Endangered Species Act Implementation Plan for the Federal Columbia River Power System

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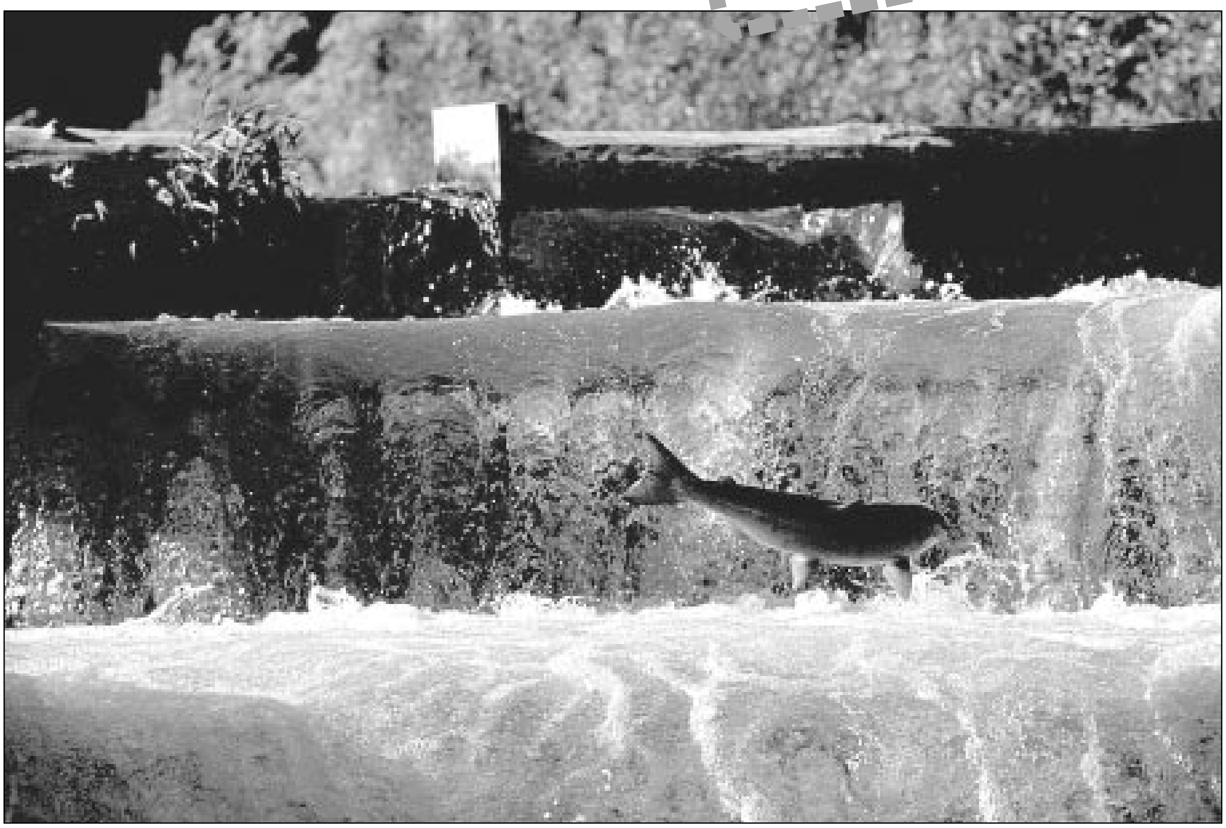

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10 Introduction

The Columbia Basin once teemed with fish. Salmon, steelhead, bull trout, sturgeon, and other fish runs supported body and spirit for the early inhabitants of the Basin. Today, most of these fish are listed under the Endangered Species Act (ESA) and fish recovery has become a legal mandate under numerous laws. One factor in the decline of the fish — but now one partner in their rebuilding and recovery — is the system of dams and reservoirs known as the Federal Columbia River Power System (FCRPS). The FCRPS dams and reservoirs are operated by the U.S. Army Corps of Engineers (COE) and the Bureau of Reclamation (Reclamation). The hydroelectric power production from these dams is marketed by the Bonneville Power Administration (BPA).

Salmon and steelhead recovery in the Basin poses daunting challenges and obstacles. Recovery must address all life stages of these fish — from the headwaters of rivers to the northern reaches of the Pacific Ocean. Recovery must occur over a wide and diverse landscape — from wild mountain streams to the dry sagebrush steppe, from irrigated crop lands to paved urban communities. Recovery must provide for immediate, emergency needs of the fish, but also commitment for the long term. Recovery must operate across multiple jurisdictions — five states, two nations, and numerous Indian tribes. Recovery must meld the needs of anadromous and resident fish, listed and non-listed fish, and hatchery and wild fish. Through all of these challenges, recovery must deal with human actions, yet strive to restore some semblance of the natural conditions and functions that support wild fish.

In full recognition of these challenges, the COE, Reclamation, and BPA (the Action Agencies) have prepared this Implementation Plan (Plan) for the FCRPS. The Plan responds to the December 2000 Biological Opinions (BOs) issued by the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) on the effects to listed species from operations of the hydropower system.[1] It also acknowledges the Action Agencies' responsibilities for fish and water quality protection under the Northwest Power Act and the Clean Water Act, respectively, and their obligations to Indian tribes under law, treaty, and Executive Order.

The Plan is a five-year blueprint that organizes collective fish recovery actions by the three agencies. The Plan looks at the full life cycle of the fish — also known as "gravel to gravel" management or an "All-H" approach (Hydro, Habitat, Hatcheries, and Harvest). However, it describes only commitments

[1] *Recovery actions in the Upper Snake and Willamette Rivers will be addressed in future Implementation Plans.*

connected to the FCRPS, not the obligations of other Federal agencies, states, or private parties. The Plan describes the Action Agencies' Goals; the Performance Standards to gauge results over time; Strategies and Priorities for each H; detailed Five-Year Action Tables for each H (2002–2006); Research, Monitoring, and Evaluation Plan (RM&E); and expectations for Regional Coordination. The Plan will be dynamic, changing over time as information and experience advance. Each year, a Five-Year Plan, an Annual (One-Year Implementation) Plan, and a progress report will be issued. Each year, the Plan will be further refined as results are reported. Future updates to the Five-Year Plan will reflect new information, including recommendations from the fish recovery planning processes.

This Plan serves several important purposes:

- To assign agency **responsibility and accountability** for implementing specific actions identified by the BOs;
- To determine and document recovery **strategies, priorities, actions, and timetables**;
- To identify **performance standards** and to facilitate and measure agency progress toward performance standards;
- To provide a basis for **agency management and progress reporting**, especially in 2003, 2005, and 2008;
- To provide a **dynamic framework** for adapting actions and achieving results over time; and
- To allow Federal, state, tribal, and public **review** of the Action Agencies' plans and achievements.

This Plan is still in preliminary form. It notes a number of areas where information is incomplete, or where work is still underway. A more detailed Annual Plan based on the Five-Year Action Tables, will be available in Fall 2001. Upon release, the Plan and Action Tables for 2002–2006 will be posted on the www.salmonrecovery.gov website.

Once this plan is finalized, the Action Agencies, in coordination with the NMFS and USPWS, will ask for review of the basic plan structure by the Independent Scientific Advisory Board (ISAB).

The Action Agencies' priorities for 2002–2006 emphasize short-term benefits and longer term needs consistent with the provisions of both the NMFS and USFWS BOs.

For anadromous fish, priorities include:

- Adult and juvenile fish passage improvements at dams, including spill and surface bypass.
- Investigation of future flow improvements
- In tributary rivers, enhancement of flows, riparian areas, passage, and screening.
- In the estuary, acquisition, restoration, and evaluation of habitats.
- Completion of sub-basin assessments and plans
- Implementation of Hatchery Genetic Management Plans and hatchery reforms.

For bull trout and sturgeon, priorities include:

- Flows and ramping rates.
- Evaluation of modified flood control operations.
- Spill tests at Libby Dam.

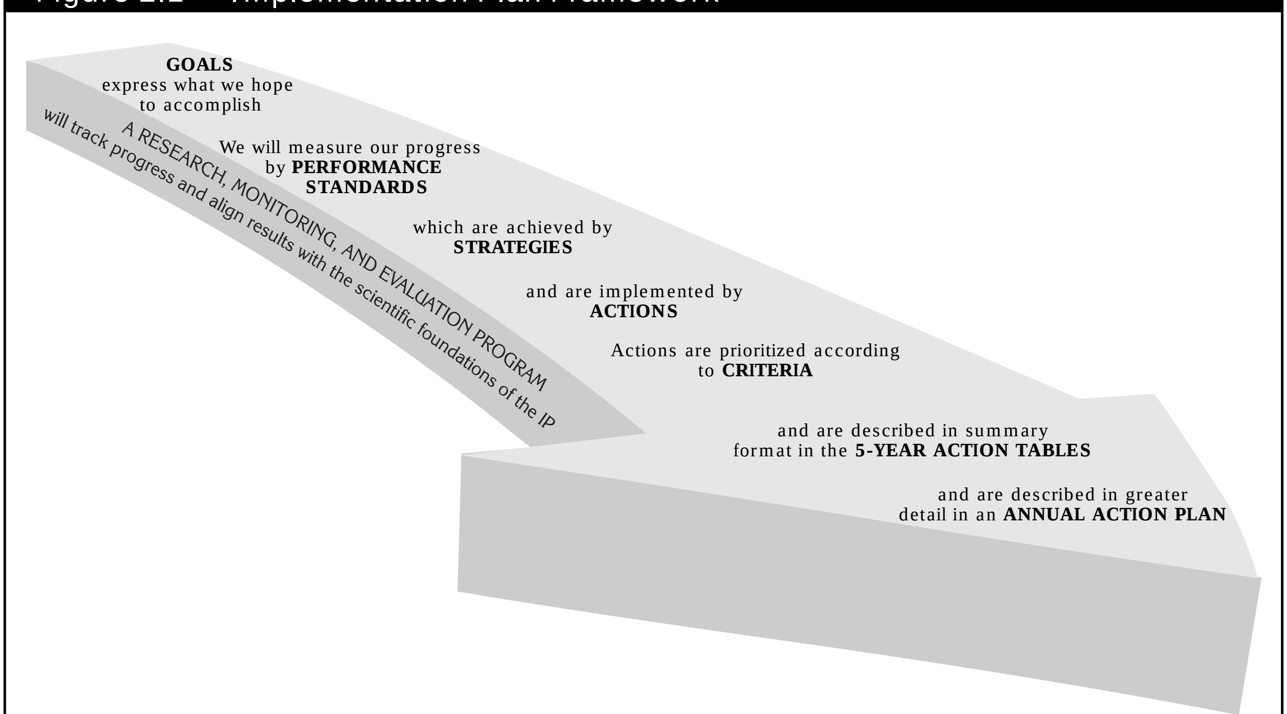
The Action Agencies recognize that effective and timely implementation of this Plan will require help, advice, and support from others throughout the Pacific Northwest. In preparing the Plan, we will work with existing regional processes and forums such as the Regional Forum, Columbia Basin Fish and Wildlife Authority (CBFWA), and the Northwest Power Planning Council (NWPPC).

The Action Agencies look forward to working with the governments and people of the region to upgrade the FCRPS, to protect and enhance fish habitat, to reform hatcheries, and to rebuild harvestable fish runs.

2.0 Implementation Plan Framework

This Plan presents a disciplined, structured approach designed to ensure clear direction, accountability for results, the effective use of Action Agency resources, and adaptive management over time as implementation of actions and studies yields new information about results and resolution of current uncertainties. The Plan focuses on meeting the biological requirements of listed fish, guided by the structure illustrated in Figure 2.1 and described in this section.

Figure 2.1 — Implementation Plan Framework



Goals

The Plan's Goals are essentially a summary of what the Action Agencies want to accomplish, working in combination with other recovery efforts in the Columbia Basin. The Goals are based in large part on various legal obligations, the goals described in several regional plans, and the NMFS and USFWS BOs.

Performance Standards

Performance Standards for salmon and steelhead are linked to the Plan's goals. They provide measures of success for salmon and steelhead at several levels.

Assessments of population targets derived from the NMFS BO help define the **Population Level** *(Tier 1)* **Performance Standards**, which are the responsibility of many parties in the region, not merely the FCRPS and Action Agencies. The NMFS BO also helps to define the **Life-Stage Specific** *(Tier 2)* **Performance Standards** necessary to achieve the population level standards, dividing them into hydro system survival standards and a composite of other survival needs. **H-specific or Physical** *(Tier 3)* **Performance Standards** will describe improvements in biological and environmental conditions.

And finally, **Programmatic** *(Tier 4)* **Performance Standards** will be tracked to see if the goals in the Five-Year Action Tables are met. Performance Standards will be adjusted over time.

Strategies

Strategies explain *how* the Action Agencies propose to achieve Performance Standards. As noted above, the overall strategy relies on a life cycle, or the **All-H Approach**. The Plan also describes Strategies for each H — **Hydro System Improvements**, **Habitat Protection and Enhancement**, **Hatchery and Harvest Reforms**. Over time, specific Strategies for each species ESU will be incorporated into the Five-Year Plan. Strategies may also be adjusted as new data are developed.

Priorities

Within Strategies, Priorities are identified for the next five years. There are more than 200 actions called for in the NMFS and USFWS BOs. Some are specifically targeted for implementation within the next five years because they are:

- expected to result in near-term survival benefits for listed stocks;
- preparations for implementation of additional survival improvement measures; or
- planning, research, and monitoring actions important for implementation and evaluation of progress.

From a practical standpoint, it will not be possible to fully implement all of the remaining actions identified in the BOs in this first five years. For these reasons, the Plan identifies Priorities and considers available science information based on the ability to achieve the survival requirements of listed fish. Priorities within each H, and eventually across all the Hs, will be adjusted over time.

Five-Year Action Tables

Included with this Plan are lists of specific projects the Action Agencies propose to implement over a five-year period, based on the Strategies and Priorities, for Hydro, Habitat, Hatcheries, and Harvest, respectively. All Reasonable and Prudent Alternatives (RPA) and Conservation Measures from the NMFS and USFWS BOs are addressed. Related BO numbers are cross-referenced. High, medium, and low priorities and related timetables are presented. These timetables and priorities match those presented in the NMFS and USFWS BOs. Ongoing actions by the Action Agencies are also included. In time, a Web-based presentation of the Five-Year Action Tables will allow the actions to be sorted a variety of ways: by Action Agency, by sub-basin, by ESU, etc. The Implementation Plan is located at: www.salmonrecovery.gov/biops_implementation.shtml

Detailed Annual Plan

Each year, a more detailed examination of the first year's actions under the Five-Year Action Tables will be prepared. (This year, the draft Annual Plan for 2002 will be available for review in the Fall.)

Research, Monitoring, and Evaluation (RM&E)

Proposals for **RM&E** are linked directly with the Performance Standards, but also will test science assumptions and uncertainties. RM&E will include the quantitative assessment of survival requirements. Emphasis is placed on the application of monitoring and research to update performance standards, confirm the expected results of actions, and reprioritize actions as needed. Additional information on science assessments and uncertainties is drawn and presented from the NMFS and USFWS BO, and from other science modeling and assessments.

Regional Coordination

The Action Agencies will coordinate the Plan with related regional efforts to inform other parties about ESA obligations and specific actions to achieve Performance Standards established in the BOs. The Plan will be shared in a timely manner with related regional processes, including the various teams making up the Regional Forum, the NWPPC, the FCRPS cultural resources mitigation program, and other Tribal, state, and Federal programs.

Appendices

Appendices included for further reference are:

- Appendix A

  Development of Provisional Performance Measures and Standards for Federal Hydrosystem Impacts in the Columbia River Basin (excerpt from Draft Paper by Federal Agency Performance Standards Workgroup)

- Appendix B

  Draft Performance Measures and Standards: Proposed Elements for Assessing Success of Habitat Actions within an All-H Management Plan

- Appendix C

  Summary of Scientific Assessments

- Appendix D

  Five-Year Actions Tables

- Appendix E

  Five-Year Work Plans

In sum, this Plan describes the Action Agencies' programs and how they will meet Performance Standards. It details as specifically as possible, measures, schedules, and responsibilities. Consistent with the NMFS and USFWS BOs, the Plan calls for the development, implementation, and testing of Strategies for each H and for each species/ESU. As the Action Agencies move past the next five years, the emphasis of the Plan is expected to shift from implementation of high-priority actions and comprehensive assessments towards the evaluation of responses to actions, at the life stage level and at the population level.

3.0 Goals

The Strategies and Priorities in Sections 5.0 and 6.0 are designed to achieve our Goals, as measured through the Performance Standards described in Section 4.0, using the RM&E program described in Section 8.0. These sections, along with the NMFS and USFWS BOs, provide the context in which the Five-Year Action Tables are determined. The following Goals are derived from *Conservation of Columbia Basin Fish: Basinwide Salmon Recovery Strategy* (All-H Paper). Because they are Basinwide, they cannot be achieved by the Action Agencies alone.

Goal 1

Avoid jeopardy and assist in meeting recovery standards for Columbia Basin salmon, steelhead, bull trout, sturgeon, and other ESA-listed aquatic species that are affected by the FCRPS.

- Halt declining population trends within 5 to 10 years.
- Establish increasing trends in naturally-sustained fish populations in each sub-region accessible to the fish and for each ESA-listed population within a timeframe determined through recovery planning.
- Maintain and improve the current distribution of fish.
- Conserve genetic diversity and allow natural patterns of genetic exchange to persist.

Goal 2

Conserve critical habitats upon which salmon, steelhead, bull trout, sturgeon, and other listed aquatic species depend, including watershed health.

- Avoid adverse modification of critical habitat for ESA-listed fish, including salmon, steelhead, bull trout, and sturgeon.
- Prevent further degradation of tributary, mainstem, and estuary habitat conditions and water quality.
- Protect existing high-quality habitats.
- Protect and enhance habitats on a priority basis.
- In the long-term, attain state and tribal water quality standards in critical habitats in the Columbia River and Snake River basins.

Goal 3

Assure tribal fishing rights and provide non-tribal fishing opportunities.

- Rebuild 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.

Goal 4

Balance other needs.

- Ensure that salmon, steelhead, sturgeon, and bull trout conservation measures are integrated with the NWPPC Fish and Wildlife Program and balanced with the needs of other native fish and wildlife species.
- Ensure that salmon, steelhead, sturgeon, and bull trout conservation measures are balanced with human needs, including FCRPS project purposes.
- In implementing recovery measures, seek to preserve resources important to maintaining the traditional culture of basin tribes.

The Action Agencies' short-term goals for anadromous and resident fish between 2002 to 2006 are presented in the Five-Year Action Tables and associated work plans. In accordance with the NMFS BO, progress will be assessed in achieving short- and long-term goals in 2003, 2005, and 2008. The Action Agencies will meet the various timelines prescribed for actions in the USFWS BO.

4.0 Performance Standards

Performance Standards are central to this Plan. For the long term, Performance Standards establish the level of improvement needed for survival and recovery in each stage of the salmon and steelhead life cycle. For the short term, Performance Standards provide clear, but flexible objectives for evaluating the success of actions under the BOs.

At present, the Performance Standards apply only to salmon and steelhead. In the future, Performance Standards will be developed for bull trout and white sturgeon as recovery planning for these species progresses. What follows is a summary of the proposed Performance Standards.

The Performance Standards proposed in this Plan are preliminary. For salmon and steelhead, the draft framework developed by the Action and Federal Fisheries Agencies (Appendix A) and the standards presented in the NMFS BO provide the basis for the Action Agencies' Performance Standards. Figure 1a in Appendix A reflects the underlying structure adopted to formulate these Performance Standards. The proposed Performance Standards will no doubt be adjusted and revised as implementation progresses and new information emerges from RM&E. The Action Agencies welcome parties in the region to help build on these Performance Standards.

A RM&E program to measure progress toward, or compliance with, these Performance Standards will be used. The structure of the RM&E program proposed in Section 8.0 is designed to link directly with the Performance Standard framework identified in this section.

A crediting system — tied closely to Performance Standards and to the RM&E program — will keep score on how well mitigation objectives prescribed in the NMFS BO are being met. A relatively simple crediting system that is based primarily on implementing BO actions and physical Performance Measures will be developed in conjunction with NMFS. The crediting system will improve as performance measurement tools are refined through experience and RM&E. In 2003, 2005, and 2008, when progress under the NMFS BO is assessed, the Performance Standards will be the tools for measurement.

Terminology

The term *Performance Standard* is often used in this section to include *Performance Measure* as well. Here is a clarification of the distinction between the terms.

Performance Standard — A *Performance Standard* is a specified goal or target deemed necessary to improve ecosystem function, improve salmon survival, and ultimately result in recovery for listed fish. A Performance Standard can be expressed in terms of an absolute quantitative target, a change in condition from some baseline, or simply verifying the proper implementation of a particular management action.

Performance Measure — A *Performance Measure* is the biological or physical condition or response that is monitored through time. A Performance Measure is either an actual measurement or an estimate of the response of interest. A Performance Measure is the response that is tracked over the course of the RM&E program. It is the pulse that is monitored to assess progress towards or compliance with specified standards. A Performance Standard should have a Performance Measure associated with it.

4.1 — Classes or Tiers of Performance Standards / Measures

Performance Standards and associated Performance Measures can be organized as a hierarchy as shown in Table 4.1, configured to reflect a chain of physical/environmental and biological responses to management actions. Management actions are implemented (Tier 4) to cause changes in physical conditions and/or biological responses (Tier 3), which in turn affect life-stage specific survival (Tier 2) that collectively are reflected as a population response (Tier 1). This Plan proposes that Performance Standards can be identified at each tier to document progress toward recovery.

Table 4.1 — Performance Standards and Performance Measures

Relationship (chain of effects) between management actions and the different response levels (Tiers 1–4) with examples of performance measures.

PERFORMANCE STANDARD HIERARCHY	EXAMPLES OF PERFORMANCE MEASURES
TIER 4 **Management Actions**	• Build surface bypasses • Fence riparian zones • Remove barriers • Complete sub-basin plans
TIER 3 **Performance Measures** (Physical/Environmental Conditions)	• Enumeration of healthy habitat units secured. • Improved measurement of temperature, stream flows, total dissolved gas (TDG) • Improvement in riverine-riparian habitat condition
TIER 3 **Performance Measures** (Biological)	• Egg-fry survival • Dam survival • Distribution/habitat use
TIER 2 **Performance Measures** (Life-Stage Survival)	• Egg-to-smolt survival • Migrant survival
TIER 1 **Performance Measures** (Population Responses)	• Population growth rate • Abundance estimates

4.2 — Tier 1 Population Level Performance Standards

Population-based Performance Standards (Tier 1) are intended to provide long-term measures of success at the level of populations. The NMFS BO focuses on population growth rate (lambda) and spawner abundance estimates as the most useful indicators of population health at this time. Technical Recovery Teams (TRT), established as part of NMFS recovery planning, will be investigating additional parameters as part of their charge.

These population responses are the highest and broadest scale for Performance Standards. They do not readily reflect effects incurred during any particular life stage, or effects of any single management action, or suite of H-specific actions. They do reflect the combined effects of all region-wide human actions and natural processes, in both the freshwater and marine environments. As a consequence, inadequate progress toward meeting population-level Performance Standards may require the *Basinwide Salmon Recovery Strategy* to be reassessed and possibly additional conservation measures identified.

Population Growth Rate as a Performance Standard

The NMFS BO currently focuses on population growth rate (lambda) as the primary Tier 1 Performance Standard and defers to the recovery planning process and TRTs to further develop population-level Performance Standards and Measures over the next three years. The NMFS BO also anticipates updates to the current methods of assessing population growth rates through an ongoing scientific review forum. NMFS will report on this review by March 1, 2005, prior to the first population level check-in assessment. Additional details regarding the methods of testing compliance with population- level Performance Standards also need to be developed beyond the description provided in the NMFS BO. In the interim period, the lambda-based tests proposed by NMFS in the BO will be used as provisional Performance Standards.

Population Abundance as a Performance Standard

In addition to lambda, adult abundance constitutes another type of Tier 1 Performance Standards. As an interim abundance-based Performance Standard, the Action Agencies propose adopting a test described in the NMFS BO for evaluation at the end of five and eight years. According to the test, each ESU and population may not have more than two consecutive years of adult returns below the five-year geometric mean at the date of the BO.

4.3 — Tier 2 Life-Stage Performance Standards

Tier 2 Performance Standards are life-stage specific survival rates. The values for life-stage survivals proposed by the Action Agencies as interim Performance Standards are derived from the NMFS BO. The BO presents survival needs based on H-related categories: one set of absolute survival Performance Standards linked to hydro system actions (Table 4.2) and another set of relative Performance Standards to reflect additional survival required from actions across all the remaining Hs (Table 4.3).

For the hydro system, the NMFS BO identifies FCRPS survival Performance Standards separately for juvenile and adult migration life stages. It is expected to take approximately ten years to fully achieve these Performance Standards.

The NMFS BO also specifies a range of survival improvements needed in all other stages of the life cycle, improvements that would be addressed through a combination of actions by others and by "offsite mitigation" performed by the Action Agencies. However, these values have practical limitations for their use as Tier 2 Performance Standards at this time, particularly because they are not specific to particular life stages.

Additional work on Tier 2 Performance Standards would be helpful to provide better guidance for the Action Agencies' habitat and hatchery investments. As noted in the BO, NMFS intends to refine its analyses by defining and apportioning the composite life-cycle improvements to specific life stages. Further guidance from NMFS about which life stages and/or offsite actions are most likely to help achieve the increases in survival are needed. In the meantime, Tier 2 Performance Standards will have primary value for assessing hydro system survival improvements, but somewhat limited value for directing and gauging the Action Agencies' offsite mitigation efforts. Nevertheless, the Action Agencies hope to see Tier 2 Performance Standards developed so they can be used to gauge the Action Agencies' progress, and progress of other parties in the Basin over time.

