP93497. 53p.

Parnell, I., D.R. Marmorek, C.N. Peters, and C.A.D. Alexander (compls./eds.). 1999. PATH: Scoping of candidate experimental management actions. Draft prepared by ESSA Technologies Ltd., Vancouver, B.C. 108 pp.

Platt, J.R. 1964. Strong Inference. *Science* **146**:347-353.

Quigley, T. M., S. J. Arbelbide (technical editors). 1997. An assessment of ecosystem components in the interior Columbia River basin and portions of the Klamath and Great Basins: Volume 3. Gen. Tech. Rep. PNW-GTR-405. Portland, Oregon: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 4 vol.

(Quigley T. M., tech. ed.: The Interior Columbia Basin Ecosystem Management Project: Scientific Assessment).

Reisenbichler, R. and J. McIntyre. 1977. Genetic differences in growth and survival of juvenile hatchery and wild steelhead trout *Salmo gairdneri*. J. Fish. Res. Bd. Can. 34:123-128 pp.

Reisenbichler, R.R. 1997. Genetic factors contributing to declines of anadromous salmonids in the Pacific Northwest. pp. 223-244 in Pacific Salmon & Their Ecosystems: Status and Future Options, F.J. Stouder, P.A. Bisson, R.J. Naiman, Editors. Chapman & Hall, New York.

Rieman, B.E. and J.D. McIntyre. 1993. Demographic and Habitat Requirements for Conservation of Bull Trout. USDA Forest Service, Intermountain Research Station. Gen. Tech. Rep. INT-302.

Sharpe, C., P. Hulett, and C. Wagemann. 2000. Studies of hatchery and wild steelhead in the Lower Columbia Region, progress report for fiscal year 1998, WDFW Kalama Research Team. Report available from State of Washington, Depart. of Fish and Wildlife, Kalama Research Team, 804 Allen St., Ste.3, Kelso, WA 98626. 54p

Simberloff, D. 1983. Competition theory, hypothesis-testing and other community ecological buzzwords. *Amer. Nat.* **122**:626-635.

Solazzi, M. F., T.E. Nickelson, S.L. Johnson and J.D. Rodgers. Effects of Increasing winter rearing habitat on abundance of salmonids in two coastal Oregon Streams. Can. J. Fish. Aquat. Sci. 57: 906-914.

Spence, B. C., G. A. Lomnicky, R. M. Huges, and R. P. Novitzki. 1996. An ecosystem approach to salmonid conservation. TR-4501-96-6057. ManTech Environmental Research Corp., Corvallis, OR. (Available from National Marine Fisheries Service, Portland, Oregon.)

Standford, J. A., and J. V. Ward. 1992. Management of aquatic resources in large catchments: recognizing interactions between ecosystem connectivity and environmental disturbance. Pages 91-124 *in* R.J. Naiman, editor. Watershed management: balancing sustainability and environmental change. Springer-Verlag, New York.

Stober, Q.J. and Nakatami, R., 1992. Water Quality and Biota of the Columbia River System, in "Water Quality in North America River Systems," Becker, D. and Neitzel, D., Editors, Battelle Press.

Stober, Q.J., M.R. Criben, R.V. Walker, A. L. Setter, I. Nelson, J.C. Gislason, R.W. Tyler, and E.O. Salo. 1979. Columbia River irrigation withdrawal environmental review. Columbia River Fishery study. Final Report FRI-UW-7919, University of Washington.

Streamnet. December 2, 1999. Glossary of Terms [glossary online]. Gladstone (OR): URL:<http://www.streamnet.org/ff/Glossary.

Taylor, J. E., Making Salmon: Economy, Culture, and Science in the Oregon Fisheries, Precontact to 1960 at 72-80, 86, 90 (Doctor of Philosophy dissertation, University of Washington, 1996).

Thomas, Duncan W. October 1981. Historical Analysis of the Columbia River Estuary: An Ecological Approach. Draft Report to the Columbia River Estuary Study Taskforce.

U.S. Army Corps of Engineers, U.S. Bureau of Reclamation, and Bonneville Power Administration. 1999. Federal Columbia River power system project operations. Biological assessment for effects of FCRPS operations on Columbia Basin bull trout and Kootenai River white sturgeon. 176 p.

U.S. Department of Agriculture, Forest Service and U.S. Department of Interior, Bureau of Land Management. 1995. PACFISH: Decision notice/decision record, FONSI, ES, Appendices for the interim strategies for managing anadromous fish-producing watersheds in eastern Oregon and Washington, Idaho, and portions of California. Washington DC: U.S. Department of Agriculture, Forest Service and U.S.

Department of Interior Bureau of Land Management.

U.S. Department of Agriculture, Forest Service. 1995. Environmental Assessment for the implementation of interim strategies for managing fish-producing watersheds in eastern Oregon and Washington, Idaho, and portions of Nevada (INFISH). U.S. Government Printing Office. Washington, D.C.

U.S. Department of Agriculture, Forest Service; U.S. Department of Interior, Bureau of Land Management. 1994. Northwest Forest Plan. Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl.

Walters, C.J. and R. Hilborn. 1976. Adaptive control of fish systems. *J. Fish Res. Brd. Canada* **33**:145-159.

Waples, R.S. 1999. Dispelling some myths about hatcheries. *Fisheries,* 24 (2):12-21.

Washington Department of Fisheries (WDF), Washington Department of Wildlife, and Western Washington Treaty Indian Tribes. 1993. 1992 Washington State salmon and steelhead stock inventory. 212 p.

Washington Forest Practice Board. 1995. Rules - WAC 222. Board Manual. Forest Practices Act - RCW 76.09. Washington Department of Natural Resources, Forest Practices Division, Olympia, Washington.

Welch, D. W.; Ishida, Y., and Nagasawa, K. Thermal limits and ocean migrations of sockeye salmon (*Oncorhynchus nerka*): long-term consequences of global warming. Can. J. Fish. Aquat. Sci. 1998; 55:937-948.

Welch, DW; Ishida, Y; Nagasawa, K; Eveson, JP 1998. Thermal limits on the ocean distribution of steelhead trout (Oncorhynchus mykiss). North Pacific Anadromous Fish Comm., Vancouver, BC [Canada]. Bulletin 1 (1998): 396-404.

Williams, J.G., S.G. Smith, and W.D. Muir. 2000. Survival estimates for downstream migrant yearling juvenile salmonids through the Snake and Columbia River hydropower system, 1966 to 1980 and 1993 to 1999. In review: *N. Amer. J. Fish. Manage.*