Table 4.2 — Tier 2 Hydro System Survival Performance Rates

ESU	ADULT SURVIVAL RATE: FCRPS System	ADULT SURVIVAL RATE: Per FCRPS Project[1]	JUVENILE SURVIVAL RATE: FCRPS In-river Only: System	JUVENILE SURVIVAL RATE: FCRPS In-river Only: Per Project[1]	JUVENILE SURVIVAL RATE: FCRPS COMBINED[2] (Transport + In-river + Differential Mortality of Transported Fish)
Chinook Salmon					
SR Spring/Summer	85.5%	98.1%	49.6%	91.6%	57.6%
SR Fall	74.0%	96.3%	14.3%	78.4%	12.7%
UCR Spring	92.2%	98.1%	66.4%	90.3%	66.4%
UWR	n/a	n/a	n/a	n/a	n/a
LCR	98.1%	98.1%	90.7%	90.7%	90.7%
Steelhead					
SR	80.3%	97.3%	51.6%	92.1%	50.8%
UCR	89.3%	97.3%	67.7%	90.7%	67.7%
MCR	89.3%	97.3%	67.7%	90.7%	67.7%
UWR	n/a	n/a	n/a	n/a	n/a
LCR	97.3%	97.3%	90.8%	90.8%	90.8%
CR Chum Salmon	n/a	n/a	n/a	n/a	n/a
SR Sockeye Salmon	88.7%	98.5%	n/a	n/a	n/a

Source: Adult standards taken from NMFS BO, Table 9.7-2. Juvenile standards taken from Table 9.7-1.

[1] *Per-project in-river survival rate calculated as the xth root of the system in-river survival rate (where x = number of FCRPS projects encountered). They are provided for illustrative purposes only. They are NOT intended to be interpreted as project-specific standards, or to be used in any way to support curtailment of survival improvement measures at an individual project.*

[2] *Values represent averages over the water years and D values in Table 9.7-1.*

Table 4.3 — Tier 2 Estimated Survival

Estimated percentage change (i.e., additional improvement in life-cycle survival) needed to achieve survival and recovery indicator criteria after implementing the hydro survival improvements in the RPA. (A value of 26, for example, indicates that the egg-to-adult survival rate, or any constituent life-stage survival rate, must be multiplied by a factor of 1.26 to meet the indicator criteria.)

SPAWNING AGGREGATION	NEEDED SURVIVAL CHANGE	
	Low	High
Snake River Spring/Summer		
Bear Valley/Elk Creeks	0	0
Imnaha River	26	66
Johnson Creek	0	0
Marsh Creek	0	12
Minam River	0	28
Poverty Flats	0	0
Sulphur Creek	0	5
Snake River Fall Chinook		
Aggregate	0	44
Upper Columbia River Spring		
Wenatchee River	51	178
Snake River Steelhead		
A-run Aggregate	44	214
B-run Aggregate	92	333
Upper Columbia River Steelhead		
Methow River	0	110
Mid-Columbia River Steelhead		
Deschutes River Sum	102	226
Warm Springs NFH Sum	36	36
Umatilla River Sum	27	31
Yakima River Sum	0	0
Columbia River Chum Salmon		
Grays River — West Fork	0	0
Grays River — Mouth to Head	18	18
Hardy Creek	0	0
Crazy Johnson Creek	0	0
Hamilton Creek	36	36
Hamilton Springs	0	0

The values presented in this table are intended to provide perspective and enable NMFS to make a qualitative judgment regarding the potential to improve the productivity of listed ESUs enough to avoid jeopardy. As discussed in the text accompanying this table, the effects of this uncertainty are particularly significant for SR steelhead and UCR chinook and steelhead.

4.4 — Tier 3 Physical and Biological Performance Standards

Tier 3 Performance Standards demonstrate the physical and biological effects of Tier 4 management actions. Cumulatively, these effects contribute to meeting Tier 1 Population and Tier 2 Life-Stage Performance Standards. They are linked to classes of H-specific actions (Table 4.4).

Tier 3 Performance Standards are provisional at this time. The Action Agencies will rely on emerging regional assessments to refine the Performance Standards over the next year. The objective is to identify final Tier 3 Performance Standards that are practical and measurable.

Table 4.4 — Tier 3 Performance Standards

	PHYSICAL	BIOLOGICAL
HYDRO	• BO flow targets (dependent on water conditions). • BO TDG standards.	• FCRPS juvenile and adult survival Performance Standards (see Table 4.2). • System and project survivals preferred by Action Agencies, but project survivals proposed as more general targets by Action Agencies.
HABITAT **tributary** **mainstem** **estuary**	• Progress toward achieving PFCs, using simplified indicators. • This might include enumeration of healthy habitat units secured; improvements in measured temperature, streamflow, sediment; amount of habitat access restored; improvement in riparian/riverine habitat.	• Preliminary biological standards might include habitat use and distribution; fish condition; over-winter survival.
HATCHERY	**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. **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.	**Broodstock** • Local, within-ESU broodstock is used in 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 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. **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 over harvest 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. **Quality and Survival** • The quality and survival of hatchery supplementation fish is increasing.
HARVEST	• Selective harvest techniques implemented and evaluated.	• Increase tributary escapement rate or spawning success for each ESU, as referenced from mouth of the Columbia. • No increase in the rate of incidental take of wild fish, above an acceptable base level.

4.4.1 — Tier 3 Hydro System Standards

Physical Performance Standards

Our physical standards for the hydro system emphasize river flow and dissolved gas. This Plan adopts the mainstem flow targets proposed in the NMFS BO as provisional Performance Standards (Table 4.5 and 4.6). These flow targets are not absolute Performance Standards, because they are not capable of being fully achieved under average and below average water conditions. The Action Agencies recognize the debate regarding permissible dissolved gas saturation levels is unresolved. Therefore, at this juncture the Action Agencies accept the operational guidelines offered in the NMFS BO as interim Performance Standards for managing gas saturation in the FCRPS.

Biological Performance Standards

The Action Agencies recommend applying the FCRPS juvenile and adult survival Performance Standards specified at Tier 2 as interim standards for Tier 3 also. System survivals are preferred for Tier 3 Performance Standards, with project survivals as more general targets.

Table 4.5 — Tier 3 Flow Targets

Proposed Performance Standards for hydro-operations. NMFS BO Table 9.6-1. Seasonal flow objectives and planning dates for the mainstem Columbia and Snake rivers.

	SPRING		SUMMER	
Location	**Dates**	**Objective**	**Dates**	**Objective**
Snake River at Lower Granite Dam	4/03 – 6/20	85 – 100[1]	6/21 – 8/31	50 – 55[1]
Columbia River at McNary Dam[2]	4/10 –6/30	220 – 260[1]	7/01 – 8/31	200
Columbia River at Priest Rapids Dam	4/10 – 6/30	135	n/a	n/a
Columbia River at Bonneville Dam	11/01 – emergence	125 – 160[3]	n/a	n/a

[1] *Objective varies according to water volume forecasts (see below).*

[2] *NMFS is contemplating moving the flow measurement location from McNary Dam to Bonneville or The Dalles dam by creating new objectives for Bonneville Dam (Conservation Recommendation 11.5).*

[3] *Objective varies based on actual and forecasted water conditions.*

Table 4.6 — Tier 3 Spill Levels

Tier 3 Proposed Performance Standards for managing dissolved gas levels in the mainstem Columbia River System. NMFS BO Table 9.6-3. Estimated spill levels and gas caps for FCRPS projects during spring (all) and summer (nontransport projects).

PROJECT[1]	ESTIMATED SPILL LEVEL[2]	HOURS	LIMITING FACTOR
Lower Granite	60 kcfs	6 pm–6 am	gas cap
Little Goose	45 kcfs	6 pm–6 am	gas cap
Lower Monumental	40 kcfs	24 hours	gas cap
Ice Harbor	100 kcfs (night) 45 kcfs (day)	24 hours	nighttime — gas cap daytime — adult passage
McNary	120–150 kcfs	6 pm–6 am	gas cap
John Day	85–160 kcfs/60%[3] (night)	6 pm–6 am[4]	gas cap/percentage
The Dalles	40% of instant flow	24 hours	tailrace flow pattern and survival concerns (ongoing studies)
Bonneville	90–150 kcfs (night) 75 kcfs (day)	24 hours	nighttime — gas cap daytime — adult fallback

[1] Summer spill is curtailed beginning on or about June 20 at the four transport projects (Lower Granite, Little Goose, Lower Monumental, and McNary dams) due to concerns about low in-river survival rates.

[2] Estimated spill levels shown in the table will increase for some projects as spillway deflector optimization measures are implemented.

[3] The TDG cap at John Day Dam is estimated at 85 to 160 kcfs, and the spill cap for tailrace hydraulics is 60 percent. At project flows up to 300 kcfs, spill discharges will be 60 percent of instantaneous project flow. Above 300 kcfs project flow, spill discharges will be at the gas cap (up to the hydraulic limit of the powerhouse).

[4] Spill at John Day Dam will be 7:00 pm to 6:00 am (night) and 6:00 am to 7:00 pm (day) between May 15 and July 31.

4.4.2 — Tier 3 Habitat Standards

Physical Performance Standards

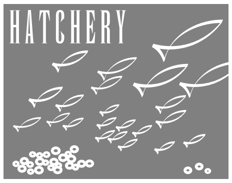
This Plan relies on the concept of Properly Functioning Conditions (PFC) for physical habitat standards. Interim Performance Standards will be based on progress toward achieving PFCs, using simplified indicators. For example, the Action Agencies' provisional physical performance might track enumeration of healthy habitat units secured; improvements in temperature, streamflows, or sediment; or improved riverine habitat conditions at the 2003, 2005, and 2008 check-in points. Until fully developed, the PFC concept will be applied as an interim set of Performance Standards.

Biological Performance Standards

In the short term, habitat standards will consider measurements of biological performance such as habitat use and distribution; fish condition; and over-winter survival. As experience and information improve in the longer term, appropriate Performance Standards might include egg to fry, egg to smolt and prespawn survivals.

Over time, the Action Agencies plan to improve on this admittedly simplified approach, particularly by developing additional physical and biological Performance Standards for the 2005 and 2008 check-in points. The Action Agencies will work closely with the NWPPC's sub-basin planning process and the NMFS recovery planning process to collect physical and biological information, and improve existing models so that the effect of Tier 4 actions can be assessed more accurately. The Action Agencies plan to complete a review and selection of key physical attributes/indicators to be used in concert with (or as part of) the monitoring and evaluation efforts within approximately one year's time.

4.4.3 — Tier 3 Hatchery Performance Standards



Performance Standards for hatcheries take the form of general guidelines and specified quantitative targets shown in Table 4.4. They address important physical standards related to hatcheries, including hatchery planning and using Hatchery Genetic Management Plans and fish marking. Also proposed are biological Performance Standards related to hatcheries, including broodstock selection and use; limits on hatchery fish straying; population thresholds to ensure that hatchery operations do not appreciably slow a listed population from attaining recovery; consideration of harvest effects, so that hatchery fish produced for harvest do not lead to subsequent overharvest of listed stocks; and quality and survival improvements.

4.4.4 — Tier 3 Harvest Performance Standards

The harvest-related Performance Standards specified in Table 4.4 reflect an overall goal to increase the tributary escapement rate or spawning success for all listed ESUs, as gauged from entry at the mouth of the Columbia River. These are the principal Performance Standards the Action Agencies will use to judge the impacts of harvest actions implemented by BPA.

4.5 — Tier 4 Programmatic Performance Standards

Documenting the execution of management actions specified in the NMFS BO and this Plan will form the most immediate test of compliance. In 2003 and again in 2005, the Action Agencies will evaluate whether management actions, including necessary coordination and action development processes, have been implemented as expected.

Tier 4 Performance Standards include the actions and the schedule defined in the BO, as modified by this planning process. Along with certain aspects of Tier 3, these Performance Standards will be a primary means of gauging progress in 2003 and 2005. At this level, the Action Agencies will document the degree to which each action has been implemented. In addition, the cumulative effects of actions, such as miles of stream fenced or numbers of barriers removed or improved, will be summarized.

4.6 — Timing and Performance Standards Refinement

The NMFS BO emphasizes the overarching importance of Tier 1 population-level Performance Standards. These are designed to evaluate and confirm assumptions about population trajectories that are considered in the BO's analysis. They are not designed to evaluate the effects associated with management actions implemented through this Plan in 2005 and 2008, since population-level effects of these actions may not be discernable at the population level until well beyond that time. Intermediate and/or surrogate measures that can be tracked in the near-term are essential for assessing short-term progress. Performance Measures and Performance Standards at Tiers 2 and 3 will eventually fill that need. Responses at those levels are likely to be detected prior to the population responses, since they collectively comprise the population response.

Performance Standards at the Tier 3 and 4 levels will provide the most immediate information regarding the implementation of the NMFS BO. In the very near term, documenting the cumulative extent to which management actions have been implemented will be the most realistic and informative assessment. Preliminary use and testing of Tier 3 Performance Standards will also occur during this time period.

In particular, the time it will take to achieve the various Tier 3 Performance Standards for habitat will vary depending on the nature of the standard and the nature of the management action. Physical standards related to water quality, water volume, or fish access can be measured relatively quickly and simply. Projects restoring channel condition, in contrast, will be more difficult to measure and will take longer to show results. Biological Performance Standards will also require longer periods for assessment. Short-term or transitional levels of performance can be used for these longer term projects pending RM&E results.

Table 4.7 summarizes expectations regarding the utility of Performance Standards over the next ten years.

Table 4.7 — Performance Measures Over Time

Example of temporal responses of various Performance Measures. These are generalized estimates of the time required for various responses to be manifested, following the implementation of some habitat actions.

	SHORT-TERM (<5 YRS)	MID-TERM (5–10 YRS)	LONG-TERM (>10 YRS)
TIER 4 **Management Actions**	• Number and distribution of actions implemented	• Number and distribution of actions implemented	• Number and distribution of actions implemented
TIER 3 **Performance Measures** (Physical/Environmental Conditions)	• Amount of habitat access restored • Number of healthy habitat units secured • Change in TDG • Reduction in surface-water withdrawal • Reduction in road density	• Amount of habitat access restored • Number of healthy habitat units secured • Reductions in TDG • Changes in temperature • Reduction in surface-water withdrawal • Reduction in road density • Reduction in fine sediment recruitment	• Amount of habitat access restored • Number of healthy habitats secured • Reductions in TDG • Changes in temperature • Reduction in surface-water withdrawal • Reduction in road density • Reduction in fine sediment recruitment • Km of streams at or near PFC
TIER 3 **Performance Measures** (Biological)	• Habitat use/distribution • Fish condition • Overwinter survival	• Egg-fry survival • Egg-smolt survival • Prespawn survival	• Egg-fry survival • Egg-smolt survival • Prespawn survival
TIER 2 **Performance Measures** (Life-Stage Survival)	• Juvenile migration	• Egg-smolt survival • Juvenile migration	• Egg-smolt survival • Juvenile migration • Estuary-ocean survival • Adult migration
TIER 1 **Performance Measures** (Population Responses)	• Population distribution • Population growth rate and population abundance per BO's 5-year check-in criteria	• Population distribution • Redd counts • Escapements • Population growth rate and population abundance per BO's 8-year check-in criteria	• Population distribution • Redd counts • Escapements • Population structure • Population growth rate • Population abundance

5.0 Strategies to Achieve Goals and Performance Standards

In order to achieve the Goals and Performance Standards for populations and life stages for habitat, and, ultimately, for harvestable fish runs, Strategies for each H — Hydro, Habitat, Hatcheries, and Harvest are identified. The Strategies and their underlying science rationale are presented in this section.

5.1 — Taking an "All-H" Approach

This Plan is guided by a fundamental strategy — the implementation of recovery actions broadly and comprehensively across all aspects of the salmon life cycle. This All-H approach was the centerpiece of the Federal Caucus' *Basinwide Salmon Recovery Strategy* (Federal Caucus, 2000). This broad strategy is supported by recent scientific reviews (Bevan, et al., 1994; NMFS 1995; NRC 1995; Independent Scientific Group (ISG) 1996) and is consistent with principles in the NWPPC Fish and Wildlife Program and the Tribal Salmon Recovery Plan (CRITFC, 1995). Although these reviews and plans have differed in their emphasis on the approach to recovery deemed most appropriate, they share this common theme — the importance of implementing recovery actions broadly and comprehensively across all aspects of the ecosystem.

Scientific Principles

Because an All-H approach provides the best chance for meeting recovery goals, the scientific principles agreed to by the members of the Federal Caucus are adopted as part of the foundation for this Plan.

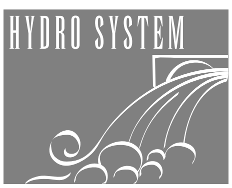
- Conservation of Columbia Basin fish and aquatic species must address all aspects of the ecosystem and the species' life cycle.
- Conservation requires a network of diverse, high quality, interconnected habitats, and high water quality. Natural systems functioning properly are crucial to rebuilding fish populations.
- 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.

- Because human activity, development, and population growth will continue, conservation depends on managing these human impacts to achieve suitable ecosystem conditions for fish.
- 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.

This strategy, and the science that supports it, recognizes that hydro system reforms alone can not and will not recover the widely distributed fish runs at risk in the Columbia Basin. The NMFS BO — and this Plan — therefore rely on measures that extend well beyond the FCRPS. Although the NMFS BO and this Plan rely on a number of improvements in dams and dam operations, they also provide for "off-site mitigation" for Federal hydro system effects — in the form of habitat protections and improvement, hatchery reforms, and support for more selective harvest. Nevertheless, the actions included in this Plan are not a recovery plan in and of themselves. Absent additional improvements by other agencies and entities, recovery will remain elusive.

It is critical that the actions described in this Plan be viewed not in isolation, but rather as key elements of the recovery program. Other entities must do their fair share across the Hs to recover salmon and steelhead. For example, habitat management for Federal lands should provide salmon recovery measures complementary to those funded under this Plan. Similarly, the success of the hatchery reforms initiated under this Plan requires the upgrade of Federal Mitchell Act hatcheries. Harvest management must also do its part by providing for the rebuilding of depleted fish runs, consistent with tribal rights. In the following sections, the additional H-specific Strategies and scientific assumptions used as further guidance to this Plan are summarized.

5.2 — Hydro System Strategies



Our basic Hydro System Strategy is to make operational, and structural fish passage improvements at FCRPS projects to increase the survival of ESA-listed juvenile and adult fish.

More specifically, the primary strategies are to:

- Improve project configuration and operations to increase adult and juvenile survival at dams;
- Improve juvenile survival in reservoirs;
- Improve adult survival;
- Improve water quality.

In addition, a number of related strategies are also included:

- Manage available storage to improve survival in reservoirs and rivers;
- Seek opportunities to acquire additional water for improving fish survival;
- Transport juvenile fish where opportunities for improved survival exists;
- Protect bull trout and sturgeon from adverse effects of hydro system operations through flows and ramping rates;
- Consider and address effects on cultural resources.

In developing the Hydro System Strategy, the Action Agencies were guided by a key scientific principle advanced by both the National Research Council (1995) and the Independent Scientific Group (1996). Specifically, that on a broad scale, river management strategies and mainstem habitat improvements should emphasize re-establishing key functions or functional attributes of a normative river. The Tribal Plan, Spirit of the Salmon (CRITFC, 1995), agrees with this approach, stating that "To support anadromous fish, mainstem habitat must be returned to natural conditions closer to those that existed prior to construction of the dams." In large measure, this principle also underpins the conceptual foundation of the NWPPC's current Fish and Wildlife Program.

The Action Agencies plan to pursue such a comprehensive approach in order to achieve the survival-based Performance Standards for juvenile and adult anadromous fish identified in the NMFS BO.

To succeed, the Hydro System Strategy must be multi-faceted since it must improve:

- Survival through various life stages for different species;
- Stream-type and ocean-type juvenile outmigration;
- Conditions for migrating adults;
- Conditions for fall chinook and chum that spawn in the mainstem of the Columbia or Snake rivers;
- Hydropower operations and configurations to improve water quality.

System and project operations are also included to provide suitable and adequate conditions for spawning, incubation, and rearing in mainstem reservoirs, free-flowing reaches, and in lower reaches of tributaries for chum and fall chinook.

Simultaneously applying and testing these assumptions, the Action Agencies will implement procedures to improve survival of juvenile fish passing dams via reduction of turbine-related mortality through alternative routes of passage such as spill, bypass, and surface bypass. Where effective, structural features at dams will take advantage of the fish's normal behavior. Dam-related projects that are likely to provide for safer passage of fish through turbines will be considered a high priority since fish will continue to pass through turbines regardless of the effectiveness of non-turbine passage alternatives. Hydro system operational strategies will be designed to improve survival of in-river migrants through strategic flow management, through the use of stored water to augment flows to depict a more natural hydrograph, and to improve water quality.

In addition, the Action Agencies will design hydro system methods to reduce juvenile losses to various fish and avian predators during those times or locations where human perturbations have either disadvantaged salmon or favored predators. Operational measures will be implemented to decrease non-native species. Actions will be pursued to enhance mainstem habitat conditions throughout reservoirs and to foster more natural processes and enhance productivity that provides cover to all migrants, better providing for the needs of ocean-type outmigrants during their so-called rearing migration. These improvements to survival of in-river migrants may obviate the need for transportation. However, in the short-term, the Action Agencies will continue transportation until the benefits are exceeded by those of in-river migration. Implementation actions will be subject to in-season management decisions.

This Hydro System Strategy provides a balanced approach to ensure that the needs of adult fish are fully achieved. This is particularly important since emphasis on operations and investments is at present focused on juveniles, yet significant uncertainties exist relative to the health and rigor of returning adults. Adult passage strategies at dams continue to focus on improving the effectiveness of collection facilities and ladders to reduce passage delay, adult fallback, and other conditions that may result in stress, excessive energy expenditures, injury, or other cumulative impacts. Project operations (turbines, spillways) are further designed to enhance effective passage. A more recent focus includes consideration of passage and reconditioning of steelhead kelts to enhance their survival and health for potential repeat spawning.

The Hydro System Strategy also includes a comprehensive research, monitoring, and evaluation program. This RM&E will facilitate learning more about the needs of this complex system and its fish and wildlife, what has been successful, and what approaches need modification. All independent reports that address Columbia Basin salmon recovery emphasize this fundamental RM&E element of recovery efforts (Independent Science Advisory Board (ISAB), 1999).

Underlying Hydro System Assumptions

The identification of actions to achieve these improvements is informed by the following scientific assumptions:

- Passage through non-turbine routes generally provides higher survival than turbines, with spill or surface bypass generally being the most favorable.
- Flow management provides an opportunity to improve conditions for outmigrants, but simple flow-travel time or flow-survival relationships do not adequately capture the complexities.
- Dams contribute to high dissolved gas supersaturation levels that may be detrimental to the health of aquatic fauna.
- Dams may contribute to water temperature variations that may contribute to delays in migration and excessive energy expenditures by adults and reduced survivability of juveniles.
- Native and non-native predators consume significant numbers of juvenile salmonids in reservoirs and near dams.
- Juvenile fish transportation generally results in more returning adults than in-river migration, but it is hotly debated and inconsistent with those who value in-river migration as the primary strategy.
- An unaccounted loss of adults is significant on a system-wide basis, and some FCRPS improvements may substantially increase adult conversions.
- Opportunities to improve mainstem habitat have been largely unexplored, but may provide significant survival benefits to migrating fish and for mainstem spawning.

5.3 — Habitat Strategies (Estuary, Mainstem, and Tributary)

The objective of our Habitat Strategy is to improve survival by protecting and enhancing the structure and function of the aquatic ecosystem. Efforts will focus on incentive-based or voluntary efforts in the estuary, mainstem, and tributary habitats on non-Federal lands. Although not required through the USFWS BO, many habitat projects will also provide benefits for resident species such as bull trout.

The Habitat Strategy is designed to address the habitat objectives of the NMFS BO to:

- Protect existing high quality habitat;
- Enhance degraded habitats on a priority basis and connect them to other functioning habitats;
- Prevent further degradation of tributary and estuary habitats and water quality.

These objectives will be met through the implementation of projects that promote the following functional improvements for tributary, mainstem, and estuary habitats:

Water Quantity — Increase tributary water flows to improve fish spawning, rearing, and migration.

Water Quality — Improve or comply with water quality standards, first in spawning and rearing areas, then in migratory corridors.

Passage and Diversion Improvements — Address in-stream tributary obstructions and diversions that interfere with or harm listed species.

Watershed Health — Manage both riparian and upland habitat, consistent with the needs of the species.

Mainstem Habitat — Improve mainstem habitat on an experimental basis and evaluate the results.

Estuary Improvement — Improve and restore habitat conditions in the Columbia River estuary.

The Habitat Strategy recognizes that various human activities have reduced the production of listed stocks, degraded their spawning and rearing habitat, and affected downstream habitat conditions (National Research Council, 1996; Independent Scientific Review Group, 1996). Nevertheless, the Action Agencies concur with the proposition of the USFS/ BLM (1997) that "Although much of the native ecosystem has been altered, core areas remain for rebuilding and maintaining functional native aquatic ecosystems." These areas exist in estuary, mainstem, and tributary habitats and efforts to improve habitat quality must be distributed geographically in order to achieve connectivity.

In their work developing a general protocol for restoration of an entire river basin, Stanford, et. al., (1996) observe that "Rivers cannot be separated in theory or practice from the lands they drain." The Action Agencies agree with this view and this viewpoint has informed the decision to develop a multi-faceted strategy for meeting the implementation of a variety of types of projects important to estuary, mainstem, and tributary habitats. Target areas include important headwaters, diverse riparian areas, biotic refuges, and biological "hot spots." For disturbed areas within each habitat zone, habitat protection and enhancement projects will focus on water quality and quantity, connectivity, riverine-riparian habitat diversity, channel condition and dynamics, and watershed condition.

The Habitat Strategy is designed to be preventative as well as curative and will support projects that protect good habitat, improve habitat carrying capacity and complexity, and increase the survival of listed anadromous and resident fish. These projects will be implemented using Federally appropriated funds and BPA ratepayer funds, will focus on protecting and rehabilitating ecologically healthy areas on private lands, and will take advantage of time-sensitive opportunities.

The Habitat Strategy will emphasize both long- and short-term approaches. Immediate or short-term projects that produce near-term biological and physical benefits will be supported — such as improving and securing additional estuary, mainstem, and tributary habitat; improving water quality, including reduction of sediment loads and temperature; increasing tributary flows; screening water diversions; addressing passage obstructions; preserving productive habitat; and, enhancing degraded habitats connected to viable habitat. For example, one strategy for reducing unnatural bank erosion and enhancing natural channel within the estuary is to reconnect alcoves, sloughs, and side channels to the mainstem; and, provide sufficient streamflow within the tributaries.

By 2003, the sub-basin plans now being developed by the NWPPC for the 16 priority sub-basins will be completed, with the balance to be completed by 2006. The sub-basin plans provide the framework critical to the development and success of the Habitat Strategy because they provide the ecological context for project identification. As the related recovery plans of the regulatory agencies become available, they too can inform the long-term Habitat Strategy of this Plan.

Washington, Oregon, Idaho, and Montana have begun work with the EPA on establishing Total Daily Maximum Loads (TMDLs). The Action Agencies will support development of TMDLs by sharing water quality information and will help to coordinate TMDL work with the sub-basin planning process.

Because the Action Agencies are relying on ecosystem principles, the methods to recover salmon and steelhead habitats should also have benefits for native resident fish, other aquatic species, and water quality.

The Habitat Strategy also includes a comprehensive RM&E program. This RM&E program will facilitate learning more about the effects of habitat improvements on fish and wildlife, what has been successful, and where approaches need modification. All independent reports that address Columbia Basin salmon recovery emphasize the fundamental importance of monitoring and evaluation to recovery efforts (ISAB, 1999).

Underlying Habitat Assumptions

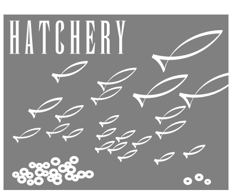
The development of the Habitat Strategy was guided by several broadly accepted assumptions identified by the Independent Science Advisory Board (ISAB) to the NWPPC. In the ISAB's Common Ground report (ISAB, 1999), which compares five recent reports pertaining to salmon recovery in the Columbia River Basin, the ISAB finds that all the reports "affirmed that maintenance and restoration of ecosystem processes and conditions are necessary to achieve restoration goals in the Columbia River Basin."[2]

In particular, the consensus of the reports on the following assumptions underpins the Habitat Strategy:

- Addressing water-related issues is likely to produce the most rapid measurable habitat and population responses.
- Reliance on ecosystem principles should form the basis for salmon recovery and these principles should be implemented through adaptive management.
- Integrated ecosystem approaches to habitat rehabilitation will require action on both public and private lands, and among all types of land uses.
- Ecosystem processes requiring protection include: riparian features and processes, large woody debris recruitment, water quality, natural sedimentation rates, floods and other natural disturbance regimes, adequate stream flows, upland (watershed) processes.
- Core or reserve areas that currently maintain strong populations of salmon and trout are of particular ecological importance and should be protected and reconnected with one another to the extent possible.

[2] *"Restoration" is defined by the Action Agencies as a process that involves management decisions and manipulation to enhance the rate of recovery (after Davis et al. 1984). The goal of restoration should be to reestablish an ecosystem's ability to maintain its function and organization without continued human intervention. It does not mandate returning to some arbitrary prior state. Indeed, restoration to a previous condition often is impossible or even ecologically undesirable.*

5.4 — Hatchery Strategies



Our Hatchery Strategy reflects care in the use of existing hatcheries and new *safety net* programs to avoid extinction.

The strategy has three parts:

- Implement hatchery reforms to reduce or eliminate potentially harmful effects of artificial production on ESA-listed populations;
- Use a safety net program on an interim basis to avoid extinction while other recovery actions take place; and
- Use hatcheries in a variety of ways and places to conserve listed populations, to aid recovery of listed populations, and to address mitigation mandates, especially tribal fishing needs.

The overall 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 in conservation and recovery. The goal includes providing fishery benefits to achieve mitigation mandates and meet obligations to tribes, but now must also include an increased emphasis on conservation and recovery, a mission for which many older hatchery programs were not designed.

The document guiding reform of each facility is a Hatchery and Genetic Management Plan (HGMP). At the regional level, the NMFS and USFWS BOs and the NWPPC's Artificial Production Review (NWPPC, 1999) all require or recommend HGMPs to address hatchery reform and supplementation issues. Other reports, such as *Wild Salmon Forever: A Citizens' Strategy to Restore Northwest Salmon and Watersheds* (Save Our Wild Salmon Coalition, 1994), also recognize the need for hatchery reform and the need for new conservation hatcheries to aid in salmon recovery.

Using the HGMP, additional guidance to be provided by NMFS, and following the sequential priorities contained in the NMFS BO, the Action Agencies will fund the development of original and/or updated HGMPs for Federally funded hatcheries in the Columbia Basin and have all completed by the 2003 check-in point. Upon approval of the HGMPs by NMFS and/or USFWS, the Action Agencies, in concert with funding from Congressional appropriations and other sources, will fund implementation of reforms and associated RM&E activities as identified in the approved HGMPs. Reforms will start at those facilities affecting the most at-risk species. HGMPs will evolve over time, informed by new information made available by sub-basin and recovery planning and/or as developed through additional genetic sampling and other RM&E programs.

The Action Agencies will pursue implementation of artificial production safety-net programs to prevent extinction of ESA-listed salmon and steelhead, and implement a suitable hatchery program for sturgeon. In April 2001, BPA began the procurement process to fund the four-step safety-net planning process for the ten salmon and steelhead populations listed in the NMFS BO. Due to the urgency of the safety-net program the Action Agencies will fund as quickly as possible the programs that are approved through the four-step process.

In addition, the Action Agencies will fund development of a comprehensive marking strategy for hatchery fish to make it possible to distinguish between natural and hatchery fish on the spawning grounds, in dam counts, and in fisheries. In April 2001, BPA began the funding process for the marking of all unmarked spring chinook salmon at the Leavenworth National Fish Hatchery. Following the development of the regionally coordinated, comprehensive marking plan, the Action Agencies will provide funding for the implementation of their share of the marking program.

Underlying Hatchery Assumptions

A significant amount of uncertainty surrounds the issue of artificial production, including the extent and nature of its risks and its potential benefits as a conservation and recovery tool. Accordingly, the Action Agencies will apply an adaptive management approach designed to reduce these uncertainties, with particular emphasis on the use of HGMPs and learning more about the effects of hatchery production. A comprehensive RM&E program will address the effects of hatcheries on natural production and the relative effectiveness of hatchery production spawners.

The Hatchery Strategy was developed based on the following assumptions:

- Artificial production may pose significant ecological and genetic risks to naturally produced salmonid populations.
- Using proper management techniques and operational protocols as defined by approved HGMPs to control deleterious effects, artificial production, due to its survival advantages, can provide a net benefit to depressed stocks.
- Artificial production can be used to seed barren habitat and/or help speed rebuilding of seriously depressed populations to carrying capacity.

5.5 — Harvest Strategies

The Action Agencies do not have a primary role in harvest management. General strategies for harvest, as reflected in the All-H Paper, are to prevent over-harvest, provide for sustainable fisheries, increase harvest selectivity, and increase escapement rates.

Our Harvest Strategy has three areas of emphasis:

- Develop selective/terminal fisheries to reduce harvest-related mortality on ESA-listed species;
- Support research to improve harvest management assessments, decisions, and evaluations;
- Support sustainable fisheries for the meaningful exercise of tribal fishing rights and non-tribal fishing opportunities consistent with the recovery effort.

The Harvest Strategy seeks to improve adult life-stage survival by pursuing actions that reduce harvest impacts on listed fish while maintaining and improving fisheries where appropriate. Following the recommendations contained in the NMFS BO, the Action Agencies will support development of selective fisheries with the goal to reduce impacts on ESA-listed stocks and increase escapement to spawning grounds. Terminal fishery development has similar potential for reducing harvest impacts on listed ESUs. This is consistent with the concept in fisheries management that with adequate spawning and rearing habitat coupled with increasing the size and number of spawning populations will, on average, increase the abundance of salmon (NRC, 1996; Hillborn, 1992; Ricker, 1973). Development and implementation of effective selective fisheries serves a dual role to: (1) reduce take of listed ESUs; and (2) enable harvest of abundant stocks where there is surplus production above minimum spawning population requirements and diversity necessary to contribute to recovery. As such, selective fisheries enhance the opportunity for increasing escapement while providing additional benefit to fisheries.

In the short-term (one to three years), selective fisheries development actions will be pursued to focus upon gear efficacy and short-term mortality assessment. Development and implementation of a plan for harvest research that includes assessing the impact that live catch gear and methods have on spawning success will also be put in place. As new information is learned, field application and ultimate fishery integration of such pilot projects is the objective of the Harvest Strategy.

Because the Action Agencies do not have any harvest management authority, it is imperative to collaborate with the appropriate state, tribal, and Federal authorities to develop and implement the appropriate implementation strategies. Success in harvest actions depends upon collaboration and cooperation with outside parties.

The ability to separate populations in fisheries is critically important when managers wish to minimize harvest impacts on specific populations (NRC, 1996 p. 255; NWPPC §8.3B). Mark-selective live capture fisheries are a potential means to separate and selectively harvest populations. For example, live capture gears and methods have reduced short-term, post-release mortality of incidentally caught coho from the standard 60 percent to as low as 5 percent when tested by Canadian gillnetters under research conditions (DFO 2001, p. 5). Some of these gears and methods will be adapted and tested on the Columbia River beginning in 2001, and others will be added in subsequent years.

Terminal fisheries are another means to selectively harvest populations (NRC, 1996, p. 249). The NMFS BO recognizes the benefit of shifting harvest efforts away from non-selective mixed stock fisheries in the ocean and mainstem and toward

Underlying Harvest Assumptions

While acknowledging the Action Agencies' limited role in harvest management and the reliance of the Harvest Strategy on collaboration with the states, tribes and Federal resource agencies, the Action Agencies have developed a Harvest Strategy based on the following assumptions:

- Selective fisheries, if implemented, have the potential to decrease harvest impacts on listed fish and/or allow greater harvest of healthier stocks.
- Mortality rates on fish released from live-capture gear can be determined and held within acceptable levels.
- Data collection and fishery assessment tools can be modified and/or enhanced to maintain or improve the effectiveness of harvest management.

known stock terminal fisheries in tributaries. When fishing occurs on a mixture of populations with different stock-recruitment functions, the less-productive components are easily and typically over-harvested (NRC, 1996; Ricker, 1958; m, 1973; Hillborn, 1985). Terminal fisheries have been created in the lower Columbia River, and other opportunities will be sought.

The technology for understanding, enumerating, predicting, and managing salmon runs must be improved. A few of these needs stem from increased reliance on selective fisheries. The NRC (1996) identified many critical gaps in knowledge, many of which are relevant to escapement management. Fundamental to this issue is that regardless of the theoretical modeling approach employed for data analysis and run prediction, basic data collection will always be a critical component of the salmon management process (Knudsen, 2000). Many existing programs are reflective of non-selective fishing regimes. The Action Agencies will support and contribute to the region's development of a selective fisheries, and modification of many current data collection and analysis tools, recognizing that management decisions require a better information base. This will be an important consideration as the Action Agencies sponsor research and implement selective fisheries in the Columbia Basin.

6.0 Priorities

There are many reasons to prioritize actions to implement the Strategies described in Section 5. These include limitations in time and resources, the need to demonstrate progress and achieve Performance Standards, the need to address critical uncertainties and test key assumptions, and the need to evaluate expected effects of actions on fish survival. From a practical standpoint, it will not be possible to immediately and simultaneously implement the over 200 actions identified in the NMFS and USFWS BOs. Furthermore, from a planning standpoint, because some actions must be informed by, and therefore follow other actions, the sequence in which the actions are implemented will contribute to their effectiveness. For these reasons, the Plan identifies priority management and research actions on the basis of their ability to achieve the survival requirements of each species/ESU.

6.1 — General Criteria

The Priorities identified in this Plan reflect specific initiatives or projects called for in the NMFS and USFWS BOs as near-term actions. These actions fall in to one or more of several important categories: (1) early-action opportunities with clear potential survival benefits to listed stocks; (2) preliminary work in preparation for implementation of such actions; and (3) RM&E actions that address key uncertainties.

The Action Agencies acknowledge that achieving the Performance Standards of the NMFS BO and the steps necessary to achieve these standards are central to avoiding jeopardy to listed anadromous species. The Action Agencies also acknowledge that the list of actions in the NMFS BO is a first cut at the actions needed to achieve the standards. As more information becomes available through implementation and through RM&E, it is anticipated that the Priorities will be revised. There will be a continuous review of the effectiveness of projects so that the Action Agencies may modify, add, or delete projects as more information is learned. Any changes will be reflected in future Plans. To ensure relevance to the goals of the Plan, the Action Agencies propose general implementation priority criteria consistent with the NMFS and USFWS BOs for assessing priority actions.

Implementation Priority Criteria

1. Does the action(s) provide measurable survival or production benefits to listed stocks that are immediate or significant or is it a necessary precursor to such actions?
2. Does the project affect listed stocks that the science analysis shows need the most improvement in survival?
3. Can the project provide broad ecological benefits to multiple life stages, species, stocks, or ESUs of listed species?
4. Does the project reduce critical uncertainties or provide information needed to support adaptive management, accountability, or crediting for listed species?
5. Does the project support efficient and feasible implementation of projects furthering the de-listing of listed species?
6. Does the project build on or complement ongoing, beneficial actions that support de-listing of listed species?

These general criteria have been further translated into priority criteria specific to each H. For Hydropower and Hatcheries, criteria for determining priorities have been derived from existing regional processes. For Hydropower, the criteria would build on the work of interagency workgroups such as the System Configuration Team. For Hatcheries, the criteria will be developed through the safety-net program and HGMPs that take into account, among other things, extinction risk, survival improvements necessary to achieve conservation and recovery, and practical and fiscal feasibility issues. The priority criteria for Habitat and Harvest have been derived from a number of regional efforts, such as the NWPPC's Provincial Reviews and the All-H Paper, but reflect more original work by the Action Agencies.

The Action Agencies acknowledge that implementation of the RPAs is central to avoiding jeopardy. Nevertheless, the use of priority criteria can assist public oversight and agency management, particularly in light of the large number of NMFS and USFWS BO actions, the complexity of the issues, and the varying degrees of uncertainty surrounding project outcomes. The Action Agencies have applied the criteria as the basis of a simple system for ranking projects — using high, medium, and low rankings. However, this first Five-Year Plan does not propose to alter the schedule or composition of any RPA actions specified in the BOs because they scheduled actions with similar priority consideration in mind. Future Five-Year Plans may propose some modifications, which will be explained in relation to the BOs.

The ranking of actions as high, medium, or low will assist the Action Agencies in two ways. First, particularly where dates or schedules are not included in the BOs, it will help determine the sequence in which the actions will be most effectively implemented. The goal here is to achieve the greatest gains in survival, as quickly as possible while acknowledging that unlimited resources are not available to the Action Agencies. For example, actions that can be quickly implemented, can be accomplished with available resources, and that provide a significant and measurable survival benefit would be implemented first. Actions whose survival benefits for listed species are less certain or which may take longer to implement or require larger capital costs would be assigned a lower priority. Second, while this Plan only looks at priorities *within* each H, the Action Agencies intend to expand the use of priority setting over time, in conjunction with Performance Standards, so that priorities *across* Hs can be considered. Thus, this simple typology will facilitate determining the most effective sequence for initiating projects over the first few years of the Plan, and then facilitate priority setting over the rest of the Plan and the second Five-Year Plan. Research and Monitoring Priorities are discussed in Section 8.0 of this document.

Relationship to NWPPC Processes and Funding

For BPA-sponsored actions, priority criteria will be applied to projects and proposals in conjunction with the NWPPC Fish and Wildlife Program. In 2001, this will include, for example, solicitations for High Priority Projects, Innovative Projects, and Power Emergency Projects — all designed to elicit projects with immediate benefits for ESA-listed fish.

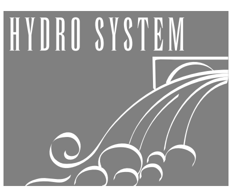
To the extent possible, BPA will try to mesh its ESA-project solicitations with the rolling Provincial Review process developed by the NWPPC, in response to recommendations by the Independent Scientific Review Panel (ISRP) and the Columbia Basin Fish and Wildlife Authority (CBFWA). Although a continuing process, the Provincial Reviews focus on different geographic areas over a three-year cycle. Because the Action Agencies will be initiating priority projects in the first year Plan that are outside of the geographic scope of the current Provincial Review process, BPA will use targeted solicitations to fill any gaps. However, after the first few years of Implementation Plans, it is anticipated that the process of prioritizing and selecting projects will be synchronized with the Provincial Review process.

Please note that development of the One-Year Implementation Plan for 2002 will differ from subsequent plans. Specifically, it includes projects initiated prior to the completion of the BO that are underway through the CRFM and NWPPC Fish and Wildlife Program and are already addressing actions identified in the RPAs. There appears little utility in re-routing such projects through the priority identification process for new projects described above, since they were previously vetted within the NWPPC process, were identified as priorities and funded, and are already on-going. The prioritization of new projects will be coordinated with the NWPPC to enable a single review to take place, with projects being considered and recommended to BPA for funding for both Northwest Power Act and ESA objectives.

In the intermediate period (the next two to three years), the ongoing NWPPC Provincial Reviews, the various watershed planning efforts of Federal land management agencies, states and tribes, the BO's and the Federal Caucus' All-H Paper provide important information that will be used in the prioritization of actions. In the longer term, the Action Agencies expect information from the ESA Technical Recovery Teams and the NWPPC Sub-basin Plans to provide species/ESU and sub-basin specific information critical to the identification and prioritization of actions.

In sum, additional information will become available over time from the various assessment efforts, and it is important to review the prioritization and implementation of actions using the best available information. Until this is possible, the Action Agencies intend to move forward using the general prioritization criteria outlined above with some modifications specific to individual Hs and RM&Es. The prioritization criteria and procedures will be updated and modified as more information becomes available from these ongoing forums, and as critical research and monitoring studies are completed.

6.2 — Hydro System Priorities Criteria



Hydro system actions that effect listed anadromous fish are considered using the Action Agencies' general priority criteria, and further evaluated under the following additional criteria. These Hydro Priority criteria will be applied within each of the four major hydro system components: system configuration, water management, water quality, and fish facilities operation and maintenance.

It is not the intent of this Plan to prioritize actions that benefit salmon over bull trout or white sturgeon. The recommendations of the FWS BO are fewer in number, are more localized, and seldom require trade-offs. The intent of this Plan is to implement these actions.

CRITERION 1 — Stock Status

Actions to benefit stocks with lowest populations and the highest rate of required population growth to avoid jeopardy have high relative priority. For example, upper Columbia spring chinook and steelhead need a high rate of improvement. Actions to help these fish could occur in the middle and lower Columbia River as juveniles of these stocks pass through these geographic areas. Actions that would improve juvenile passage survival, reservoir survival, or adult passage in the middle and lower Columbia River, would be beneficial to upper Columbia River stocks and therefore receive special attention.

CRITERION 2 — System Survival

Ultimately, the Action Agencies are seeking overall improved survival of juvenile and adult fish through the hydro corridor. Consequently, attention is given to those actions that have the highest estimated or potential improvement to the most fish and to the most ESUs within the hydro corridor.

CRITERION 3 — Dam Passage Survival

The best available information indicates that the lowest survival percentages consistently occur at Bonneville, The Dalles, and Lower Monumental dams. Actions to improve survival at these dams are of higher priority than dams that already have relatively high passage survival.

CRITERION 4 — Reservoir Passage Survival

Priority will be given to actions that target reservoirs determined to have the lowest rates of juvenile survival. For example, data consistently show the lowest reservoir survival rates occur in the pool between McNary and John Day dams. John Day reservoir survival improvement actions (e.g. predator control) are relatively high in priority. Also, predation is high in Lower Granite pool for summer migrants and fall chinook.

The System Configuration Team annually prioritizes hydro system configuration actions. The priority system described for configuration is thus more refined than those for the other hydro system components. The Action Agencies are working on comparable methods to set priorities for water management, water quality and operations and maintenance. More developed priority systems for these components will be developed in cooperation with the Regional Forum this summer and addressed in the final Plan this fall.

> **Immediate Hydro System Priorities (2002–2006)**
>
> For anadromous fish, the immediate Hydro System Priorities include adult and juvenile passage improvements at individual dams, including spill, surface bypass development, and the specific upgrades. Potential flow improvements will be explored, including additional Canadian water and a flood control evaluation. The Action Agencies will continue to spread the risk approach to fish transportation and conduct needed transport studies. The Action Agencies will implement measures to improve water quality (temperature and dissolved gas) and develop a Water Quality Improvement Plan. The Action Agencies will also develop and implement monitoring and evaluation plans and conduct advance planning for possible future actions.
>
> For resident fish, the 2002–2006 hydro priorities include completing the EIS on VARQ flood control operations, completing spill tests at Libby Dam, and conducting studies.

6.2.1 — System Configuration Priorities

Much attention has been given over the last decade to improving juvenile and adult passage through the complex hydro system facilities. Enhanced turbine designs, fish by-pass systems, and enhanced system operations today enable 27 percent to 50 percent of Snake River spring/summer chinook salmon and steelhead smolts to survive in-river migration through the hydro system, as compared with an estimated survival rate of 5 percent to 40 percent in the 1970s.

Most of the physical improvements to the dams and their associated fish facilities have been made through a program referred to as the Columbia River Fish Mitigation (CRFM) Program. Congressional appropriations are approved each year through the Congressional budget cycle and vary from year to year. Each fall, after the appropriations are enacted, a committee known as the System Configuration Team (SCT), made up of state, tribal, and Federal representatives, makes recommendations regarding priorities of projects proposed for funding.

Physical improvements to hydroelectric facilities at non-CRFM projects are also recommended in the both the NMFS and USFWS BOs. These improvements will be implemented by Reclamation at their projects and by the COE at non-CRFM dams such as Libby, Dworshak, and Chief Joseph. Decisions for these projects are made in a different manner than for CRFM projects. The priority approach described below does not incorporate these recommended improvements. However, these projects will be included before the Plan is finalized this fall.

The Action Agencies propose several adjustments to the priority-setting approach in an effort to achieve the Performance Standards required by the NMFS BO. The proposed approach looks across multiple fiscal years and favors projects that have the greatest survival benefits for listed fish. However, the SCT will continue to play a crucial role in vetting and recommending project priorities.

Our proposed priority system for system configuration actions is illustrated in Table 6.1. The Action Agencies have not yet assigned configuration project priorities in this Plan. The Action Agencies intend to discuss this proposed priority-setting method and process with the SCT, and expect to include priorities discussed with the SCT in the final Plan.

Table 6.1 — BO Configuration Priorities for Salmon and Steelhead

Based on NMFS BO priorities and potentially most significant improvement and/or research information needs

PRIORITY LEVEL	DESCRIPTION
H	2003 check-in items from the NMFS BO.
H/M	Juvenile studies and improvements for Bonneville, The Dalles, Lower Monumental or other high potential juvenile passage improvements not already included above. Key system evaluations (such as "D" value, multiple bypass mortality) not already included above. Most significant adult passage facility issues (fallback, ladder temperature, holding) not already included above.
M	Juvenile studies and improvements with moderate potential survival benefits. Potentially significant adult passage facility issues. Adult migration /unaccounted loss/ spawning success studies. Higher risk adult passage reliability issues.
L/M	Less significant juvenile and adult evaluations and improvements. Lower risk adult facility reliability issue.
L	Other measures.

6.2.2 — Water Management Priorities

The Action Agencies jointly manage the FCRPS for multiple purposes, including fish recovery, power production, irrigation, recreation, flood control, and navigation. The NMFS and USFWS BOs recommend water operations to avoid jeopardy to listed fish.

Each year, the Action Agencies manage a varying amount of water that enters the FCRPS as precipitation runoff and melting snowpack. Water management operations impact the fish species in the following ways: (1) spill is provided for juvenile fish passage at the downstream run-of-river dams; (2) water is released from the storage reservoirs to provide migration flows; (3) water is released from storage reservoirs to maintain water over spawning beds in the mainstem Columbia; (4) water is released from storage reservoirs to maintain minimum daily flows required by bull trout and white sturgeon; and (5) water is released to enhance water quality.

Currently a Technical Management Team (TMT) makes seasonal water management recommendations to the Action Agencies. Disputes and policy matters may be referred to the Implementation Team (IT) and Regional Executives for further deliberation. One value of the TMT and IT is to inform the Action Agencies of differing views and potential impacts, even if consensus cannot be achieved.

As shown on Table 6.2, water management decisions involve critical trade-offs between the needs of both listed fish species and other legislated purposes of the FCRPS. The contributions of the Federal storage projects to the needs of listed fish in the Columbia Basin are illustrated in the upper portion of the table. The bottom portion of the table identifies a number of other issues and authorized uses that will need to be considered and deliberated by the Action Agencies when making water management decisions. It should be noted that some of the lower group of considerations are secondary concerns and are not tradeoffs against meeting the objectives of the BO.

Table 6.2 — Water Management Priorities

ESU CONSIDERATIONS*

STORAGE DAMS

	GRAND COULEE FALL	GRAND COULEE SPRING	GRAND COULEE SUMMER	LIBBY FALL	LIBBY SPRING	LIBBY SUMMER	HUNGRY HORSE FALL	HUNGRY HORSE SPRING	HUNGRY HORSE SUMMER	DWORSHAK FALL	DWORSHAK SPRING	DWORSHAK SUMMER
Snake River Steelhead Flows	None	Strong	None	None	Strong	None	None	Strong	None	Minor	Minor	Strong
Upper Columbia River Chinook Flow	Minor	Strong	Strong	Minor	Strong	Strong	Minor	Strong	Strong	None	None	None
Upper Columbia River Steelhead Flows	Minor	Strong	Strong	Minor	Strong	Strong	Minor	Strong	Strong	None	None	None
Mid-Columbia River Steelhead Flows	Minor	Strong	Strong	Minor	Strong	Strong	Minor	Strong	Strong	Minor	Minor	Strong
Snake River Fall Chinook	None	None	Strong	None	None	Strong	None	None	Strong	Strong	Strong	Strong
Snake River Spring Chinook	None	Strong	None	None	Strong	None	None	Strong	None	Minor	Minor	Strong
Snake River Summer Chinook	None	Strong	Strong	None	Strong	Strong	None	Strong	Strong	Strong	Strong	Strong
Columbia River Chum	Strong	Minor	None	Strong	Minor	None	Minor	Minor	None	Strong	Minor	None
Bull trout Flows	None	None	None	Strong	Strong	Strong	Strong	Strong	Strong	Strong	Strong	Strong
White Sturgeon Flows	None	None	None	None	Strong	Strong	None	None	None	None	None	None

* ESU's listed by lambda rating (worst to best)

LEGEND

- **Strong Connection**
- **Minor Connection**
- **No Connection**

OTHER CONSIDERATIONS

STORAGE DAMS

	GRAND COULEE FALL	GRAND COULEE SPRING	GRAND COULEE SUMMER	LIBBY FALL	LIBBY SPRING	LIBBY SUMMER	HUNGRY HORSE FALL	HUNGRY HORSE SPRING	HUNGRY HORSE SUMMER	DWORSHAK FALL	DWORSHAK SPRING	DWORSHAK SUMMER
Benefits Water Quality — Dissolved Gas	None	None	None	None	None	None	None	None	None	None	None	None
Benefits Water Quality — Water Temperature	None	None	None	Connection	Connection	Connection	Connection	Connection	Connection	None	Connection	Connection
Cultural Resources	Connection	Connection	Connection	Connection	Connection	Connection	Connection	Connection	Connection	Connection	Connection	Connection
Ferry Operation (Inchelium)	Connection	Connection	None	None	None	None	None	None	None	None	None	None
Boating Access for recreation	Connection	Connection	Connection	Connection	Connection	Connection	Connection	Connection	Connection	Connection	Connection	Connection
Irrigation Deliveries	Connection	Connection	Connection	None	None	None	None	None	None	None	None	None
System Flood Control	None	Connection	None	None	Connection	None	None	Connection	None	None	Connection	None
Local Flood Control	None	None	None	Connection	Connection	None	Connection	Connection	None	Connection	Connection	None
Vernita Bar (Spawning, Emergence)	Connection	Connection	Connection	Connection	Connection	Connection	Connection	Connection	Connection	None	None	None
Canadian Fish and Wildlife Impacts	None	None	None	Connection	Connection	Connection	None	None	None	None	None	None
Kootenay Lake Impacts	None	None	None	Connection	Connection	Connection	None	None	None	None	None	None
Flathead Lake Impacts	None	None	None	None	None	None	Connection	Connection	Connection	None	None	None
Resident Fish	Connection	Connection	Connection	Connection	Connection	Connection	Connection	Connection	Connection	Connection	Connection	Connection
Non-Listed Anadromous Fish	Connection	Connection	Connection	None	Connection	Connection	None	Connection	Connection	None	Connection	Connection

LEGEND

- **Connection**
- **No Connection**

Table 6.2 may be used to inform the development of H/M/L priorities in the future. At this time, the Action Agencies propose to continue to make water management decisions through the TMT and IT processes emphasizing the water management Priorities shown in Table 6.2.

Examples of how this table would influence water management decisions are described below.

If one looks at the far right-hand portion of the ESU considerations table, it can be seen that water released from Dworshak in the summer is strongly connected to the needs of a large number of listed fish. A response to this would be to manage water releases at Dworshak to assure ample supplies of water are available for release in the summer. Another example is the strong connection between spring and summer water releases at Libby with white sturgeon and bull trout needs. Conserving water releases in the fall and winter would maximize water availability in the spring and summer.

6.2.3 — Water Quality Priorities

The ecological objectives of ESA and the Clean Water Act (CWA) impose requirements on the operation of the FCRPS hydro system. There are primarily two water quality parameters that impact water management decisions: water temperature and total dissolved gas (TDG) levels.

The Action Agencies propose to prioritize water quality actions of the NMFS RPA as follows:

Planning

The Action Agencies will work with Federal, state, and tribal organizations with water quality responsibilities to develop both short- and long-range plans that identify actions at FCRPS projects that will further both CWA and ESA objectives. Water quality actions from the NMFS BO with definite deadlines will be prioritized first. For example, NMFS BO Action 130 calls for the completion of the DGAS Study by April 30, 2001; Action 132 calls for the development of systematic review of the fixed monitoring sites by February 1, 2001; Action 133 calls for development of a total dissolved gas model as part of the DGAS study by the spring of 2001; Action 143 calls for a plan to model water temperature stratification by June 30, 2001; and, Action 136 calls to continue maximizing spillway deflectors through 2004.

Medium priority for the water quality program will be RPAs that directly involve fish, but do not have a specific deadline, such as Action 141 (evaluation of juvenile fish condition due to critical diseases and water temperature), Action 142 (implementation measures addressing juvenile fish mortality for high temperatures at McNary), Action 131 (monitoring physical and biological effects of TDG).

Actions that have some water quality component, but are primarily ESA actions, such as Actions 134, 135, 137, 138, 139, and 140, will be evaluated and funded as described under System Configuration (Section 6.2.1).

There are some concerns by the Action Agencies regarding full implementation by NMFS Action 131. At this time it does not appear that redundant monitoring at all fixed monitoring sites will be necessary based on the 2000 data completeness performance of total dissolved gas and water temperature at the fixed monitoring sites (ranging from 88.0 to 99.9 percent, and most stations being above 94 percent). The Action Agencies will, however, continue discussion with the Regional Forum Water Quality Team concerning this subject.

Actions and Operations

Actions recommended within the NMFS and USFWS BOs will be given high implementation priority. Actions such as: (1) structural changes at FCRPS dams to reduce TDG; (2) spill tests at Libby Dam to identify TDG levels; (3) installation of additional fixed gas monitoring stations to improve the accuracy of gas level samples; and (4) management of storage reservoirs (Dworshak for example) to retain cool water for the benefit of listed fish species in the warm summer season are examples of projects that will be given priority. Short-term actions and operations that keep TDG below the interim standards described in the NMFS BO (120 percent TDG standard) will also be accorded high priority. Long-term plans and actions will be designed to reach the 110 percent TDG standard within 10 to 15 years.

The Action Agencies also acknowledge that there are additional actions that are appropriate for CWA, but that are nonessential for the survival and recovery of listed species. Appendix B of the NMFS BO charts a course for development of a water quality plan for the mainstem Columbia and Snake rivers to address the long-term goal of attainment of TDG and temperature. The Action Agencies will work with regional entities to scope the activities for the water quality plan, so that it is compatible with the Total Maximum Daily Load process currently under way by the states, tribes and EPA, to address temperature and TDG in the mainstem.

6.2.4 — Operation and Maintenance Priorities

Prioritization of Operations and Maintenance (O&M) actions will be implemented by the Fish Passage O&M Coordination Team (FPOM), as is the current practice. Priority will be given to reasonable and prudent actions identified in the BOs. Examples of O&M actions identified in the BOs that would be given priority are: (1) operation and maintenance of fish passage facilities; (2) juvenile fish transportation; (3) procurement of spare parts for adult passage facilities auxiliary water systems; and (4) the development over time of project specific O&M actions, schedules and/or management plans.

O&M priorities will reflect the following:

- Meet the increasing O&M needs of aging fish passage and spillway facilities;
- Incorporate new O&M requirements as new fish and passage facilities are installed;
- Accommodate annual budget requirements associated with operational changes and research needs;
- Implement preventative maintenance programs for fish passage facilities to assure long-term reliability.

6.3 — Habitat Priorities

In addition to considering the general priorities when ranking habitat projects, the Action Agencies will consider the following three Habitat Priority Criteria: generating immediate habitat benefits relevant to BO actions; implementing an integrated RM&E program for habitat; or facilitating sub-basin and watershed assessments.

CRITERION 1 — Generating Immediate Benefits

Examples of projects generating immediate benefits include restoring or improving in-stream flows, removing passage barriers, protecting high-quality habitat, improving water quality, and screening diversions. In the short-term, the Action Agencies will initiate these types of projects in priority sub-basins, those with the potential ability to respond to water-related restoration, and in sub-basins where they can generate immediate benefits." In recognition of the urgency associated with the suite of Habitat actions required in the NMFS BO, the Action Agencies are pursuing implementation of projects offering immediate benefits even pending the completion of the sub-basin plans.

CRITERION 2 — Implementing an Integrated RM&E Program

The degree of progress on implementing priority projects, as reflected by measurable benefits, will comprise the basis for the evaluation of the Plan at the 2003, 2005, and 2008 checkpoints.

CRITERION 3 — Facilitating Sub-basin Assessments and Plans

The Action Agencies agree with the identification in the NMFS BO of sub-basin assessments and plans as the organizing framework for the Plan, and key to the success of the Habitat Strategy. As a result, completion of the sub-basin plans is a high priority and is dependent upon the NWPPC process (as specified in the BO) and will not be complete until 2006. A schedule for completion is set out in the Five-Year Action Tables and associated workplans. As sub-basin assessments are completed, they will be used as the context for making planning decisions on the relevance, priority, potential benefits, and location of proposed projects. In the interim, projects will be prioritized and implemented based upon Criterion 1 considerations.

The Action Agencies would like to provide two examples of the application of these criteria: the Bureau of Reclamation's tributary habitat actions, and the estuary improvement program.

Bureau of Reclamation Tributary Actions

NMFS recommended three of 16 priority basins for Reclamation action in 2002, and these will be the highest Priority for the Reclamation program. However, the sequence for prioritizing the remaining basins remains to be determined. Reclamation has applied the Action Agencies criteria to identify a schedule for Priority actions after 2002.

Second year and subsequent year sub-basins were selected by considering: (a) the criticality of the ESU where ESUs listed as endangered were prioritized over those listed as threatened; (b) the NWPPC schedule for development of sub-basin assessments and plans where the assessments provide the interim context in which to complement specific sub-basin projects undertaken by other entities (following NWPPC assessments)*;* and (c) logistics associated with moving into geographically contiguous locations that is considered to promote a smoother transition to a new sub-basin and create an environment to foster future partnerships.

The following schedule for entry into priority sub-basins resulted from these considerations:

FY 2002: Lemhi, Methow, Upper John Day, Middle Fork John Day

FY 2003: Entiat, McKenzie, Upper Salmon

FY 2004: Middle Fork Clearwater, North Fork John Day, Wenatchee

FY 2005: Clackamas, North Fork Santiam, Upper Cowlitz,

FY 2006: Lewis River, Little Salmon, Lower Willamette-Clackamas

Within this program, Reclamation's priority actions are based on Criterion 1 to generate immediate benefits by: (1) screening diversions to current criteria; (2) modifying or eliminating migration barriers; and (3) acquiring and/or securing sufficient streamflows.

COE Estuary Habitat Program

The Lower Columbia River Estuary Program's (LCREP) Estuary Management Plan is the framework that will be used to identify, coordinate, and prioritize NMFS BO projects in the estuary. At the urging of the Oregon and Washington governors, the LCREP has convened an ESA Executive Committee to oversee this coordination role and to integrate the BO estuary actions with the existing LCREP and state activities. The ESA Executive Committee will work closely with the existing LCREP science and policy committees. The Action Agencies are members of the ESA Executive Committee and the existing LCREP Science Committee. LCREP, NMFS, and the USFWS have already cross-checked the LCREP Management Plan and the BO to identify common Priorities. These are substantial because NMFS used the LCREP Plan to develop the estuary actions in the BO.

Initial efforts are under way to link the LCREP efforts with this Plan. An Estuarine Workshop in June 2001 will identify specific projects and priorities for implementation by the Action Agencies. The Action Agencies intend to offer Priority criteria for discussion by the participants.

The LCREP workgroup will also be coordinating with the NWPPC's Provincial Review for the Estuary and the Lower Columbia provinces. To assist in coordination, the June 2001 Estuary Workshop will identify the ecological values and processes that are important to the lower Columbia River and determine what criteria can be used to develop habitat protection and restoration priorities. Information from this workshop will be further refined and form the basis for the July 2001 Lower Columbia and Estuary Provincial Reviews and any subsequent planning efforts deemed necessary.

Immediate Habitat Priorities (2002–2006)

The Action Agencies immediate Habitat Priorities combine action, assessment, and planning.

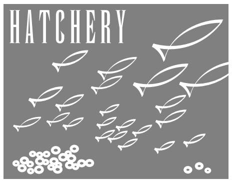
In the tributaries, the Action Agencies will implement projects in priority sub-basins that improve flow, passage, and screening problems. The Action Agencies will work with the NWPPC to ensure that sub-basin plans are completed by 2006. A water brokerage will be established to test the effectiveness of various transactional strategies for increasing tributary flows. The Action Agencies will partner with agricultural incentive programs to provide long-term protection of 100 miles of riparian habitat each year.

In the estuary, the Action Agencies will work with LCREP to conduct assessments and move forward with habitat acquisition and improvement projects.

In the mainstem, experimental projects will be conducted to see if mainstem habitat conditions can be improved.

Finally, the Action Agencies will work with both the Federal Habitat Team and the RM&E Committees to develop a practical monitoring and evaluation program for habitat.

6.4 — Hatchery Priorities



Initially, priorities for hatchery actions will largely reflect the logical and necessary sequence of actions that must occur in the hatchery arena, such as the development of HGMPs, the planning and risk assessment of candidate populations for the safety net populations, and the development of the comprehensive marking strategy. Within these categories of activities, implementation priorities will take into account, among other things, extinction risk, survival improvements necessary to achieve conservation and recovery, and practical and fiscal feasibility issues.

In general, the Action Agencies will consider the following prioritization criteria for actions:

- Rescue an ESU from extinction;
- Rescue a population within an ESU from extirpation;
- Result in reforming hatchery practices that reduce deleterious effect and/or better align mitigation mandates with conservation and recovery missions, with an emphasis on those species that are most at risk;
- Facilitate distinguishing between hatchery and naturally produced fish.

CRITERION 1 — Rescue an ESU from extinction.

Under the ESA, the NMFS listed distinct population segments are termed ESUs. These constitute a “species” for the purposes of the ESA. Each ESU is considered to possess a unique genetic resource for the biological species. Each ESU may be comprised of one or more local breeding populations (demes). When the whole of the ESU is in imminent danger of extinction a hatchery program may be the only means possible for preservation of the remaining genetic information. For example this is the case for Red Fish Lake sockeye.

CRITERION 2 — Rescue a population within the ESU from extirpation.

Protection of the ESU begins by protecting and restoring the local populations or aggregates of populations. Populations with significant downward trends and/or very low levels of abundance whose loss would significantly lead to further endangerment of the ESU will be considered for intervention with artificial production utilizing the safety-net program.

CRITERION 3 — Reform hatchery practices to reduce deleterious effects, with an emphasis on those species most at risk.

Hatchery-reared fish have the potential to negatively affect wild spawning populations. Deleterious effects include competition, disease transfer, genetic dilution, and others. Sometimes the problems are a function of hatchery operations that can be modified to reduce known or potential negative interactions with ESU’s natural spawning populations. In other cases the goals, objectives and operation of existing programs should be re-examined through the development of

Immediate Hatchery Priorities (2002–2006)

For anadromous fish, immediate priorities include planning and initial startup activities.

For hatchery reform and the safety-net programs, the Action Agencies expect to complete the planning process with HGMPs and begin implementing recommendations according to the schedule identified in the NMFS BO. For existing hatcheries, that would include but may not be limited to physical modification of facilities and/or changes in broodstock collection and egg-to-release rearing protocols known to be beneficial to listed fish. Additional measures will be identified over time as sub-basin, recovery planning, and RM&E processes provide new information relevant to artificial production. In addition, to improve the ability to distinguish between hatchery and natural fish in fisheries and escapements, the Action Agencies will develop and contribute to the implementation of a fish marking program.

For resident fish, the Action Agencies will maintain the preservation stocking program and associated rearing facilities for Kootenai River white sturgeon.

HGMPs, to identify ways to better accomplish their mandates while also contributing to the conservation and recovery of listed species.

CRITERION 4 — Mark fish to facilitate distinguishing hatchery produced from naturally produced fish.

Research to better understand hatchery and natural fish interactions, the development of selective fishing methods and gears, and monitoring and evaluation of supplementation strategies all require the ability to distinguish between hatchery and naturally produced fish. Marking fish is critical to these needs. This issue is of interest regionwide and across all the Hs. A comprehensive marking strategy must consider regional, national, and international implications. Once a marking strategy has been developed with input from the regional fisheries managers, the Action Agencies will contribute funding to help implement it.

6.5 — Harvest Priorities

The Action Agencies have examined possible harvest improvement actions following the six general priority principles. The highest priorities will be assigned to actions that develop and test selective in-river fishing methods and gear in a variety of circumstances (time, area, species), and RM&E actions designed to measure the effects of selective fisheries on listed ESUs.

As new information is acquired about which measures work and which do not work, the Plan will focus on enabling the deployment of these methods and gear, recognizing the need for collaboration with the fishery managers.

Projects that address NMFS BO Conservation Measures to reduce fishing effort (e.g., conservation easements) and fishing capacity (e.g., license buy-back or lease-back) have medium priorities ,due in part to uncertainty ensuring that biological benefits will accrue to the spawning grounds.

Immediate Harvest Priorities (2002–2006)

In the short-term (2002–2004), the Action Agencies will pursue methods to develop selective fisheries that are focused upon gear efficacy testing of live-catch gear (e.g. tooth-tangle nets, floating traps, etc.), and assessments of short-term salmonid mortality resulting from release of fish from live-capture gear. The Action Agencies will focus subsequent work on developing a plan for harvest research that includes assessing the impact of selective gear use on spawning success of salmonids. As new information is developed, the main objectives will be field application and ultimate fishery integration of such pilot projects. In addition, the Action Agencies will support measures aimed at improving the data collection, catch-sampling programs, and other improvements in harvest methods necessary to prosecute a selective fisheries strategy and generally improve harvest management decisions.

For the longer-term (2004–2006), priorities will transition to deploy selective fisheries gear and methods to the extent they are effective at reducing take of ESA-listed species, working with the states and tribes. The Action Agencies will also favor specific measures including pursuit of lease-back/ buyback of fishing capacity and/or fishery conservation easements that result in a decrease in take of listed species.

7.0 Guide to the Five-Year Action Tables

Appended at the end of this Plan are Five-Year Action Tables that list the Hydro system, Habitat, Hatchery, Harvest, and RM&E actions the Action Agencies will implement to achieve Performance Standards of the NMFS BO. An additional table summarizes actions that address the USFWS BO for Kootenai River white sturgeon and bull trout. The Five-Year Action Tables list specific measures or projects that are consistent with the Strategies and Priorities described earlier. Some activities are underway, while others will be initiated to address the RPA actions over the course of the Five-Year Plan.

Table Origin

The tables for the four Hs and for RM&E were initially developed by reviewing existing Action Agencies' programs and evaluating their relevance to the 199 actions required by the NMFS BO. The Action Agencies intend to continue implementing projects that clearly support ESA-related objectives. These projects have successfully passed the existing prioritization processes.

Next, the Action Agencies evaluated project proposals received through BPA's recent project solicitation (High Priority, Innovative, Power Emergency, and Provincial Review) for their relevance to various RPA actions. Relevant projects have been included in the tables.

Actions for resident species are summarized in a separate table for emphasis. This table shows 78 actions identified in the USFWS BO, but does not yet include detail for ongoing projects. The table also *does not* include eight actions for the Reasonable and Prudent Measures for bull trout (i.e., 10.A.1.3 – 0.A.3.2), because those requirements are covered by more explicit actions that apply to the BO Terms and Conditions (i.e., 11.A.1.3 – 1.A.3.2).

Table Elements, Benefits, and Limitations

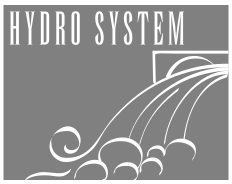
The tables outline:

- The type of actions;
- Priority;
- Locations;
- Accountable agency;
- Schedule; and
- Other information for projects and categories of projects.

At this time the Action Agencies' ability to provide project level details in the Five-Year Action Tables is constrained by: the absence of any completed sub-basin assessments; limited ability of the TRTs to inform the implementation process with recovery goals; and, the need for consensus with NMFS and USFWS regarding the mechanics of the monitoring and evaluation check-ins. To facilitate this task, the Action Agencies will move the information currently residing in the Action Tables into a database management system.

Work Plans — For key items and high priority items in the Action Tables, the Action Agencies are developing five-year (2002–2006) work plans, showing broad planning tasks and schedules. More details will be provided for the upcoming year in the 2002 Annual Plan.

7.1 — Hydro System Actions



The Five-Year Hydro System Actions Table is divided into several sections: System Configuration, Water Management, Water Quality, and Operations and Maintenance.

System Configuration

There are three ways for downstream migrants to pass the dams. They may enter bypass systems and be carried through the bypass system to the downstream pool, they may pass over the spillway, or they may pass through the turbines. System configuration actions are focused on improving survival in each of these passageways as well as increasing non-turbine passage. Bypass systems route downstream migrants away from the turbines.

System configuration also includes fish ladder improvements that are designed to help adults circumvent the dams more quickly and to avoid falling back over the dam through the spillways and turbines.

Configuration projects also are directed at reducing gas saturation by shaping and modifying the spillways. These projects are termed "gas fast-track projects."

Water Management

Water management operations describe how:

1) Spill is released at the downstream run-of-river dams;

2) Water is released from the storage reservoirs to provide migration flows;

3) Water is released to maintain water over spawning beds in the mainstem Columbia;

4) Water is released to maintain minimum daily flows required by bull trout and white sturgeon; and

5) Water is released to enhance water quality.

A variety of water management actions are implemented each year or will take several years to implement. Water management projects include water conservation improvements and water acquisition from the Upper Snake River by Reclamation; VARQ; and the Banks Lake drawdown (the latter two actions will require NEPA and NHPA compliance, before they are implemented).

Management plans and completion schedules for multi-year projects are detailed in the Five-Year Water Management Plan. States, local governments, stakeholders, and the public will have an opportunity for involvement in these processes to inform site-specific implementation decisions. Tribal governments have an opportunity to consult the Action Agencies regarding potential impacts on tribal resources, including traditional cultural resources.

Water Quality

There are two water quality elements that impact water management decisions: water temperature and total dissolved gas (TDG) levels. The NMFS BO addresses both TDG and water temperatures in the Snake and Columbia rivers. The Hydro System Actions Table includes a number of near-term actions and studies, as well as the longer term development of a Water Quality Plan.

With respect to dissolved gas, the Hydro System Actions Table reflects the fact that current standards of 110 percent cannot be met during periods of voluntary spill for fish passage. Achieving this standard will require a request for a state water quality variance to operate the FCRPS to achieve 120 percent of the dissolved gas standard. Also, management techniques that keep dissolved gas levels below lethal levels (130 percent or more for more than one week) will be developed.

Operations and Maintenance

FCRPS operation plans are developed annually by the COE in coordination with BPA, the regions fish agencies, Indian tribes and others. The Fish Passage

Plan (FPP) documents agreements on: seasons and criteria for adult and juvenile fish passage facility operation and maintenance; operating procedures in the event part of a facility malfunctions; spill patterns for adult and juvenile fish passage; turbine unit best efficiency operating ranges and operating priorities; turbine maintenance guidelines; special project operations to support special maintenance activities and research; juvenile fish transportation plan; and other information and criteria pertinent to operating the projects for fish passage. The NMFS BO recommends fish passage actions, operational guidelines and coordination procedures. The annual Fish Passage Plan is the Action Agencies response to these NMFS recommendations.

The COE, through the Fish Passage O&M Coordination Team (FPOM), prepares annual and 5-year maintenance plans for each of the dams including fish facilities. The NMFS BO calls for the continued preparation of these O&M plans, and suggests that current maintenance levels should be enhanced and that the proposed new fish passage facilities will increase maintenance requirements. The NMFS BO also requires the Action Agencies to focus on maintenance of juvenile and adult passage facilities, preventative maintenance and the establishment of a spare parts inventory for critical fish passage facilities.

Transmission capacity in many areas within of the FCRPS service area is currently fully allocated. Spring river operations (high flows) have a correspondingly high need for transmission capacity to deliver the electricity to often-remote markets. The NMFS BO identifies two transmission constraints, which at times pose limitations on fish passage operations. It recommends several actions to remove transmission constraints and enable full implementation of the spill and flow augmentation strategies of the BO. BPA's Transmission Business Line is developing plans to respond to these BO requirements.

The Action Agencies will implement a number of NMFS and USFWS BO required studies through the O&M program. Kelt studies, an evaluation of juvenile transportation strategies, and bull trout distribution studies in the Lower Snake and the North Fork of the Clearwater Rivers are examples of such studies.

Hydro System Work Plans

Work Plans for many of the Hydro System projects are included in Appendix E. The reader is referred to these plans for detailed project information.

7.2 — Habitat Actions

In the Five-Year Habitat Actions Table (see Appendix D), habitat actions are divided into three main categories: tributaries, estuary, and mainstem. Actions in each category are briefly described, e.g., improve riparian habitat, add large woody debris, or excavate backwater sloughs. For tributary actions, there is a further division by sub-basin.

Individual actions are listed under the following subcategories:

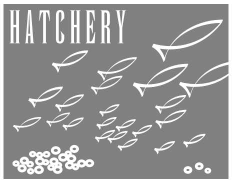
- Assessment, planning, coordination;
- Protection;
- Acquisition;
- Enhancement;
- Research;
- Monitoring and evaluation; and,
- Category for high-priority solicitation

Generally, this sequence is intended to impart a sense of chronology to future projects.

Habitat Work Plans

The Five-Year Habitat Work Plan (see Appendix E) provides a broad overview of the sequence of actions the Action Agencies will take to implement offsite activities in the habitat arena. In the near-term, tributary actions address water issues through screening of irrigation ditches, water acquisition and flow improvements, and removal of passage barriers such as irrigation push-up dams. Concurrently, the Action Agencies will support the NWPPC sub-basin planning process that will guide mid- and longer-term efforts to protect, enhance, and restore healthy habitat throughout the watersheds. Estuary actions will include inventory, research, and modeling efforts to guide future actions, as the Action Agencies also implement appropriate near-term projects to restore tidal wetlands and other key habitats. Mainstem habitat activities for the near term will focus on assessing habitat conditions and potential for improvements, and identifying restoration sites where improvements can be initiated.

7.3 — Hatchery Actions



The Hatchery Actions Table includes two broad categories of actions: offsite mitigation actions called for under the NMFS BO and ongoing BPA-funded NWPPC Fish and Wildlife Program artificial production actions. All actions are grouped into the subcategories of marking, hatchery reform, safety-net artificial propagation, or RM&E. Please note that BPA has already begun the procurement process to fund the four-step planning process for the artificial propagation safety-net program (NMFS BO Action 175).

Hatchery Work Plans

The Hatchery Work Plan provides a general overview of the sequence the Action Agencies will take to implement hatchery actions. The NMFS BO calls for three hatchery programs — Hatchery reform, safety net, and marking of fish. The Action Agencies propose a step down program structure to be followed across the programs to manage the implementation plan. For each program a team of Action Agency representatives will be formed to develop a detailed implementation plan to include scheduling, project coordinators, and cost. These core groups will oversee the implementation of the agency specific actions. The core group will also coordinate with oversight groups comprised of NMFS, FWS, NWPPC, Tribes, and additional stakeholder groups as needed. The Action Agency core group representatives will work to ensure completion of agency specific responsibilities under the BO's.

7.4 — Harvest Actions

The Five-Year Harvest Actions Table describes the Action Agencies' prioritization of projects that address harvest-related actions identified in the NMFS BO.

Harvest Work Plan

The Harvest Work Plan focuses on the Action Agency development of selective fisheries actions. This work is dependent upon full implementation of a comprehensive hatchery marking strategy. Subsequent work will focus on development of a plan for harvest research that includes assessing the impact of selective gear use on spawning success of salmonids. The Harvest Work Plan includes the steps the Action Agencies will take to transition to full deployment of selective fisheries that reduce the incidental take of ESA-listed fish.

7.5 — RM&E Actions

The RM&E Actions Table collects the RM&E from all four Hs. The table includes habitat actions for tributary, mainstem, and estuary habitats. Activities such as data management cover the basinwide or landscape scale. The actions are divided into four categories: compliance, physical, and environmental, life-stage survival, and population survival. Each category is divided further in to projects that address status, effectiveness, and research.

RM&E Work Plan

The RM&E Work Plan proposes a schedule for developing RM&E and Data Management plans. The RM&E Work Plan identifies the steps the Action Agencies will take to have RM&E and Data Management Plans incorporated into their annual and five-year Plan by the spring of 2002.

7.6 — Kootenai River White Sturgeon and Bull Trout Actions

The table for the resident species covered in the USFWS BO lists actions that could have also been distributed among tables for the four Hs and RM&E. Categories and subcategory classes are consistent with the other tables. The table does not include priorities for actions, which are presently being established. Cost estimates and schedules for many of the 78 actions are also being developed.

8.0 Research, Monitoring, and Evaluation

8.1 RM&E Strategies

The primary objectives of the RM&E component of this Plan are:

- Track the status of fish populations and their environment relative to required performance standards;
- Identify the physical and biological responses to management actions;
- Resolve critical uncertainties in the methods and data required for the evaluation of future population performance and needed survival improvements.

A disciplined and well-coordinated RM&E program is needed to help confirm the Action Agencies' scientific assumptions, resolve key scientific uncertainties, and provide the basis for performance tracking and adaptive management. A coordinated program will maximize efficiencies, avoid duplication, and properly control experiments to minimize confounding factors or actions.

The need for RM&E is widely recognized within the Basin (CRITFC 1995; ISG 1996; Federal Caucus 2000; NWPPC 2000). Substantial RM&E efforts are ongoing. For example, under the Anadromous Fish Evaluation Program, the COE sponsors a structured process to identify and address RM&E needs associated with: (1) hydro facility operations and performance; (2) new fish facilities at COE dams; and (3) the general biological effects on juvenile and adult salmonids passing through the mainstem corridor. Additionally, the NWPPC's 2001 Fish and Wildlife Program, funded and administered by BPA, includes over 100 projects addressing both anadromous and resident fishes that are classified either as Monitoring or as Research and Evaluation, with budgets totaling $35 million. Although these projects are in place, the region still needs a comprehensive program to achieve the objectives of RM&E identified above.

Many other projects include tasks designed to monitor and evaluate their results. The National Research Council estimated that BPA and the COE alone are spending approximately $70 million per year on research (NRC 1996). The Action Agencies' RM&E programs will be selected and reviewed through a RM&E coordination process that will include broad agency and tribal participation and scientific review that take into consideration existing conceptual RM&E proposals (NRC 1996; Federal Caucus 2000; Bisbal, *in press*).

At this point in time, the Action Agencies' general RM&E strategy for salmon and steelhead is to:

- Maintain and modify ongoing RM&E efforts until a more structured and coordinated RM&E framework and plans are developed and approved;
- Expeditiously implement RM&E actions that address high-priority needs;
- Collaborate with the NMFS recovery planning and research programs, the Federal Caucus' *Basinwide Salmon Recovery Strategy*, the NWPPC sub-basin planning, and state and tribal planning efforts to develop a basinwide RM&E program and data management system.

The Action Agenices' general RM&E strategy for resident fish is:

- For Kootenai River white sturgeon, to define, monitor, and evaluate flows below Libby Dam that meet natural reproduction objectives specified in the final recovery plan;
- For bull trout, to work with the USFWS resident fish recovery planning efforts to obtain basic population and distribution data needed to develop Performance Standards and to identify critical RM&E needs.

Proposed Process for Developing an RM&E Plan

In this section the Action Agencies propose a RM&E structure tied to Performance Standards as a "strawman" to advance regional discussions. The Action Agencies propose to develop, in coordination with other interested parties, two parallel, multi-federal agency Technical Oversight Committees (TOC): one that would oversee the development of a comprehensive RM&E Plan (RM&E TOC), and the other that would oversee the development of a linked Data Support System (Data Management TOC). Technical support groups may be formed to help accomplish various tasks and products at the direction of the committees. The Federal Caucus will provide policy guidance for each TOC. The TOCs would solicit state, Tribal, and private technical review of proposals and products.

These TOCs and the scope of their efforts are proposed to be defined through charters developed through the Federal Caucus during Summer 2001. The TOCs will develop the initial RM&E and data system frameworks, detailed work plans, and schedules for work products by Fall 2001.

A critical component of the RM&E framework will be a direct and clear link to the structure and concepts of Performance Standards. The development of a comprehensive five-year RM&E plan that can meet the research and monitoring and data support objectives of this Plan, consistent with the needs of NMFS and USFWS recovery planning and the NWPPC sub-basin planning, will be targeted for first year of completion by March 2002. When the comprehensive RM&E and Data Management plans are developed and adopted, the Action Agencies will modify existing programs or implement new RM&E programs, consistent with the Action Agencies' respective authorities and responsibilities.

As a first step, the Action Agencies will convene an initial workgroup session in the Summer 2001 to map out RM&E cross-agency and process efforts that need coordination, to identify more specific products and scope of the work, and to identify next steps for the formation of the RM&E and Data Support Oversight Committees.

The Action Agencies will collaborate with the NMFS, USFWS, and the NWPPC and other parties through participation on these TOCs and technical support groups. The Action Agencies are particularly interested in helping ensure that the plans include the following technical and policy components:

RM&E Plan Components

Technical issues

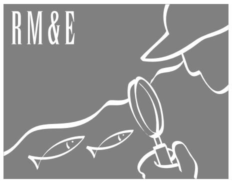
- Are produced expeditiously so that they can guide the substantial investments being made in RM&E projects;
- Focus on critical uncertainties related to recovering listed species and measuring progress toward that goal;
- Take into account ongoing projects with RM&E components and how those projects may be adapted to conform to the comprehensive plans;
- Account for the capabilities and limitations of RM&E tools and identify improvements needed in those tools.

Policy issues

- Balance RM&E with the need for decisive and substantive on-the-ground actions to restore listed populations; and,
- Consider the scopes of authorities and responsibilities of the parties involved in selecting, funding, and implementing RM&E projects.

In the interim — until more comprehensive RM&E plans are developed and adopted — the Action Agencies intend to continue their present RM&E efforts and to adapt those efforts to meet immediate needs. Additional RM&E actions/measures will be implemented consistent with the NMFS and USFWS BOs. In general, the RM&E actions selected for salmon and steelhead will focus closely on the Performance Standards of the NMFS BO.

8.2 — RM&E Structure



The NMFS BO proposed a framework for a comprehensive RM&E program that encompasses both the entire salmon lifecycle and different geographic areas (tributary habitat, hydropower corridor, and the estuary and nearshore ocean environment). This structure includes five types of monitoring: (1) population status monitoring; (2) environmental status monitoring; (3) effectiveness monitoring; (4) quality of regional databases; and (5) compliance monitoring.

In addition, NMFS outlined a hierarchical three-tier approach to monitoring freshwater systems and the estuary. NMFS designed these tiers to consist of different levels of biological detail and habitat attributes. For example, Tier 1 includes the broadest level of sampling with many sites sampled infrequently. Tier 2 details population status and identifies relationships between environmental characteristics and population trends. Tier 3 establishes mechanistic links between management actions and fish population response and assesses the relative fitness of hatchery fish.

Although the monitoring structure proposed in the NMFS BO includes necessary elements, the tiers are described differently for monitoring and Performance Standards. Therefore, the Action Agencies propose the following modified structure for regional discussions (a "strawman" proposal) that captures all the elements of the NMFS monitoring structure, but arranges them according to geographic zones and management areas. This modified structure links directly with tiers of Performance Standards and Performance Measures. That is, the Action Agencies identify five types of monitoring that correspond with the four tiers of Performance Standards and Performance Measures described in Section 4.

TIER 1 — Population Monitoring

Assesses annual population growth (lambda).

TIER 2 — Life-Stage Survival Monitoring

Describes egg-smolt survival, juvenile migration survival, estuary and ocean survival, and adult migration survival.

TIER 3(a) — Biological Monitoring

Assesses attributes such as presence/absence, distribution, abundance, straying, reproductive success, fecundity, habitat use, genetic variability, and fish condition factor, health, and growth.

TIER 3(b) — Physical/Environmental Monitoring

Assesses attributes associated with properly functioning condition (PFC), resource availability, temperatures, total dissolved gases, distribution and abundance of competitors and predators, and distribution and abundance of exotics.

TIER 4 — Compliance Monitoring

Assesses whether management actions have been implemented properly and maintained.

Each "type" of monitoring is further divided into three "levels" of monitoring:

- **Status Monitoring**

  Assesses the status of fish and their environment over time. Status monitoring is not designed to assess effects of management actions on fish and their environment. Rather they simply track trends over time.

- **Effectiveness Monitoring**

  Assesses the effects of management actions on fish and their environment. Here the purpose is to use valid studies to assess the success of management actions.

- **Research**

  Explores areas of critical uncertainty (e.g., delayed [extra] mortality, reproductive success of wild and hatchery fish, stray rates of wild fish).

The structure described in this Plan includes RM&E within three geographic zones: (1) tributary habitat; (2) hydropower corridor; and (3) estuary and nearshore ocean environment. These zones are consistent with those described in the NMFS BO and provide a logical classification of monitoring and research in the Columbia River Basin. Indeed, the RPA calls for actions affecting fish survival in these three zones. Table 8.1 further illustrates and describes this proposed RM&E structure.

Table 8.1 — Proposed RM&E Structure

Structure of research, monitoring, and evaluation proposed by the Action Agencies

GEOGRAPHIC ZONE	MANAGEMENT SCALE	TYPE OF MONITORING	LEVEL OF MONITORING	EXAMPLES
1. Tributary Habitat	1. Columbia Basin Scale	1. Population (Tier 1 PS/PM)	Status	Assess lambda and population abundance.
			Effectiveness	Assess the validity of population models.
			Research	Develop population extinction models.
		2. Life-stage Survival (Tier 2 PS/PM)	Status	Assess life-stage specific survivals (e.g., juvenile migration).
			Effectiveness	Effect of reducing mixed-stock fishery on adult survival.
			Research	Develop population models.
		3a. Biological (Tier 3 Biological PS/PM)	Status	n/a
			Effectiveness	n/a
			Research	n/a
		3b. Physical/ Environmental (Tier 3 P/E PS/PM)	Status	Describe ecoregion, geology, landtypes, ownership, etc.
			Effectiveness	n/a
			Research	n/a
		4. Compliance (Tier 4 PS/PM)	Status	Monitor efficiency and consistency of sampling programs (e.g., dam counts).
			Effectiveness	Monitor update of data management system and new harvest management/technology.
			Research	Monitor development of more efficient sampling programs.
1. Tributary Habitat	2. ESU Scale	1. Population (Tier 1 PS/PM)	Status	Assess lambda for each ESU.
			Effectiveness	Assess the validity of population models.
			Research	Develop ESU-specific extinction models.
		2. Life-stage Survival (Tier 2 PS/PM)	Status	Assess life-stage survivals for ESU.
			Effectiveness	Assess validity of life-stage survival models.
			Research	Develop life-stage survival models.
		3a. Biological (Tier 3 Biological PS/PM)	Status	Describe presence/absence, distribution, abundance, and genetic variability.
			Effectiveness	Monitor biological responses to removal of barriers, preservation, improved flows and water quality.
			Research	Effects of fertilization; Minimum size of riparian zone.
		3b. Physical/ Environmental (Tier 3 P/E PS/PM)	Status	Describe VBTs, channel types, flows, water quality, etc.; describe distribution and abundance of exotics.
			Effectiveness	Monitor environmental responses to removal of barriers, preservation, improved flows and water quality.
			Research	Effects of removing exotics.
		4. Compliance (Tier 4 PS/PM)	Status	Monitor efficiency and consistency of sampling programs.
			Effectiveness	Monitor implementation of management actions, e.g., barrier removal, fertilization, increased tributary flows.
			Research	Monitor implementation of research actions.
1. Tributary Habitat	2. Population Scale	1. Population (Tier 1 PS/PM)	Status	Assess lambda of tributary populations.
			Effectiveness	Assess validity of population models.
			Research	Identify most important factors associated with lambda.
		2. Life-stage Survival (Tier 2 PS/PM)	Status	Assess egg-smolt and prespawn survivals.
			Effectiveness	Assess validity of population-specific survival models.
			Research	Identify most important factors associated with survivals.
		3a. Biological (Tier 3 Biological PS/PM)	Status	Assess fry, juvenile, smolt, and adult abundance, straying, redd counts, fecundity, condition, habitat use, and genetic variability.
			Effectiveness	Monitor biological effects of fertilization, hatchery reform, reduced poaching, habitat restoration, and preservation.
			Research	Assess biological responses to attributes of PFC; examine stray rates of wild fish; evaluate reproductive success of hatchery and wild fish.
		3b. Physical/ Environmental (Tier 3 P/E PS/PM)	Status	Assess PFC.
			Effectiveness	Monitor environmental responses to habitat restoration, preservation, and barrier removal.
			Research	Identify most important factors associated with biological gains.
		4. Compliance (Tier 4 PS/PM)	Status	Monitor efficiency and consistency of sampling programs.
			Effectiveness	Monitor implementation of management actions, e.g., hatchery reform, poaching, habitat restoration.
			Research	Monitor implementation of research actions.

(continued)

GEOGRAPHIC ZONE	MANAGEMENT SCALE	TYPE OF MONITORING	LEVEL OF MONITORING	EXAMPLES
2. Hydropower Corridor	n/a	1. Population (Tier 1 PS/PM)	Status Effectiveness Research	See Columbia Basin, ESU, and Tributary Management Scales.
		2. Life-stage Survival (Tier 2 PS/PM)	Status	Assess juvenile (including D) and adult migration survival.
			Effectiveness	Monitor effects of management actions on juvenile and adult passage survival.
			Research	Alternative methods to estimate "D" values.
		3a. Biological (Tier 3 Biological PS/PM)	Status	Assess fall chinook spawning success and juvenile survival; evaluate lower-river stock productivity.
			Effectiveness	Monitor biological effects of spill at individual projects, bypass improvements, transportation schedules, and cool-water releases from Dworshak.
			Research	Assess effects of competition and predation; evaluate transportation; assess adult return rates; assess fallback rates; research tagging techniques.
		3b. Physical/ Environmental (Tier 3 P/E PS/PM)	Status	Describe reservoir habitat, temperatures, dissolved gases, flows (spill).
			Effectiveness	Monitor environmental effects of different spill regimes and cool-water releases from Dworshak.
			Research	Assess relationship between spill patterns and dissolved gas concentrations.
		4. Compliance (Tier 4 PS/PM)	Status	Monitor efficiency and consistency of sampling programs.
			Effectiveness	Monitor implementation of management actions, e.g., spill, bypass, flow augmentation.
			Research	Monitor implementation of research actions.
3. Estuary/Ocean	n/a	1. Population (Tier 1 PS/PM)	Status Effectiveness Research	See Columbia Basin, ESU, and Tributary Management Scales.
		2. Life-stage Survival (Tier 2 PS/PM)	Status	Estimate estuary/ocean survival over time for different stocks.
			Effectiveness	Monitor effects of management actions on survival in the estuary.
			Research	Monitor effects of hydro operations on estuary/ early ocean survival.
		3a. Biological (Tier 3 Biological PS/PM)	Status	Describe juvenile and adult distribution and habitat use in the estuary.
			Effectiveness	Monitor biological responses to habitat restoration in the estuary.
			Research	Evaluate effects of hydro operations on fish growth and health in estuary and plume.
		3b. Physical/ Environmental (Tier 3 P/E PS/PM)	Status	Describe the physical and chemical characteristics of the estuary, abundance and distribution of predators and competitors, and availability of resources.
			Effectiveness	Monitor environmental responses to habitat restoration in the estuary.
			Research	Develop and plume model.
		4. Compliance (Tier 4 PS/PM)	Status	Monitor efficiency and consistency of sampling programs.
			Effectiveness	Monitor implementation of management actions.
			Research	Monitor implementation of research actions.

Tributary Habitat RM&E Strategy

The tributary habitat zone includes areas upstream from the hydro system corridor. This Plan divides the tributary habitat zone into three "management scales," arrayed from coarse to fine scale: (1) Columbia Basin scale; (2) ESU scale; and (3) population[3] scale. The reason for dividing the tributary habitat zone into separate management scales is to capture different levels of biological detail and habitat attributes.

At the "Columbia Basin Scale," the Action Agencies will describe coarse-scale environmental attributes such as ecoregions, geologic districts, land types, and land ownership, and biological/population attributes such as distribution and annual population growth (lambda).[4] This scale corresponds roughly with "Landscape Imagery" in the NMFS BO and provides information to assess associations between coarse-scale environmental attributes and status of fish populations. Monitoring of coarse-scale attributes will occur once every three years. Also included under this scale is the development and maintenance of the regional data management system. Although the database includes information collected at all management scales and geographic zones, it is a basinwide endeavor and therefore is described as an action at the coarsest scale.

The ESU management scale includes attributes that describe the status of entire ESUs and their environment. Important biological/population attributes at this scale include distribution (presence/absence), abundance, lambda, life-stage specific survivals (e.g., egg-smolt survival, prespawn loss), and genetic variability. Environmental factors include valley bottom types, channel types, stream flows, water quality, and distribution of exotics, to name a few. At this scale, the Action Agencies will examine relationships between status of the ESU and environmental factors. Sampling at this scale depends on the study, but at a minimum will be annual.

At the finest population management scale, monitoring and research describe the status of independent populations that make up ESUs. The focus here is to assess biological attributes of independent populations. Biological attributes would include, for example, population-specific adult abundance, fecundity, habitat use, and fry, juvenile and smolt survival. Environmental attributes include stream habitat complexity and diversity, sediment recruitment, riparian habitat, and other elements of PFC. Research at this scale could include an evaluation of reproductive success of hatchery and wild fish, examination of stray rates, and effects of nutrient enhancements. Because these activities are specific to individual populations, they are described at the finest scale. Sampling at this scale will be annual.

Hydro System Corridor and Estuary/Ocean

The Plan does not divide the hydro system corridor and the estuary/ocean zones into different management scales. These zones include research and monitoring activities specific to their geographic areas. The hydro system corridor includes studies that address juvenile and adult passage, estimates of delayed mortality, fall-back rates, and effects of transportation. Environmental attributes include monitoring flows, temperatures, dissolved gases, and abundance and distribution of predators. In addition, studies on fall chinook are included in this geographic zone. Within the estuary/ocean zone, studies will assess juvenile and adult survival and distribution, physical and chemical characteristics of the estuary, and effects of competitors and predators on listed species. The Action Agencies will develop a plume model and evaluate the effects of dam operations on survival of listed species in the estuary.

Because monitoring is a scientific activity, it will change as knowledge increases. However, the foundation of monitoring will be based on valid study designs that encompass appropriate spatial and temporal scales. The success of monitoring and research depends on a sound sampling program.

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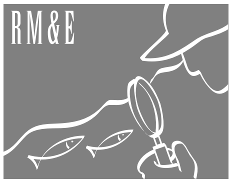
[3] *We use population to mean an aggregation of one or more local breeding units (demes) that are closely linked by exchange of individuals, but are isolated from other populations to such an extent that exchange of individuals among populations do not affect the population dynamics or extinction risk of the populations over a period of 100 years. An ESU can consist of one or more independent populations.*

[4] *In this report section we list several examples of biological and environmental attributes and research and management activities under the different geographic zones and management scales. These examples should not be considered complete, nor should it be assumed that all examples will be implemented. The Action Agencies offer these only as examples.*

8.3 — RM&E Priorities



This section provides a proposed set of ranking criteria for RM&E actions that are needed to support estimates of the biological and environmental effects of management actions, update Performance Standards, confirm the expected results of actions, and reprioritize actions. RM&E will take place at each level in the structure outlined in Table 8.1. The proposed RM&E TOC will determine the working process and products necessary to ensure that an RM&E program provides information for Performance Standards at each level.

The Action Agencies will have significant management and funding responsibilities for this program. However, there are substantial additional RM&E requirements in the region related to recovery planning and actions by other Federal and non-Federal parties, which are beyond the responsibilities of the Action Agencies and are not covered in this Plan. We will work with the TOCs to ensure that the RM&E program under this Plan is coordinated with the responsibilities of other parties and provides information needed to adequately credit our actions.

Proposed criteria for prioritizing RM&E activities include the following, consistent with the NMFS and USFWS BOs:

Time Required, Statistical Power — If the activity is likely to produce useful results within the five- to ten-year timeframe for the BO, it will be ranked higher than one where more time will be required to yield information relevant to management decisions. Activities that yield statistically reliable results given the design of the experiment (duration, type, and intensity of monitoring) will be ranked higher than those that do not. If survival rates are being monitored, the change should be large enough to be important in reducing extinction risks, or increasing the likelihood of recovery.

Significance for Assessment of Management Actions — Is the expected change sufficiently large to warrant close monitoring? If not, there should be some other justification for the RM&E activity. For example, one might expect the results to generalize to unmonitored populations or locations. Some monitoring will be directed at changes in survival rates due to RPA management activities, while other activities are intended to estimate baseline survival rates or environmental conditions. Both are needed, but RM&E activities should generally be closely tied to RPA management actions or resolve a critical uncertainty identified in quantitative assessments of actions.

ESU Significance — Monitoring directed at ESA-listed ESUs will be ranked higher than activities directed at other stocks. For those directed elsewhere, there should be another justification for conducting the activity (e.g., smolt-to-adult returns (SARs) for Middle Columbia chinook, to compare the Snake and Upper Columbia stocks). Populations with higher extinction risk or greater requisite increases in survival rates will generally receive higher priorities for both management and research actions.

Cost Feasibility — In prioritizing competing RM&E activities intended to produce roughly the same information, cost of the different activities will be one criterion in selecting projects for funding. Feasibility will also be important. For example, a project may be powerful and well designed, but may be impractical due to logistical constraints (e.g., take permits cannot be issued quickly, customized equipment may take too long to build).

Relationship to Other Research — To what extent does the proposed activity depend on other projects, and to what degree does it build on ongoing, related work? Some projects may conflict with other research. For example, a "control" stock for habitat enhancement cannot simultaneously be a "treatment" stock for nutrient supplementation. These conflicts require resolution before RM&E activities are undertaken.

Immediate RM&E Priorities (2002–2006)

The Action Agencies immediate RM&E priorities are Tier 3 effectiveness monitoring and research in tributary habitat areas and the formation of a coordination and planning group (proposed TOCs) to develop a comprehensive RME plan by Spring 2002. This work will further define RM&E needs, timelines, funding and priorities. In addition, the Action Agencies will start refining Tier 1 Performance Standards and Tier 2 hydro system corridor Performance Standards and begin developing Tier 2 Performance Standards for other life stages and Hs.

Table 8.2 — RM&E Priority Criteria

Examples of criteria and possible numerical scores for ranking RM&E projects.

CRITERIA	LOW (1)	MEDIUM (2)	HIGH (3)
1. Time required, statistical power	10+ years needed, low statistical power (< 50% chance of detecting large changes in survival rates)	1-3 years needed, > 80% chance of detecting modest changes in survival rates	Expensive ($100K - $1M) but no serious logistical problems
2. Significance for assessment of management actions	Low (< 5%) expected change in survival or environmental conditions, very site specific	5 years needed, > 70% chance of detecting moderate changes in survival rates	High (> 10%) expected changes in survival rates; expected to apply to several ESUs
3. ESU significance	Does not apply to any ESUs, even indirectly	Low expected changes but should apply to several stocks	Applies directly to high-risk ESUs
4. Cost, feasibility	High cost ($1M+), important logistical hurdles must be overcome	Direct application to ESUs needing only moderate survival rate increases	Low cost (< $100K), no logistical problems
5. Relationship to other research	Conflicts with high-ranked ongoing research	Neither interferes with nor build on other ongoing work	Useful for several other ongoing, highly ranked projects

8.4 — Key Research Needs

Some of the key areas of uncertainty and research needs are identified through summaries of the NMFS BO Assessment and through additional scientific analyses performed through the 1995 NMFS BO mandated PATH analyses for Snake River stocks and QAR analyses for Upper-Columbia River stocks. These summaries are provided in Appendix C. The uncertainties discussed within this section are focused on data or methodology issues that were discussed during consultation and development of the NMFS BO. Because these uncertainties can have such a substantial effect on the level of non-hydro mitigation measures required by Federal and non-federal regional parties to avoid jeopardy to the stocks, they will receive high priority in RM&E plans, scientific peer reviews, and reassessments of analytical methods. These increases in knowledge and methods will require updates to the assessments of needed survival and the expected effects of actions and require adaptive management to insure continued success in recovery efforts.

This section, and the associated Appendix C, summarizes the analytical approach, results, and associated uncertainties of quantitative modeling assessments that have estimated population level survival requirements and expected benefits of actions for the ESA-listed anadromous fish populations (some of the uncertainties related to resident fish are also provided in section 8.4.10). Much of this information is presented in more detail in various parts of the NMFS BO. Our intent is to summarize the assumptions and issues underlying this Plan structure to: 1) help focus and prioritize needed research, 2) emphasize the need for continued refinement of performance standards, and 3) identify the critical importance of a strong RM&E program, performance tracking, and adaptive management to insure the Plan is successful.

The assumptions and uncertainties we highlight are: Historical Time Period; Hatchery Supplementation Policy and Spawner Effectiveness; Density Independence; Independent Populations; Differential Delayed Mortality of Transport Fish (D Value); Extra (Delayed) Mortality of In-river and Transported Fish; uncertainty in Lambda and Extinction Risk; Effects of Other Hs; and Effect of Reservoir Operations on White Sturgeon and Bull Trout.

8.4.1 — Historical Time Period

The NMFS BO assessments of needed survival improvements are based on the spawner returns from 1980–1999. However, NMFS's review of trend analyses for Pacific Northwest salmonid stocks (Coronado and Hilborn, 1998, and Deriso, et al., 1996) indicates that the climatic and other background conditions influencing survival have been below average for most of that period. Restricting the analysis to this time period has the effect of projecting these generally poor ocean conditions into the future. This restriction can have significant effects on the assessment of the needed survival improvements required for all ESUs. In the BO assessment, adding the years 2000 and 2001 (projected from jack counts) to the analysis reduced the estimated survival increases required by as much as one third or more (NMFS BO, Appendix A). In the QAR assessment of Upper Columbia stocks, Cooney (NMFS, March 2000) used three different starting points for population projections. The results for Wenatchee spring chinook showed the survival improvement required to avoid the risk of extinction criteria was either 95, 47, or 2 percent depending on whether a historical time period back to 1980, 1970, or 1960 was used, respectively. Additional analyses using the CRI model by Hinrichsen and Paulsen (unpublished manuscript) showed that changing the starting or ending 1980 to 1999 period by five years could either increase survival requirements by over 2 to 3 times or totally eliminate any need for improvement. In addition, this analysis showed that this change in time period assumption could change the rank order of stocks that needed the most survival improvements. Assessments by PATH using longer historic time periods for calibration have also showed less survival improvements needed to meet recovery targets relative to the 1980 to 1999 BO assessment period. PATH experimental management analyses restricted its analysis to the 1980–1999 period consistent with NMFS analyses and had similar results relative to the broader time series.

The ISAB model review (ISAB, 2001), as well as work by many oceanographers (e.g., Hare and Mantua, 1999, Inverse production regimes: Alaska and west coast Pacific Salmon, *Fisheries*, 24: 6-14**)** note that decadal cycles in ocean survival appear to be common. A variety of oceanographic indices suggest that the Pacific Decadal Oscillation (PDO) may have shifted to a regime more favorable for Columbia River salmon. Returns to the Columbia River in recent years support this possibility. In particular, there have been record returns of spawners in 2000 and 2001. In addition, recent SAR estimates by NMFS (2000 transport white papers) also suggest that ocean survival for Snake River spring/summer chinook have increased substantially in the late 1990s. These estimates are surely influenced to some degree by hydro system operations, harvest, etc. However, it is reasonable to conclude that a substantial portion of the recent increases is caused largely by increased marine survival.

While long-term ocean cycles appear to be very important to return rates, the length and duration of these cycles are uncertain. In addition, shorter cycles, such as El Nino events, also affect return rates. Finally, the interaction of global climate change with decadal and inter-annual ocean conditions, and the impact of those conditions of Columbia River salmon is unknown.

The sensitivity to historic time periods and the recent data supporting improving ocean conditions leads us to conclude that the NMFS BO assumption of continued, low marine survival rates and the assessment of required survival improvements may be conservative. In addition, the sensitivity to better ocean and climate conditions suggests that increased marine survival, if it continues for several years, may allow some "breathing room" while increases in freshwater survival are attained via improvements in juvenile rearing, smolt migration, and adult upstream survival. Additional research is needed to help understand the mechanisms of these ocean and climatic survival conditions, and to help improve forecasting and related fisheries management capabilities and ensure that affected populations can persist over the full range of environmental conditions they are likely to encounter.

8.4.2 — Hatchery Supplementation Policy and Spawner Effectiveness

The NMFS BO assessments of needed survival improvements for supplemented ESUs looks only at the wild component of the population in isolation. Therefore, the assessment assumes that any ongoing supplementation programs that are part of these ESUs do not contribute to future population levels in the assessment of extinction risk and recovery. This is consistent with NMFS policy interpretation of the ESA that the health of an ESU should be based solely on the wild fish component. Determination of the true population status (in light of the uncertainty about the effectiveness of hatchery fish spawning in the wild) and the future survival improvement needed is dependent on reducing the uncertainty about the reproductive success of hatchery fish spawning in the wild.

There is very limited data on success of hatchery spawners in producing returning adult offspring. NMFS evaluated survival requirements using a broad range of 20 to 80 percent historical effectiveness of hatchery-origin spawners to cover this uncertainty. Obtaining empirical estimates of supplementation effectiveness will be an important part of this Plan. There is currently little data available and experimental methods for obtaining this information will likely take longer than five years to get initial results and much longer for reliable results. It is important that experiments be initiated immediately to address these critical uncertainties. Additionally, it will be very important to perform research on the potential adverse effects of supplemented fish on the health of the ESU.

8.4.3 — Density Independence

The NMFS BO analysis of needed survival improvements assumes that fish survival is independent of the population density at all life stages. This assumption is consistent with analysis that looked at the performance of individual populations of an ESU independently over the 1980 to present time period. While density dependence is not apparent in single-stock models of population dynamics using only 1980–present data, PATH and others have found strong evidence of compensatory mortality (higher survival rates at low population levels) and carrying capacity limits in Snake, Lower Columbia, and Upper Columbia populations using data from the late 1950's to present. Similar relationships are apparent when using multi-stock models (e.g., all seven Snake index stocks) with common years effects.

If the survival rates of ESU populations are density dependent at certain life stages (i.e., egg to smolt survival), than the CRI analysis would tend to be pessimistic about extinction risks and optimistic with regards to survival increases necessary to achieve recovery levels. Incorporating density dependence would therefore tend to support lower risk for Plan actions that may not have immediate survival benefits, but require higher overall survival improvements to meet longer term recovery goals. Research on density dependence (independence) is needed to provide a better understanding of the potential benefit of actions over time. It will also be important to address this assumption in the future regional collaborative review of the analytical methods that is called for in the NMFS BO prior to March 1, 2005, and to address this uncertainty through additional RM&E.

8.4.4 — Independent Populations

The NMFS BO, Mid-Columbia QAR and PATH assessments all assume that spawning aggregations of an ESU behave as independent populations in isolation. Given the geographic proximity and genetic similarity of many of these sub-groups, NMFS notes in it's BO that this assumption is highly unlikely and may lead to pessimistic assessments of needed survival improvements (NMFS BO, Section 6.3.1.5). NMFS further notes it is likely that the review by TRT's to further define spring/summer populations may result in some grouping of these currently defined aggregates, and expanding their population sizes and demographic descriptions, which may result in reducing survival improvements necessary to avoid extinction. On the other hand, there is the potential that TRT review of some populations could lead to even more restrictive definitions of populations with little or no assumed interbreeding leading to more pessimistic assessments than the current BO.

Research regarding population structures, natural straying between aggregations and adaptations to the assessment methods to include meta-population dynamics may be warranted as high priority actions within the Plan. A comprehensive monitoring program to be developed will contribute substantially to resolving this uncertainty, as will TRT efforts to define populations.

8.4.5 — Differential Delayed Mortality of Transported Fish (D Value)

The differential delayed mortality of transported fish (D value) is the estimated ratio of the post-Bonneville survival of transported fish relative to in-river migrating fish. This differential mortality can occur during any time from release below Bonneville Dam, through the estuary and ocean life stage, and during adult upriver migration to the specific dam from which they were transported. The factors determining D are complex and may depend on transported and in-river migrant relative differences in timing to the estuary and fish condition.

Research indicates that D may increase over the migration season suggesting that transported fish may survive better if they enter the estuary later in the year (Hinrichsen, 1999). The D factor is estimated from the SARs of the in-river and transported fish, and the model based estimates of the smolt passage survival of in-river fish. Uncertainty in D is therefore directly related to uncertainty in SARs and modeled survival estimates. The BO assessment of survival increases needed assumes that D ranges from 0.63 to 0.73 for all spring/summer chinook and from 0.52 to 0.58 for all steelhead based on two different methods for expanding 1994 to 1997 estimates of in-river survival to the entire river reach. The adult SARs are based on relatively small numbers of returning adults causing large confidence intervals for the D estimates.

The BO assessment for fall chinook assumes a D value of 0.24 based on one year of PIT-tag data which was one of several alternatives for estimating D that were developed in PATH.

Even less information is available on potential D values for Upper Columbia spring chinook and steelhead. Historical data when fish were transported from McNary indicate a D ranging from 0.8 to 1.0 (NMFS BO Sections 9.7.2.3.3 and 9.7.2.7.3); NMFS assumed D values equal to those for the Snake River stocks (0.63 to 0.73 for spring/summer chinook and from 0.52 to 0.58 for steelhead). This uncertainty has little effect under current conditions because few Upper- and Mid-Columbia stocks are currently transported. However, an improved understanding of D will be necessary to determine the appropriate role of McNary transportation in future years. In fact, decisions on emergency transport operations in the low flow conditions of 2001 would have benefited from improved understanding of this issue.

The wide range of values estimated for D and the potential spatial and temporal variability that are not fully understood represents highlight the need to obtain better information on D. Further, the future role of transportation and the potential benefit of major hydro system configurations are highly sensitive to this uncertainty. This Plan will place a high priority on transportation studies targeted at reducing these uncertainties and factors affecting D.

8.4.6 — Extra (Delayed) Mortality of In-River and Transported Fish

Extra mortality (EM) was first conceived in the PATH process to explain the additional mortality reflected in the historic time series of spawner-recruitment data that could not be explained by the other predictor variables in their life-cycle models. These other predictor variables included: (1) spawner-recruitment productivity parameters; (2) estimates of in-river passage survival from juvenile passage models; (3) estimates of delayed mortality of transported fish relative to in-river fish (D value); and (4) a common year effect parameter that accounts for year-to-year changes in productivity that are common across a large group of stocks and that is intended to capture common environmental effects. EM is in effect a variable that takes up any leftover or unexplained mortality or loss of productivity that is not accounted for (or that may be incorrectly accounted for) by these other predictor variables. PATH identified many potential hypotheses to explain the potential sources of extra mortality, but limited its analysis to three hypotheses: hydro system (existence of Snake River Dams), ocean regime shift, and stock viability degradation (Marmorek and Peters, 1998). One important hypothesis that was initially pursued was the hypothesis that EM was a function of hydro system mortality, but this was later rejected based on analyses that showed no correlation between juvenile passage survival and EM.

EM is a critical uncertainty in the NMFS BO in the evaluation of the removal of the lower Snake River dams. The NMFS BO and PATH analyses both show that if EM is not significantly related to the existence of the Snake River Dams, than removal of these dams will have very minor benefits to the listed stocks. The NMFS BO identifies an RPA that includes alternatives to dam removal. However, if the ESU stocks are not performing to the desired level at the end of 10 years, additional mitigation alternatives will be considered including breaching of Snake River dams. It is therefore critical to resolve this uncertainty regarding the source or sources of EM before a decision can be made to remove dams with any confidence that this action would have a significant benefit. In addition, other actions that can be identified to decrease EM could provide major improvements in survival. NMFS has identified additional EM hypotheses in the BO related to the potential effects of hydro on prespawning mortality and mortality related to changes in ocean plume/estuarine conditions. Development of monitoring and research that may help define mechanisms of EM will be a high priority in the RM&E plan.

8.4.7 — Uncertainty in Lambda Estimates

The level of survival increases needed to meet the jeopardy standards for each ESU depends critically on the lambda (annual population growth rate) estimates determined in the NMFS BO assessment. The accuracy and precision attending lambda estimates is obviously important in this regard. Related assessments by McClure et al (2000) and Hinrichsen (2001) showed that the lambda and extinction risk estimates (using variants of the Dennis model that is applied in the BO assessment) have very broad confidence intervals. Lambda estimates are imprecise due to high variability in population growth and mortality from year to year. The estimation technique uses less than half of the available spawner count data for many stocks by limiting the years of analysis to 1980 to present in order to address the impacts of the current hydropower configuration.

NMFS plans to update the lambda and survival improvement estimates at the 5 and 8 year check-in assessments. Additional work is required prior to that time to determine the best ways to use lambda in rigorous statistical tests. NMFS also plans to perform a regional collaborative review of the analytical methods prior to March 1, 2005. The Plan may be modified as appropriate as these assessment methods are updated. Additional research is required to help sort out the differences among modeling approaches and, more importantly, to assess their efficacy in predicting the future of listed stocks.

8.4.8 — Effects of Habitat, Hatchery, and Harvest Actions

The NMFS BO assumes that required survival increases beyond those attained via hydro system actions will be made up by habitat, hatchery, and harvest actions. These actions will consist of measures implemented by the Action Agencies in combination with the actions of other Federal and non-federal entities. Our Strategies and Priorities for implementing actions is outlined in this Plan in Sections 5 and 6. A critical uncertainty in the implementation of the Plan and in the evaluation of the success of measures at the 5 and 8 year check-ins will be the effect of these actions on the environment and on life stage specific survival rate and population level response. In particular, a high level of uncertainty exists for the magnitude and response time of habitat actions. The NMFS BO assumes all habitat actions take effect immediately, which can result in overly optimistic projections of needed survival if there are substantial delays in the response to actions. These broad areas of uncertainty will be addressed as a major component of a comprehensive RM&E plan which is discussed in Sections 5.6 and 6.5.

8.4.9 — Effects of Reservoir Operations on White Sturgeon and Bull Trout

Reservoir operations can affect resident fishes in several ways. For example, they can reduce connectivity and thereby increase population fragmentation. They can also increase total dissolved gases to levels that are harmful to fish and invertebrates. Reservoir operations can alter water temperature regimes, which may interfere with migration patterns, timing of spawning, and rearing potential. Operations can also alter flow patterns, which may affect spawning migrations, spawning behavior and success, recruitment of spawning substrates, year-class strength, and invertebrate production. Rapid changes in flows can strand fish and invertebrates and reduce spawning and rearing habitat both upstream and downstream from the dam. However, the extent to which reservoir operations affect the production of bull trout and white sturgeon is largely unknown.

There are further uncertainties pertaining to the use of mainstem reservoirs and fish passage facilities by bull trout populations. The Action Agencies have included investigations of the size, location, and behavior of these populations in this Implementation Plan. However, as outlined in the USFWS BO, further research may be necessary to address specific mainstem operational or configurational modifications that may be warranted once these populations are further defined. The Action Agencies expect to coordinate this research with the USFWS, as well as other regional fishery managers, and incorporate such research into the comprehensive program discussed elsewhere in this section.

There is no question that gas bubble disease can affect aquatic organisms downstream from hydroelectric dams. However, the level of gas saturation at which bull trout and white sturgeon are negatively affected is unknown. Although current water quality standards do not permit total dissolved gas to exceed 110 percent, laboratory and field research suggest that several species of fish are not negatively affected at gas saturation that approaches 120 percent (Dell, et al., 1974; Weitkamp and Katz 1980; Ryan, et al., 2000). Research is needed to assess the effects of various levels of total dissolved gas saturation on bull trout and white sturgeon.

Hydroelectric facilities often require frequent changes in generation that can alter the volume and velocity of water released downstream. The effects of these altered discharge patterns on seasonal and diel movements, spawning behavior and success, redd placement, habitat use, stranding, and population structure of bull trout are mostly unknown. Reservoir operations may also affect the abundance and distribution of bull trout food. The USFWS BO noted that bull trout in Lake Pend Oreille may become greatly depressed if the kokanee (an introduced species) forage base is lost. Maiolie and Elam (1993) believe that reservoir operation is likely the single largest factor contributing to the decline of kokanee in Lake Pend Oreille. Currently, there is no evidence that bull trout survival is related to the production of kokanee. Because bull trout are opportunistic feeders (Goetz 1989), research is needed to assess the effects of reduced kokanee production on the survival of bull trout.

The spawning success of white sturgeon appears to be closely related to the magnitude of spring flows in the Kootenai River. White sturgeon are broadcast spawners, releasing their gametes in fast water during spring high flows (April through July). Spawning at peak flows with high water velocities disperses and prevents clumping of the adhesive eggs. When spring flows are reduced, spawning success appears to decrease (Paragamian, et al., 1997). Additional research is needed to assess the minimum spring flows necessary for successful reproduction of white sturgeon in the Kootenai River. Studies are also needed to identify what effect other factors such as predation and diking have on the production of white sturgeon. Finally, information is needed on the level of spawning success necessary to maintain a viable population and to look at the trade-offs between resident fish and anadromous fish mitigation options.

9.0 Implementation Processes

This Plan intersects with a number of ongoing projects, programs and processes in different ways.

The following section describes the relationships between the Plan and:

- The 2000 Biological Opinion Record of Decisions (ROD);
- New and ongoing Environmental Impact Studies (EIS);
- Programs for compliance with National Historic Preservation Act and other cultural resources obligations;
- Relations with the 13 tribes of Columbia River Basin; and
- Ongoing fish and wildlife programs and processes in the region.

9.1 — 2000 Biological Opinions Decision Records

Each Action Agency has or will issue decision records to implement the RPA described in the 2000 NMFS BO, as expressed in the Five-Year and Annual Implementation Plans. The decisions will be developed in accordance with the BOs, and consistent with applicable NEPA analyses.

The COE issued its decision statement (Record of Consultation and Statement of Decision) on May 15, 2001.

9.2 — New and Ongoing Environmental Impact Studies

Lower Snake River Juvenile Salmon Migration Feasibility Study

In response to the National Marine Fisheries Service 1995 BO, the COE initiated the Lower Snake River Juvenile Salmon Migration Feasibility Study. The study focuses on how the Lower Snake River dams can be changed to improve survival and assist recovery prospects for Snake River ESA-listed salmon and steelhead stocks.

The study examines the following four major alternatives for the lower Snake River dams:

- Maintain the existing fish passage system with current and planned improvements;
- Maximize transportation of juvenile fish;
- Make major system improvements such as removable spillway weirs, behavioral guidance structures, surface bypass, gas abatement measures, and turbine passage improvements; and
- Permanent breaching of the dams.

In December 1999, the COE released a draft Feasibility Report and Environmental Impact Statement (FR/EIS) on these alternatives for public review, as stipulated in the 1995 BO. In order to allow all affected parties in the region to address the issues within the broader context of other ongoing regional efforts for Columbia River Basin fish, a preferred alternative was not identified in the draft FR/EIS. In conjunction with the Federal Caucus, the COE held 15 public meetings throughout the region (Oregon, Idaho, Washington, Montana, and Alaska).

The COE continues to progress toward a final FR/EIS. The COE is now processing the considerable volume of comments received and is analyzing the substantive issues raised. At this point in the evaluation, all four alternatives are still under consideration. The information and measures called for in the NMFS BO will be a factor in the COE's choice of a preferred alternative in the final FR/EIS. It is anticipated that the final FR/EIS, with a preferred alternative, will be completed in 2001. If appropriate, the final FR/EIS will be used to seek Congressional authorizations for construction.

The NMFS BO does not rely on dam breaching to avoid jeopardy. However, it indicates that breaching should be kept as a future option, and establishes a schedule and triggers for determining whether to pursue this option. The BO recognizes that breaching is a major action requiring NEPA compliance and Congressional authorizations. In addition, it lays out an expedited schedule to allow for the quick implementation of breaching or other more aggressive actions if necessary.

BPA Fish and Wildlife Implementation Plan EIS

BPA's environmental impact analysis of the effects of implementing the NMFS and USFWS BOs is in three parts: (1) The System Operation Review (1995) and its Record of Decision (ROD) (1997), along with analyses tiered to them, cover operation of the FCRPS; (2) The Programmatic Wildlife Mitigation (1997) and Programmatic Watershed Management (1997) EISs provide coverage for off-site mitigation under both the BOs; and, (3) the NWPPC Fish and Wildlife Program. BPA's Draft Fish and Wildlife Implementation Plan EIS, to be released in June 2001, covers the over-arching policy alternatives available to BPA.

BPA expects to finalize the Fish and Wildlife Implementation Plan EIS by the end of 2001. This EIS will provide the BPA Administrator, and the public, with a broad-based analysis of the possible environmental consequences of BPA's fish and wildlife mitigation and recovery decisions. Upon completion of a Final Fish and Wildlife Implementation Plan EIS, the Administrator will select an alternative, a policy direction, to guide BPA's future fish and wildlife mitigation and recovery efforts.

BPA expects its actions under this Plan to be covered under either the existing EISs noted above or under the new Fish and Wildlife Implementation Plan EIS. Where supplemental analyses are necessary, they will build on this underlying structure.

VARQ EIS

VARQ reduces system flood control drafts at Hungry Horse and Libby in average and below-average water years. Reclamation and the COE, as co-lead agencies, will prepare an EIS to evaluate the impacts of the change in operation. The NMFS and USFWS BOs called for the EIS and coordination with Canada to be completed in time to implement VARQ at Hungry Horse in 2001 and at Libby in 2002. Implementation of this action may proceed following consideration of the EIS and will be reflected in a ROD.

Banks Lake Study and EIS

The Banks Lake Drawdown Study will examine the effects of an additional 5-feet reduction in the surface elevation of the reservoir during the month of August. This would reduce the amount of water pumped into Banks Lake by about 130 thousand acre feet, which could effectively increase the amount of Columbia River water available for flow augmentation. Reclamation will prepare an EIS that will describe the potential environmental, cultural, and economic impacts of the proposed action. Implementation of this action may proceed following consideration of the EIS and would be reflected in a ROD. The NMFS BO calls for the completion of the study and EIS by June 2002.

Reclamation NEPA Compliance for 16 Tributary Sub-basin Habitat Improvements

Implementation of Reclamation's tributary sub-basin habitat improvements under NMFS BO Action 149 will require NEPA compliance prior to project implementation. Reclamation plans to perform programmatic NEPA on a sub-basin basis, initiating this effort in the year prior to program implementation in each sub-basin. Programmatic NEPA would address the three program components of diversion screening, migration barrier modification, and instream flows. Individual projects will be evaluated for site-specific impacts, such as cultural resource evaluations, and these site-specific impacts will be addressed and tiered into the programmatic NEPA document. Prior to completion of programmatic NEPA in any sub-basin, evaluations and appropriate NEPA documentation will be completed on a case-by-case basis. In addition to NEPA compliance, Reclamation will pursue programmatic ESA consultations with NMFS and the FWS as appropriate.

9.3 — Cultural Resources

Programs for compliance with National Historic Preservation Act and other cultural resources obligations are linked to the actions under this Plan. Actions described in the Plan affect reservoir levels, operations, and transmission facilities — all of which, in turn, may have potential impacts on broadly defined cultural resources. Several statutes, including the National Historic Preservation Act (NHPA), Native American Graves Protection Act (NAGPRA), the Archeological Resources Protection Act (ARPA), policies and executive orders establish the framework for protection of these cultural resources.

Hydro System Actions

In order to meet cultural resources responsibilities as they relate to the operation of the FCRPS, including actions taken under the Plan, the Action Agencies will continue with and enhance the collaborative relationship developing through Reservoir Cooperating Groups, an outgrowth of the Intertie Development and Use EIS and the SOR EIS. These groups allow the Action Agencies, Tribes, and State Historic Preservation Officers, and Tribal Historic Preservation Officers to identify issues, objectives, and management actions collaboratively. BPA directly funds $3.7 million annually and the COE and Reclamation secure another $0.7 million annually to support this cultural resources program. The program is intended to fulfill the Action Agencies' cultural resource responsibilities under mandates such as the NHPA and NAGPRA, as well as for emergency management situations.

Some actions proposed in the Plan were not contemplated at the time the reservoir groups were established. The Action Agencies will share information on hydro system actions in the Plan in a timely manner with the reservoir cooperating groups so that they may plan their survey and compliance work at appropriate times and places, and also explore necessary adjustments to the program. To the extent the cultural resources program develops goals and objectives, the Action Agencies can consider those in annual updates of the Plan. This dialogue may also be an appropriate time to assess the overall direction and effectiveness of the program.

The VARQ and Banks Lake environmental review processes, and BPA's Fish and Wildlife Implementation Plan EIS will include consultation with affected tribes regarding cultural resources impacts. The Action Agencies will also consult pursuant to NHPA and as appropriate with individual tribes.

Habitat, Hatcheries, and Harvest Actions

The Plan includes off-site actions to aid in the FCRPS avoidance of jeopardy and to assist in recovery of listed species. Many of the actions called for in the BOs already have full or partial environmental compliance, including outlines of the processes the Action Agencies will follow for ensuring compliance with cultural resource laws and policies. BPA's Wildlife Mitigation Program and Watershed Management Program EISs and their RODs discuss these processes. In addition, BPA's Fish and Wildlife Implementation Plan EIS will also provide guidance for ensuring fulfillment with all cultural resource obligations. BPA may engage in programmatic consultations where the necessary parties are willing to do so, or it can seek compliance on a project-specific basis for individual undertakings. BPA will rely on existing categorical exclusions or programmatic agreements where they're applicable and no extenuating circumstances require additional steps to ensure the Action Agencies meet their cultural resource obligations. Reclamation and the COE will ensure compliance with cultural resources evaluations and mitigation in concert with NEPA compliance for off-site mitigation actions.

9.4 — Tribal Involvement

The 13 Columbia Basin tribes are sovereign governments with management authority within their reservation boundaries. The Federal government has a unique relationship with the Columbia Basin tribes as established in treaties and executive orders. The Action Agencies recognize that actions included in this Plan may have direct and indirect impacts on tribal resources. The Action Agencies will fulfill their obligations by working directly with the tribes to seek a mutually acceptable approach to tribal involvement. Options include, among others, formal policy consultations, technical consultations, government-to-government consultations, and information sharing.

9.5 — Regional Programs

Northwest Power Planning Council (NWPPC) — The NWPPC is an interstate agency formed by the states of Idaho, Montana, Oregon, and Washington and operating pursuant to the Northwest Power Act. The Northwest Power Act calls on BPA to use its funds and other authorities in a manner consistent with the NWPPC's Fish and Wildlife Program. In order to ensure that actions BPA takes to fulfill BO responsibilities as further defined in the Plan are integrated with actions taken to implement the NWPPC's Fish and Wildlife Program, BPA will coordinate selection and implementation of off-site mitigation actions through the NWPPC's processes. In implementing actions contained in this Plan, Reclamation and COE will also inform the NWPPC of their off-site BO implementation actions in order to allow for a unified approach.

ISAB Review — The Action Agencies will ask the Independent Scientific Advisory Board (ISAB) to review our final Five-Year Implementation Plan. The Action Agencies seek validation of the conceptual framework of the Plan and will provide the ISAB with specific questions to guide their review. Following adoption of the Plan, the Action Agencies anticipate significant coordination between the NWPPC processes and the activities the Action Agencies will be initiating under the Plan.

ISRP Review — The Action Agencies, particularly BPA, expect to work with the NWPPC to integrate the prioritization process described in this Plan with the review of the proposals conducted by the Independent Scientific Review Panel (ISRP). Those proposals that are not responding to BO implementation requirements would be reviewed by the ISRP using their current criteria. The ISRP will review all proposals on the basis of their scientific and technical merit and make appropriate recommendations. Thus, the ISRP would perform, as is the current practice required by the Northwest Power Act, project-specific reviews for all the on-going projects (not ESA-related) and new proposals (focused to meet BO actions) submitted for funding through the various NWPPC processes. The other Action Agencies will inform the NWPPC of their off-site BO implementation in order to coordinate their actions with those undertaken by BPA through the Council process.

Sub-basin Assessment and Planning — The Action Agencies will be working closely with the NWPPC, and with NMFS and USFWS, on sub-basin assessment and planning. A common template for assessments has already been prepared. The schedule and priority for sub-basin plans is currently being developed. The Action Agencies will work to ensure completion of these plans by 2006.

Provincial Reviews — In the near term, BPA will use the NWPPC's Provincial Review process as the primary vehicle for soliciting project proposals to address BO actions. The Action Agencies recognize the value inherent in the Provincial Review process that allows all proposals to be evaluated in the context of a comprehensive plan. Provincial project solicitations will identify specific BO implementation needs in conjunction with broader non-ESA Northwest Power Act priorities. However, because the Provincial Review process is a rolling three-year process, it will be necessary for an additional mechanism for targeted solicitations to be instituted.

Targeted Solicitations — As stated above, the preferred and primary vehicle BPA will use to solicit projects to fulfill our Plan requirements is the Provincial Review process to ensure the best possible integration of ESA implementation with the broader goals of the Northwest Power Act's fish and wildlife goals. Targeted solicitations will likely be necessary on a limited basis in the following circumstances: (1) In the event that an Plan requirement does not fit within the schedule for the Provincial Review; (2) if there are insufficient qualifying projects presented in response to a Plan requirement in a Provincial Review. It may also be necessary, on a very limited basis, to respond to an emergency or unanticipated need to do a time-limited targeted solicitation or contract.

In the case of targeted solicitations/contracts BPA will coordinate with the NWPPC to ensure integration of Plan actions with the NWPPC Fish and Wildlife Program. BPA also anticipates discussing with NMFS and USFWS, as appropriate, the parameters of the solicitations. All targeted solicitations/contracts (if appropriate subjects of scientific review) will be reviewed by the ISRP.

Data Management

The Action Agencies will be coordinating the data management needs for this Plan and for RM&E with the NWPPC. The Action Agencies recognize that the NWPPC is already working on coordinated data management for the Basin.

The Federal Caucus, the Federal Habitat Team, and All-H Implementation

The Action Agencies continue to have representation on the Federal Caucus pursuant to the December 2000 Memorandum of Understanding among Federal Agencies Concerning the Conservation of Threatened and Endangered Fish Species in the Columbia River Basin. Each agency will also have representation on the Federal Habitat Team, as well as with Interior Columbia Basin Ecosystem Management Plan (ICBEMP) and the Northwest Forest Plan, to coordinate off-site mitigation actions. Actions taken under this Plan will be coordinated with the Federal Caucus.

The Action Agencies are participating in the Federal Habitat Team and will coordinate the Plan with other Federal efforts. However, the Action Agencies do not intend to delay the implementation of actions required by the BOs pending the development of coordination processes and procedures by the Federal Habitat Team. Consequently, the development of this first-year Plan will not be as fully coordinated with other, non-Action Agency members of the Federal Habitat Team as future Plans will be once the team is fully functional.

Lower Columbia River Estuary Program

The Action Agencies will coordinate actions in the estuary with the Lower Columbia River Estuary Program. More detail on this coordination is described under Section 6.3 Habitat Priorities.

Regional Forum

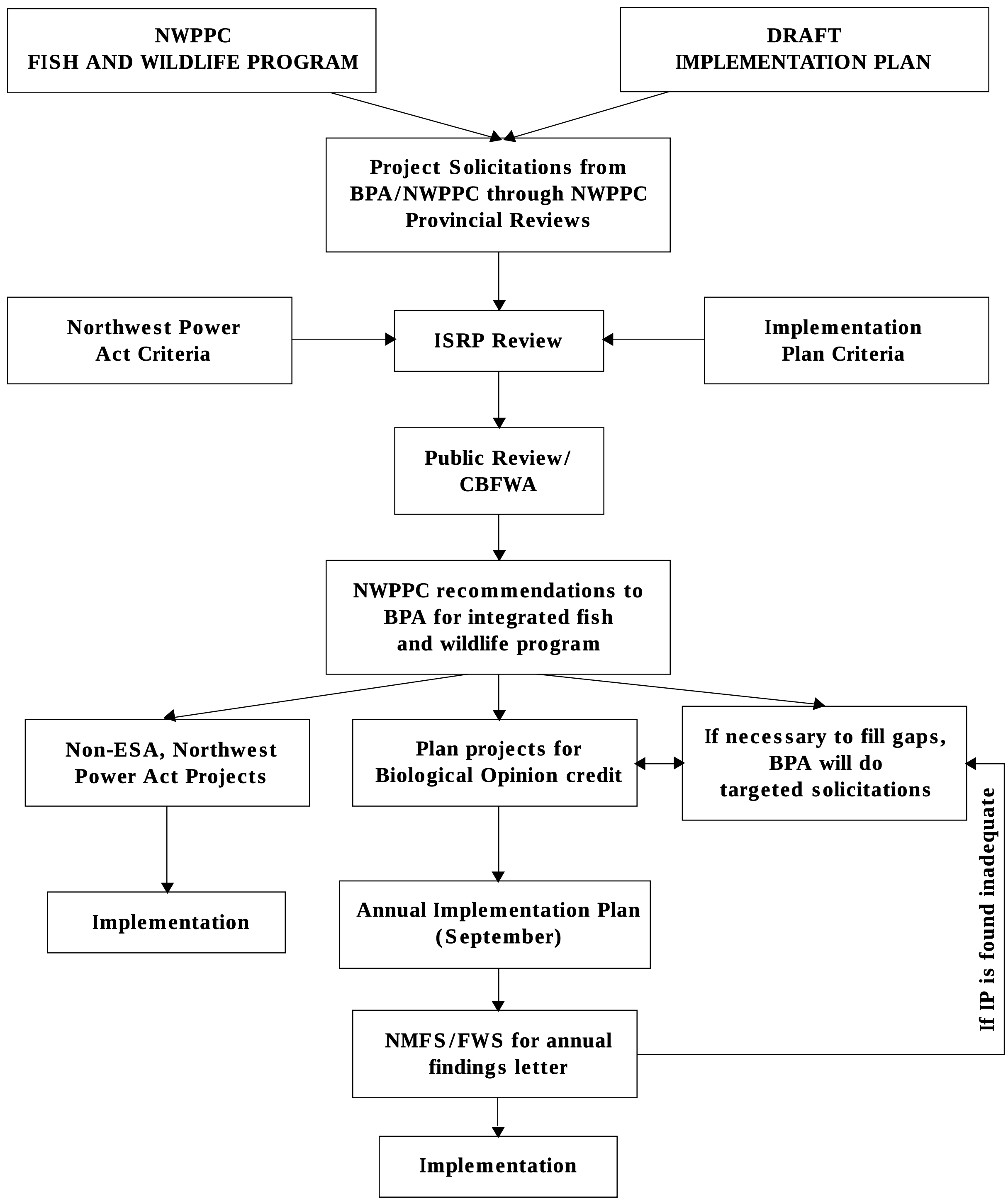
Development of the hydro system portion of the Plan will be coordinated through the NMFS Regional Forum. The goal of this Forum is to ensure the broadest possible technical and policy input in planning, funding and implementation decisions regarding the operation and configuration of the FCRPS.

Regional Forum Teams include the Executive Committee; the Implementation Team; the Technical Management Team; the System Configuration Team; and the Dissolved Gas Team. Membership of the Implementation Team is open to senior program and policy level personnel from the states, Tribes and Federal agencies. The other teams and subgroups operating under the Implementation Team's guidance are open to Federal, State, and Tribal representatives with technical expertise in hydroelectric operations and/or the effects of hydroelectric operations on listed migrating and resident fish. All meetings of the Regional Forum are open to the public. Meeting minutes are distributed available for review on the NMFS Northwest Region homepage at: www.nwr.noaa.gov

U.S. v. Oregon

The Action Agencies will coordinate implementation of harvest-related actions as appropriate with relevant parties, such as the U.S. v. Oregon process, and ocean management forums, such as the Pacific Fisheries Management Council and Pacific Salmon Treaty. The Action Agencies are not parties to U.S. v. Oregon and will rely on NMFS and USFWS to play an active role in assisting the Action Agencies in the necessary coordination between actions taken under this Plan and the U.S. v. Oregon Process.

Figure 9.1 — Implementation Plan and NWPPC Fish and Wildlife Program Integration



10.0 Conclusion

The Action Agencies are committed to a better future for the endangered and threatened fish of the Columbia Basin. Through this Plan, we build on our past efforts to improve fish survival and fish habitat, and recognize that more remains to be done. Through this Plan, we intend to take action, undertake studies, and measure the results of our actions. Through this Plan, we acknowledge the need to work closely with others throughout the region who share our commitment and responsibilities for fish recovery. The Action Agencies are hopeful that the comprehensive program we describe, combined with similar efforts by others, will help to recover the Basin's salmon and steelhead, bull trout and sturgeon.

We ask you to submit your comments to us by the date noted in our transmittal letter. We will accept electronic (preferred) or written comments on the questions listed here. Comments can be e-mailed to: federalcaucus@bpa.gov

Our mailing address is: Action Agencies Implementation Plan, c/o BPA-P, P.O. Box 3621, Portland, OR 97208

We ask reviewers of this Plan to consider these questions as they prepare their input to us.

1. Adaptive management and RM&E are critical components of the Plan. Are there alternative approaches or components that we should consider?
2. We have attempted to take a comprehensive but practical approach to Performance Standards. Are there other Performance Standards that would be practical and could be used to gauge performance, particularly in the short term?
3. Are the criteria for prioritizing actions appropriate? Are there other specific criteria you would suggest?
4. Currently, the timing of the hatchery HGMPs and sub-basin assessments has not been integrated in the plan. Would it make sense to align the schedules of these processes with the implementation planning needs? Do you have suggestions for the best way to integrate them?
5. Is accessing the materials via the website useful? Were you able to find specific information of interest to you on the website? Is there information beyond what is currently included on the website that would aid coordination efforts with other regional planning and implementation processes?

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Appendix A

Excerpt from Draft Paper

By

Federal Agency Performance Standards Workgroup

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DEVELOPMENT OF PROVISIONAL PERFORMANCE MEASURES AND STANDARDS FOR FEDERAL HYDROSYSTEM IMPACTS IN THE COLUMBIA RIVER BASIN

(MARCH 13, 2000 - DRAFT)

I. Introduction

Although salmon and steelhead are subject to both natural and human-caused mortality, twelve species in the Columbia River basin are listed under the Endangered Species Act (ESA), primarily due to human-caused mortality. Human activities that affect salmonids can be divided into four broad categories: hydrosystem (including the effects of mainstem hydroelectric dams and storage reservoirs), tributary habitat, hatcheries, and harvest. The National Marine Fisheries Service (NMFS) is developing population-level measures of survival and recovery for each species. For each of nine affected life-history stages, NMFS will identify protection and conservation actions for the appropriate categories of human activity, estimate an expected change in total survival as a result of these measures, and compare these predictions to the levels needed for survival and recovery. Selected actions can then be combined to form an overall ESA Recovery Plan to direct salmon recovery efforts.[1]

Our ability to measure the success of a recovery plan will depend on the development of an acceptable set of performance measures and associated goals or standards that can be used to judge the success of the recovery effort. This paper addresses a process for formulating these performance measures in the context of three objectives:

1. Propose a procedure for placing hydrosystem-related performance measures and standards in context with performance measures and standards for other, non-hydrosystem actions that affect various life-history stages;

2. Develop a suite of provisional performance measures and standards applicable to hydrosystem-related actions; and

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[1] Other ecosystem-scale recovery efforts have preceded our experience and have encountered similar issues. Notable examples are the Everglades and Chesapeake Bay striped bass recovery programs (Appendix A).

3. Develop a blueprint for revising the hydrosystem-related performance measures and standards in the context of mitigation measures using non-hydrosystem activities (i.e., in a comprehensive recovery planning effort).

Organization of This Paper

In the following section (Section II), we present an overview of the concepts of performance measures and standards, linking the hierarchy of these parameters to a hierarchy of biological responses. Practical considerations, such as the need to convert the performance measures defined for decision-making into measures that can be monitored, are also discussed. In Section III, we present a method for evaluating combinations of values of life-history stage specific performance measures that represent survival through the hydrosystem or through the effects of harvest, habitat, and hatchery activities on the species' status, relative to potential performance measures at the population level. Section IV includes examples of several "provisional" hydrosystem performance measures (and associated standards), presented for consideration in the event that the analytical tools for developing the population-level performance measures are not available and allocation issues are not resolved prior to upcoming decision points. In Section V, we describe next steps in the process of developing performance measures and standards.

II. Hierarchy of Performance Measures and Standards

Performance Measures and Standards - Definitions

A performance measure describes 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 (HCP) have suggested the parameter "survival of smolts passing a dam" as a useful and informative performance measure and have set an associated standard of 95%. 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.

This paper focuses on performance measures and standards related to the operation and configuration of the Federal Columbia River Power System (FCRPS). The most meaningful performance measures are those defined in the first tier, at the **population-level** (Figure 1a). Here, measures and standards (goals) can be stated in terms of spawner abundances, 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**. Therefore, it is appropriate to define a second tier of performance measures and standards for the human-induced components of survival in each (of nine) life-history stages (e.g., spawning to emergence, emergence to parr, parr to smolt, etc.) (Figure 1a). The performance measures in the second tier should sum to the population-level performance measure. Within each life-history stage, management actions can affect fish survival or condition in each of four categories of **human activities**: hydrosystem, harvest, habitat, and hatcheries. Therefore, we describe a third tier, in which the performance measures and standards for each life-history stage are broken down into those for the appropriate categories of human activity (Figures 1a and 1b). 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.

Figure 1a. Hierarchy of performance measures (PMs), as described in the text.

Tier 1: Population-Level Performance Measures

- Absolute extinction risk
- Quasi-extinction risk
- 1995 FCRPS Biological Opinion "survival" metric
- 1995 FCRPS Biological Opinion "recovery" metric

Tier 2: Life-History Stage Specific Hydrosystem Survival Performance Measures

Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6	Stage 7	Stage 8	Stage 9	
Spawning to Emergence	Emergence to Parr	Parr-Smolt	Smolt @ Upper Dam to Smolt @ BON	Smolt @ BON to "Early Ocean"	"Early Ocean" to maturity	Adult @ CR mouth to Adult @ BON	Adult @ BON to Adult @ Upper FCRPS Dam	Adult @ Upper FCRPS Dam to Adult @ Spawning	**Total Survival**

Tier 3: Performance Measures for Human Activities

Stage 1 – Hydr	Stage 2 -- Hydr	Stage 3 -- Hydr	Stage 4 – Hydr	Stage 5 – Hydr			Stage 8 – Hydr	Stage 9 – Hydr	= Σ Hydro PMs
					Stage 6 – Harv	Stage 7 – Harv	Stage 8 – Harv	Stage 9 – Harv	= Σ Harv PMs
	?	?	?	?	?	?	?	?	= Σ Hab PMs
	?			?	?	?	?	?	= Σ Hatch PMs

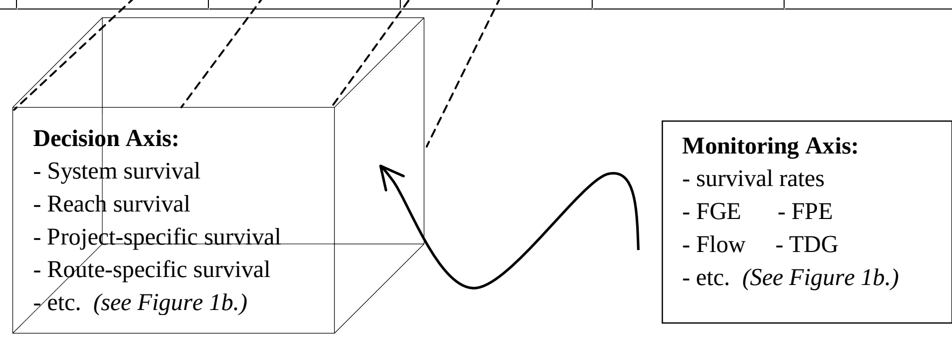

Figure 1b. Tier 3 performance measures for human activities, decision and monitoring axes – detail from box at the bottom of Figure 1a, expanded for each life stage that is affected by Hydro configurations and operations.

Tier 3: Performance Measures for Human Activities

Stages 1-3		**Stage 4**		**Stage 5**		**Stage 8**		**Stage 9**	
Decision Axis	Monitoring Axis	Decision Axis	Monitoring Axis	Decision Axis	Monitoring Axis	Decision Axis	Monitoring Axis	Decision Axis	Monitoring Axis
• Areal extent of mainstem spawning habitat • Adequate cover during incubation and rearing (including compensation depth for TDG) • Connectivity to migration corridor during emergence • Water and sediment quality in mainstem spawning, incubation, and rearing habitat	• Flow rate • Elevation over redds • Temp • Turbidity • TDG	• System survival • Reach survival • Project survival • Route-specific survival	• Survival rates (e.g., from PIT- and radio-tag studies) • FPE • FGE • Temperature • TDG • Spr/sum flow • FPP juvenile criteria	• Delayed mortality • Direct mortality (asso. w/ water management) • Direct mortality (asso. w/ spawning and rearing for chum and LCR chinook)	• Fish condition • Smolt timing to estuary • Fall/winter flows • Predation indices • Comparison of SARs for fish groups with different hydro experiences • Comparison of R/S ratios for fish groups with different hydro experiences	• Adult survival through Federal reach (not incl. harvest)	• Conversion rates (not incl. harvest, turnoff, and differential fallback rates) • Radio telemetry • FPP adult criteria	• Delayed mortality	• Condition of adults at upper dam • Compare % unspawned females in spawning areas above different numbers of dams (?) • Temperature in reach above upper dam (influenced by Federal water management)

Note: Monitoring may involve the use of surrogate species, hatchery fish, or surrogate reaches for survival estimates

Ideally, all three tiers of performance measures and their associated standards would be stated in common units, such as the survival of naturally-produced fish of a particular species or evolutionarily significant unit (ESU). However, performance measures and standards defined for the purpose of regulatory decision- making may have to be converted into parameters that can be monitored after a decision is made. For example, the effectiveness of a decision regarding whether to proceed with a suite of management activities may be monitored and evaluated as survival from point A to point C in the "smolt-to-ocean-entry" life-history stage of naturally-produced fish within the ESU (a second tier performance measure). However, it may only be possible to monitor the survival of hatchery fish and only between point A and point B. It would be necessary to convert the expected survival of naturally produced fish between points A and C into an expectation of the (measurable) survival of hatchery fish between A and B. The decision about effectiveness may be based on inferences from a number of related observations, possibly combined into a modeling framework. Also, if survival between points B and C represents or includes indirect mortality associated with a human activity, the causal mechanisms (e.g., injury, fish condition, predation rate) may become underlying components of the suite of recommended performance measures, even though they may be difficult to directly observe. The same may apply to mortality associated with habitat modifications, which are difficult to monitor but can be converted into a suite of performance measures stated as environmental parameters.

First Tier: Population-Level Performance Measures

Population-level performance measures are useful for evaluating the full suite of human activities and environmental conditions affecting survival over the whole life cycle. Because there is inherent "noise" (unexplained variability) in these indices, it may be difficult to detect broad-scale population-level responses resulting from modifications of specific human activities[2]. With the exception of the survival and recovery performance standards defined by the Biological Requirements Work Group (BRWG) for Snake River chinook and sockeye salmon (***citation***), performance standards have not been identified at the population level for Columbia basin ESUs at this time. When these goals are developed, NMFS expects that, at a minimum, the population-level performance standards will not jeopardize the continued existence of the listed ESUs[3]. Managers may also chose to define population-level performance measures more conservatively, to include, for example, protection for non-listed anadromous and resident fish, to include a harvestable surplus (that would meet the Federal government's tribal trust responsibilities), or different probabilities that survival and recovery will be achieved. In this paper, however, the discussion of population-level performance standards is restricted to NMFS' survival and recovery jeopardy standards for listed salmon and steelhead. Details are presented in Section III.

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[2] Preliminary analyses from the experimental management group of the Plan for Analyzing and Testing Hypotheses (PATH) (Marmorek and Peters 2000) illustrate that it may take on the order of decades to detect a change in population-level performance measures that can be attributed to changes in human actions.

[3] Per NMFS' 1995 FCRPS Biological Opinion, a suite of actions (i.e., hydrosystem, harvest, habitat, and hatchery activities) that does not jeopardize a listed species results in a "high" likelihood of survival and a "moderate to high" likelihood of recovery (NMFS 1995).

Second Tier: Life-History Stage Specific Survival Performance Measures

The second tier of performance measures and associated standards, the **life-history stage specific survival estimates**, reflect effects incurred during specific portions of the life cycle[4]. Because there is usually a more direct cause-and-effect relationship (less noise), life-history stage specific performance measures are expected to be more useful than population-level performance measures for assessing the effects of a particular human activity. However, these relationships are still complex because, for some ESUs, more than one human activity may affect a particular life stage and the effects of a given human activity may be expressed over more than one life-history stage.

The greatest difficulty in setting performance standards for each life-history stage is ensuring that these are consistent with the population-level performance standards. That is, the performance standards for the egg-to-smolt, smolt-to-adult, and adult life-history stages should, in combination, result in a population-level response (e.g., number of spawners) that satisfies the population-level performance standard. To accomplish this, one needs to know the population-level performance standards. And, because there are, in theory, many alternative ways of combining survival in different life stages to meet the population-level standards, there must be some allocation of mortality among the various life-history stages. This is discussed further with respect to the third tier of performance measures.

Third Tier: Performance Measures for Human Activities

The third tier of performance measures and standards represents the crux of most management decisions. This tier seeks to link the effects of **human activities** to life-history stage specific survival rates. **Hydrosystem (i.e., FCRPS) performance measures** will be defined at this level. These performance measures are likely to encompass several life stages (e.g., mainstem smolt emigration, estuary and early ocean survival, adult survival during upstream mainstem passage, and adult survival between the last dam and the spawning area). It is unlikely that survival in any life-history stage is exclusively a function of the FCRPS hydrosystem; some natural mortality (e.g., predation) would occur even if the FCRPS had never existed and other ongoing human activities (e.g., mainstem harvest of adults) influence survival in the existing system. **This paper addresses only performance measures of effects related to the operation and configuration of the FCRPS hydrosystem. The authors assume that other teams will be designated that will address performance measures for other sources of human-caused mortality. Although Figure 1b demonstrates a distribution of the effects on each life stage among harvest, habitat, and hatchery activities, this is for illustration only and should not be interpreted as a conclusion or recommendation of the authors.**

The challenge of setting performance standards for each category of human activity is ensuring that, when considered in tandem with natural survival rates, the cumulative effect will be equivalent to that of the associated life-history stage specific performance standard (and,

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[4] The survival through each life-history stage (e.g., egg-to-smolt, smolt-to-ocean entry, marine residence, smolt-to-adult, and adult freshwater survivals) is the result of (1) natural mortality, (2) direct mortality from human activities in this life stage, and (3) indirect mortality due to human activities in preceding life-history stages.

ultimately, to the population-level performance standard). The allocation issue identified in Tier 2, above, is actually a Tier 3 issue, because managers can only influence human-derived sources of mortality. Therefore, a Tier 2 decision to require, as performance standards, a certain mainstem adult survival, coupled with a particular mainstem smolt survival, actually reflects a Tier 3 decision to allocate the necessary survival of adults and juveniles among, for example, harvest and hydrosystem activities.

Allocations of this sort have not yet been made within the region. Even if they had been made, analytical tools for ensuring consistency among life-history stage and population-level performance standards are not currently available for all ESUs. This paper addresses these problems in two ways.

First, for those ESUs for which analytical tools (CRI, PATH) are available, we examine the life-history stage specific survival rates that could result from alternative human activities (hydrosystem and all other activities) and the population-level survival rates that would be expected to result from each combination. After identifying the population-level performance standard necessary for a particular management decision, policy makers can determine which combination(s) of FCRPS hydrosystem and other actions are likely to (1) achieve this performance standard and (2) represent an acceptable allocation of human-caused mortality among life stages**.** This process is discussed further in Section III.

Second, for the other ESUs (i.e., for which these analytical tools are not available), we propose a range of potential FCRPS hydrosystem performance standards (discussed in Section IV). That is, these suggestions are provisional, in the sense that we expect that they would be refined when the analytical tools and policy allocation decisions become available for each ESU. We use ESUs for which the first approach is also possible to test the reasonableness of this second approach. That is, do the life-history stage specific performance standards sum to a reasonable population-level performance standard?

Practical Considerations Relative to Performance Measures for Monitoring

In the preceding section "Hierarchy of Performance Measures and Standards", we noted that performance measures and performance standards developed for decision making may have to be converted into other metrics that can be monitored. The previous sections have focused largely on the use of measures and standards for decision making. However, a number of issues must be addressed when they are considered for monitoring purposes. Earlier, we said that we would restrict our discussion of population-level measures and standards to threatened and endangered salmonid stocks in the basin. As such, naturally spawning wild populations and the condition of their habitat should form the basis for the response units. However, in many cases the abundance of wild stocks is so low as to preclude them being used for monitoring purposes[5], particularly if

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[5] Fish used in these evaluations need to be tagged; thus fish of hatchery origin will in all likelihood be used for these purposes. We suggest that either PIT-tags or radio tags be employed to estimate smolt survival, and radio tags be used for adult survival estimates. Using these technologies smolt and adult survival estimates can be obtained for spring/summer chinook (stream-type) fall chinook (ocean-type), and steelhead. However, smolt survival estimates for ocean-type chinook present some limitations that

handling and marking are involved. In such cases, hatchery stocks may be the only option for use as surrogates. A key task in setting second tier, life-history stage specific performance standards, and third tier, those relating to human activities, is to convert standards intended primarily for wild fish (for decision-making purposes) into equivalent standards for hatchery fish or mixed stocks, a problem further addressed in Section IV. Similarly, it may be necessary to monitor one ESU (e.g., Snake River spring/summer Chinook salmon or steelhead) to infer the survival of another (Snake River sockeye salmon). The temporal scale of monitoring, versus that of expected effects, must also be considered. The performance standard may be defined as seasonal average survival or average survival over many years. Where monitoring is possible on a daily or weekly basis during a season, what is the expectation for the monitoring response on a given day or week?

As described earlier, it may not be possible to monitor survival through all of the life-history stages that must be considered when deciding whether or not to proceed with a suite of actions. The decision may rely upon a variety of related observations that are organized in some manner (e.g., in a quantitative modeling framework or in a descriptive "white paper" review) to infer the effects of the action on the life stage in question. For monitoring purposes, it may be necessary to rely on mechanistic responses, which can be converted into life-history stage specific performance measures and standards. These can include biological indicators such as smolt migration speed, indices of fish predation, disease incidence and severity, or indices of fish condition. If these mechanisms are also difficult to measure and interpret in terms of incremental changes in survival, another option is to monitor the environmental conditions that are thought to drive these mechanisms. This interplay among environmental conditions, life-history stage survival and population performance is the foundation of the Ecosystem Diagnosis and Treatment (EDT) analysis used in the Northwest Power Planning Council's (NPPC) Framework Program. Some of the environmental parameters or features can include river discharge levels, water temperature, sediment load, etc. It is critical that the relationships between these environmental variable and the biological response be documented over time through monitoring, to reduce uncertainty and thus to provide managers the ability to modify performance standards (i.e., the adaptive management process).

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may preclude its usefulness as a performance measure. Specifically, a portion of the population migrates slowly through the system, often passing detection sites after they have been disabled for annual

APPENDIX B

PERFORMANCE MEASURES AND STANDARDS: PROPOSED ELEMENTS FOR ASSESSING THE SUCCESS OF HABITAT ACTIONS WITHIN AN ALL-H MANAGEMENT PLAN

1.0 Introduction

Fisheries managers are currently developing an array of management actions that could be implemented to recover fish stocks in the Columbia River Basin that are listed under the Endangered Species Act (ESA). These actions would then be combined to form an overall ESA Recovery Plan that would direct recovery efforts. Assessing the success or failure of a recovery plan requires that performance standards and measures be established. The region is just beginning to take steps necessary to develop an acceptable set that could be used to evaluate success of the recovery efforts.

Our purpose in this report is to draft habitat-based interim performance standards and measures that could be used to assess the effects of habitat-directed management actions in the Columbia River Basin. These performance standards and measures are specific to habitat-related conditions and are intended to protect ESA-listed resident[1] and anadromous fishes. The overall goal of these performance standards and measures is to restore[2] degraded habitat and to preserve or secure relatively undisturbed areas. This, in turn, should improve the survival, production, population structure, and diversity of ESA-listed stocks.

In this document we focus on ESA-listed anadromous stocks. Performance standards and measures for resident fish (bull trout and Kootenai River white sturgeon) are being developed in the recovery planning processes for these species.

2.0 Description of Performance Standards and Measures

We define performance measures (PM) as measurements or estimates of either a biological response or an environmental condition. Performance measures monitor progress toward some specified performance standard (PS), goal, or objective. That is,

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[1] In this document we use the term “resident” to mean non-anadromous fish. Therefore, by our definition, “resident” would also include fluvial and adfluvial fish.

[2] We define “restoration” as a process that involves management decisions and manipulation to enhance the rate of recovery (after Davis et al. 1984). We believe the goal of restoration should be to reestablish an ecosystem’s ability to maintain its function and organization without continued human intervention. It does not mandate returning to some arbitrary prior state. Indeed, restoration to a previous condition often is impossible or even ecologically undesirable.

PM are used to assess direction and rates of movement of biological and environmental conditions toward some specified target (i.e., PS).

All habitat-related performance measures should posses certain characteristics in order to be useful. Performance measures should (1) reflect effects of habitat-related actions and not be confounded by effects from other factors (e.g., hatchery or harvest actions), (2) be readily interpretable and instructive, and (3) represent either a biological or environmental response. We believe that it is unproductive to prescribe a performance standard for which there are no practical performance measures. Therefore, we attempt to identify PS with PM that have obvious biological implications and are feasible to monitor or evaluate. Because management actions target ESA-listed stocks, naturally-spawning wild populations and their respective habitat conditions form the basis for PM.

2.1 Hierarchy of Performance Standards and Measures

Performance standards and measures can be arrayed in a hierarchy. The array, from the highest level to the lowest, includes: (1) **broad-scale fish population responses**, (2) **life-stage specific survival estimates**, and (3) **biological and physical/environmental responses**. Physical/environmental responses should reflect properly functioning condition (PFC) in tributary habitat. See NMFS (1996) for a description of properly functioning condition.

Tier 1—The highest level, broad-scale fish population responses, include indices such as population abundance, escapement abundance, annual population growth (lambda), population distribution, population structure, smolt-to-adult return rates (SARs), and gene pool dynamics (many of these indices are part of CRI and QAR). All these indices are sensitive to the cumulative effects that occur throughout the entire cycle of the population. That is, the size of the population is a function of all natural and anthropogenic factors affecting the population. As such, they do not readily reflect effects incurred during any particular life stage, or effects of a given management activity or land use.

Tier 2—The second level of PS and PM is life stage-specific survival estimates, which reflect effects incurred during specific segments of the life cycle. These measures include survival of four life stages: (1) egg-smolt survival, (2) juvenile migration, (3) estuary-ocean survival, and (4) adult migration. Tier 2 measures are particularly sensitive to conditions encountered within specific periods of the life cycle. In contrast to broad-scale performance measures, these are well suited to reflect effects incurred during individual life stages, including responses to habitat alteration or hydroelectric operations. For example, egg-smolt survivals may be useful PM for detecting effects of stream habitat alterations. As management actions are implemented, one could monitor life-stage survivals and develop response functions related to environmental conditions (the latter constitute Tier 3 PM).

Tier 3—The third level is comprised of both biological and physical/environmental conditions. Changes in these physical/environmental conditions should affect biological conditions (e.g., population[3]-specific abundance, distribution, growth, survival, habitat use, and condition), which then translate into Tier 2 life-stage specific survivals. We identify three different categories of physical/environmental conditions: (1) preservation measures, (2) water quantity/quality measures, and (3) physical measures. Preservation measures track the total area of ecologically "healthy" watersheds or streams that are secured and protected from anthropogenic disturbances. Ecologically healthy areas may include important headwater areas, riparian areas, biotic refuges, or biological hot spots[4] that are currently functioning properly. Water quantity/quality measures track factors related to stream flows (e.g., peak flows, base flows, and drainage network) and water quality (e.g., sediment, turbidity, temperature, nutrients, and pollution). Physical measures, on the other hand, track habitat attributes such as substrate, physical barriers, large woody debris, riparian habitat, floodplain connectivity, pool quality, and streambank condition, to name a few.

Theoretically, direct links exist between Tier 3 PM and Tier 2 and 1 PM (Table 1). Indeed, one would assume that restoring habitat conditions (Tier 3 PM) would increase survivals (Tier 2 PM) and ultimately the production, abundance, population structure, and diversity (Tier 1 PM) of ESA-listed stocks. In fact, the linkages among levels of PM are the foundation of the EDT analysis. We believe that EDT applied at the scale of sub-basin or watershed will be useful in evaluating the efficacy of habitat alternatives. However, in many cases, the linkages between Tier 3 environmental conditions, Tier 3 biological conditions, and Tier 2 life-stage survival PM have not been validated. Therefore, we believe that well designed research is needed to validate assumed relationships between environmental conditions and life-stage survivals. This research will occur at the same time PM are monitored. Information gained from valid research can be used to "fine tune" management actions and PM. Thus, we see the implementation of PM and management actions as an iterative process.

We can think of a couple of examples where a direct link between Tier 3 and Tier 2 PM does not exist. Preservation measures (a category of Tier 3 physical/environmental PM) do not link directly with Tier 2 PS and PM because there is no intent to increase specific life-stage survivals of stocks within healthy environments. Rather, the approach is simply to protect stocks within healthy environments. Therefore, in this case, the management action to preserve existing healthy ecosystems does not directly translate into increased survival of listed stocks. As another example, the removal of dispersal barriers (Tier 3 physical/environmental measure) does not directly translate into increased specific life-stage survival. It may increase abundance and distribution of the stock (Tier 1 PM), but could have no affect on specific life-stage survival.

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[3] We use population to mean an aggregation of one or more local breeding units (demes) that are closely linked by exchange of individuals, but are isolated from other populations to such an extent that exchange of individuals among populations do not affect the population dynamics or extinction risk of the populations over a period of 100 years. An ESU can consist of one or more independent populations.

[4] Biological "hot spots" are generally smaller riverine habitat patches that provide critical biological elements and processes essential to healthy riverine systems (*sensu* Doppelt et al. 1993).

Table 1. Relationships (chain of effects) between management actions and the different levels of performance standards (PM). Also shown are different types or classes of performance measures and a few examples.

	Types or Categories	Examples
Management Actions ↓		● Secure and protect healthy ecosystems. ● Augment and maintain suitable flows. ● Protect riparian zones. ● Replace nutrients. ● Reduce gas saturation levels. ● Secure and protect estuarine habitat.
Tier 3 PM (Physcial/Environ. Conditions)	(1) Preservation measures	● Enumeration of healthy habitat secured.
	(2) Water quality/quantity measures	● Evaluation of temperatures. ● Evaluation of stream flows. ● Estimation of surface-water withdrawal. ● Estimation of fine sediment recruitment and load. ● Evaluation of TDG.
↓	(3) Physical measures	● Evaluation of road density. ● Enumeration of dispersal or migration barriers. ● Evaluation of riverine-riparian habitat condition.
Tier 3 PM (Biological)	(1) Monitoring	● Egg-fry survival ● Overwinter survival ● Distribution/habitat use ● Fish condition
	(2) Research	● Examine relationships between environmental conditions and biological conditions.
Tier 2 PM (Life-Stage Survival)	(1) Monitoring	● Egg-to-smolt survival ● Juvenile migration ● Adult prespawn survival
↓	(2) Research	● Examine relationships between environmental conditions and life-stage survivals.
Tier 1 PM (Population Responses)		● Annual population growth ● Redd counts ● SARs ● Population structure ● Population distribution

2.2 Temporal Scales

It is important to consider the temporal scale at which monitoring and evaluation are likely to identify biological and environmental responses. Recall that PM are estimates of biological responses (e.g., increase in egg-to-smolt survival) or changes in environmental conditions (e.g., increase in kilometers of stream functioning properly). Most Tier 1 and Tier 2 PM describe long-term (>10 yrs) responses. Tier 3 PM (biological and physical/environmental measures) describe both long-term and near-term (<10 yrs) responses. Thus, in the near-term, it appears that primarily Tier 3 PM provide information to managers. However, even Tier 3 PM may not provide adequate information within the first 5 years. Therefore, a fourth tier would track the number and magnitude of projects implemented within the first 5 years. Tier 4 would provide an accounting of management and research actions implemented. The Action Agencies would receive “credit” for each habitat action implemented. For example, the region could tabulate the number of migration barriers removed or improved (Tier 3 physical measure), the number of stream kilometers protected from land use activities (Tier 3 preservation measure), or the number of kilometers of stream meeting water quality standards (Tier 3 water quantity/quality measure). Some projects should command more credit if they are more likely to recover or protect listed stocks. Thus, a weighting system would be developed.

Because different measures have different response times, we envision three temporal scales for monitoring PM: (1) short-term (<5 years), (2) mid-term (5-10 years), and long-term (>10 years) (Table 2). In the short-term, as described above, managers would tabulate habitat actions implemented (Tier 4) and assess progress toward reaching annual targets or performance milestones. In one sense, these annual targets represent PS and the number of actions implemented represent PM. Clearly, this accounting does not necessarily measure effectiveness of the actions, but it does demonstrate progress toward improving habitat conditions. Once habitat actions are implemented, some Tier 3 PM would reflect short-term, mid-term, and long-term responses. Some responses would appear immediately after implementation (e.g., increased flows, barrier removal, nutrient enrichment), while others may not appear until mid-term (e.g., water quality improvements, improved fish condition and abundance). Still others may take more than 10 years to respond (e.g., riparian structure, LWD recruitment).

Logically, Tier 1 and Tier 2 PM would lag behind changes in environmental conditions. It is likely that some Tier 2 PM would respond in the short- to mid-terms (e.g., egg-smolt survival, juvenile and adult migration survival). However, natural variability may mask treatment effects in the short-term. Most Tier 1 PM would likely respond in the long-term (e.g., annual population growth, SAR, stock-recruitment relationships). Therefore, Tier 1 PM would tend to lag behind Tier 2 PM.

In sum, the Action Agencies will rely on implementation accounting (Tier 4) and a few Tier 3 and possibly a few 2 PM in the short-term. In most cases, the latter will be less useful in the short-term because of natural variability. Both Tier 1 and Tier 2 PM will be more instructive in the mid- to long-terms.

Table 2. Temporal responses of various performance measures (PM).

Performance measures	Short-Term (<5 yrs)	Mid-Term (5-10 yrs)	Long-Term (>10 yrs)
Tier 3 PM (Physical/Environ. Conditions)	● Number of actions implemented ● Number of barriers removed or improved ● Number of healthy habitats secured ● Reductions in TDG ● Changes in temp ● Reduction in surface-water withdrawal	● Number of actions implemented ● Number of barriers removed or improved ● Number of healthy habitats secured ● Reductions in TDG ● Changes in temp ● Reduction in surface-water withdrawal ● Reduction in road density ● Reduction in fine sediment recruitment	● Number of actions implemented ● Number of barriers removed or improved ● Number of healthy habitats secured ● Reductions in TDG ● Changes in temp ● Reduction in surface-water withdrawal ● Reduction in road density ● Reduction in fine sediment recruitment ● Km of streams at PFC.
Tier 3 PM (Biological)	● Overwinter survival ● Fry-parr survival ● Habitat use/distrib. ● Fish condition	● Egg-fry survival ● Egg-smolt survival ● Overwinter survival ● Prespawn survival	● Egg-fry survival ● Egg-smolt survival ● Prespawn survival
Tier 2 PM (Life-Stage Survival)		● Egg-smolt survival ● Juvenile migration	● Egg-smolt survival ● Juvenile migration ● Estuary-ocean surv. ● Adult migration
Tier 1 PM (Population Responses)	● Pop. distribution	● Pop. distribution ● Redd counts ● Escapements	● Pop. distribution ● Redd counts ● Escapements ● SARs ● Population structure

2.3 Spatial Scales

We broadly identify three major habitat zones for ESA-listed anadromous stocks in the Columbia River basin. These major zones include: (1) tributary habitat, (2) hydropower corridor (mainstem Snake and Columbia rivers), and (3) estuary and nearshore ocean environment. For convenience, we treat tributaries affected by federal storage reservoirs (i.e., Libby, Dworshak, Albeni Falls, and Hungry Horse dams) separately (Appendix 4C) from other tributaries in the Columbia River Basin. This segregation within the tributary habitat zone allows us to identify specific PS and PM related to the operations of these federal storage facilities.

It is well understood that different factors operating at different spatial scales affect the distribution and abundance of listed stocks. This is especially true in the tributary habitat zone. There, factors such as ecoregion (soils and climate), geologic districts (rock types), and geomorphology (land types, elevation, and aspect) affect the distributions and abundance of listed stocks at coarse (landscape or geographic) scales. Regional climatic conditions strongly influence geographic variation in distributions of salmonids. Within areas that provide suitable geographic or landscape attributes, fine-scale attributes such as habitat size and complexity affect the local distribution and abundance of fish. Other fine-scale factors include dispersal barriers, exotic species, stream size, and point- and nonpoint-source pollution. In relatively simple terms, fish distribution and abundance are constrained on coarse (geographic) and fine (local) scales.

Because different processes operate at different spatial scales within the tributary habitat zone, PS and PM should be scale-specific. That is, PS and PM at the coarse (landscape or geographic) scale will likely differ from those at the fine (stream reach or watershed) scale. Therefore, within the tributary habitat zone, we identify two different spatial scales within which we describe PS and PM. The coarse scale will be no smaller than a 4th level hydrologic unit code (HUC) (hereafter referred to as "sub-basin"). This scale is intended to capture entire sub-basins, such as the Methow, Wenatchee, Pahsimeroi, Lemhi, and Umatilla basins. In some cases it may be necessary to use a 3rd level HUC to capture the entire sub-basin (e.g., Deschutes or John Day systems). The fine scale will be no larger than a 6th level HUC (hereafter referred to as "watershed" or "stream"). These scales should roughly correlate with the distribution of populations or sub-populations.

Across tributary habitats within the Columbia River Basin, a large suite of coarse-scale factors interact making each sub-basin relatively unique. For example, at the coarse scale, the Lemhi Basin is very different from the Wenatchee Basin. They exist in different ecoregions, and geology and geomorphology differ. Ideally, therefore, each sub-basin or cluster of similar sub-basins should have their own specific PS and PM. Because we currently lack the information necessary to write unique PS and PM for each sub-basin or cluster of similar sub-basins, we propose interim PS that could be applied generally across sub-basins. After baseline information is compiled (through literature investigation, research, or monitoring), PS and PM can be adjusted to reflect increased understanding of limiting factors within each sub-basin.

At finer scales within the tributary habitat zone, PS and PM should be tailored to specific watersheds or streams based on the potential of those areas to provided suitable habitat. Again, however, we currently lack the information necessary to write unique PS and PM for each watershed or stream. Therefore, we propose interim PS that could be applied generally across fine scales. Because one size does not fit all, these PS and PM will be fine-tuned after suitable baseline information (e.g., watershed analysis) is compiled.

At this time we see no need to identify PS and PM at different spatial scales within the hydropower corridor and the estuary/ocean habitat zones (at this time we have not identified PS and PM for the nearshore ocean environment). Thus, only in the tributary habitat zone do we identify PS and PM at different spatial scales.

2.4 Crediting

The Action Agencies have funded a variety of "offsite" habitat actions to offset or mitigate for fish and wildlife losses associated with the construction and operation of the FCRPS. As yet there has been no formal credit attributed to those actions with respect to fishery resources. There has been a crediting formula applied for wildlife impacts. For wildlife crediting, the currency is habitat units. When the full complement of units destroyed by the FCRPS is replaced by an equal number of habitat units that are secured and placed in protection, full credit is awarded and the obligation is met. No such scheme exists for fishery resources.

The issue becomes more complex for fish, however, since there is a suite of All-H management actions that can be directed at fish. The Action Agencies are most directly responsible for improving survival conditions within the FCRPS. There is a need for establishing a crediting formula to determine how much "offsite" mitigation is required to offset survival shortfalls associated with the operation of the Hydro system. A shortfall is defined as the difference between an established life stage-specific survival standard and actual survival realized under current operations. Although it has been accepted that management actions funded and implemented in the Habitat sector can be used to offset Hydro sector shortfalls, it has not been established how much habitat action is required to meet the obligation, or whether all habitat actions deserve equal weight in any future crediting formula. We explore these issues to provide a foundation for the federal Caucus to consider when formulating a crediting scheme.

Below we offer a rough outline for two different crediting systems. The first one is survival-based and represents a long-term system for crediting offsite mitigation. Because this approach requires modeling, it will not be available in the short-term. The second is habitat-based and assumes that increased survival is correlated with habitat improvements. The second is an interim approach that can be used until the survival approach is refined and perfected.

2.4.1 Survival-based crediting

We recognized three types of habitat management actions that can be implemented: (1) protection, (2) restoration, and (3) mitigation. Protection involves either securing or purchasing high-quality habitat within watersheds and the estuary, and ideally associated upland tracts. This preserves critical refugia from development and can provide connectivity among critical habitat types. Given the dramatic increase in development on waterways throughout the west, the protection strategy seems essential in our view, and should be weighted at the highest level in any crediting formula. Restoration actions, on the other hand, attempt to improve the function of degraded areas (e.g., fence riparian zones, import LWD, nutrient enrichment). In situations where habitat has been completely lost or is un-repairable, mitigation may be the only option (e.g., hatchery production). Here, we focus on protection and restoration strategies.

The allocation of management effort with respect to geography has implications to crediting. Since listed ESUs are the units driving regional recovery efforts, should habitat actions target localized areas occupied by specific ESUs, or common areas encountered by several listed ESUs (e.g., estuary)? Should areas absent listed ESUs be ignored, or perhaps receive discounted credit for habitat actions implemented in those locations? If one accepts the premise that all areas are not equally important, and listed ESU distribution dictates emphasis, then higher priority areas (i.e., occupied by listed ESUs) should be weighted more in a crediting formula.

For the long-term, we propose the use of survival as the currency credit accounting. Any survival shortfall in the Hydro system will be offset by survival gains obtainable through habitat actions. Once that survival shortfall has been compensated, the obligation is satisfied and full credit is awarded. Adopting survival as the currency will require a modeling exercise. The basic conceptual steps are as follows:

I. Establish Performance Standards and Baseline Conditions
   1. Define Hydro survival PS for each ESU (Tier 2, life stage-specific PS).
   2. Estimate current Hydro-related survival for each ESU.
   3. Calculate the shortfall as the difference.

II. Conduct Modeling Analysis
   1. Specify the Hydro PS (goal) by life stage.
   2. Measure or estimate current baseline survivals for other life history stages (e.g., egg to fry, parr or smolt, prespawning adult, juvenile estuarine residence, etc.).
   3. Use benchmarks as input to some life cycle model(s) and report output, which becomes the benchmark for future model runs.
   4. Estimate survival gains in Habitat - Implement a suite of Habitat actions, translating them to life stage survival estimates, via EDT or some other set of biological rules.
   5. Estimate current Hydro survival empirically.
   6. Calculate life-cycle model output under the Habitat action plan, using #4 and #5.
   7. Compare the population response under the Habitat action plan to the Benchmark condition. If the population response equals or exceeds the Benchmark, then full credit is awarded and the obligation is met. If not, further habitat actions are required.

We recognize that this is a very generic framework replete with complex details, assumptions, and ultimately compromises. We offer it as a starting point upon which the region can build a more complete approach.

If such an approach is adopted, there are some fundamental considerations that will require resolution. Unfortunately it may be difficult to translate important habitat actions into survival currency. There is a distinction between protection actions that preserve quality habitat and restoration actions that attempt to improve the function of degraded habitat. Crediting protection actions using the shortfall credit format might not work. There are not necessarily readily estimable survival gains associated with preserving quality habitat. Reclaiming and connecting isolated habitat areas will also be difficult to translate into survival gains. So the survival modeling exercise may not capture the ecosystem function benefits associated with these important habitat strategies. A separate crediting scheme that generally follows the strategy adopted for wildlife crediting may need to be considered.

2.4.2 Habitat-based crediting

Because the survival-based crediting system currently does not account for survival gains associated with preservation measures and requires development of complex model(s), we propose an interim crediting system based on habitat. The benchmark for the habitat-based approach is PFC (Properly Functioning Condition; NMFS 1996). In general, the habitat-based approach describes current habitat conditions and then estimates the amount of habitat improvement achieved (restoration measures) or amount of properly functioning habitat that would be lost if not secured or preserved (preservation measures). Credit is awarded based on habitat protected or improved.

As we just noted, we offer PFC as the foundation for habitat-based crediting. NMFS (1996) identifies 18 attributes associated with PFC. These 18 attributes are separated into six distinct conceptual groupings (i.e., water quality, habitat access, habitat elements, channel condition and dynamics, flow/hydrology, and watershed condition). NMFS (1996) identifies three conditions for each attribute: (1) properly functioning, (2) at risk, and (3) not properly functioning. For example, if we consider only fine sediments, a stream is properly functioning if fines are less than 12%, at risk if fines are between 12% and 20% (east side), and not properly functioning if fines are greater than 20% (east side).

We propose that the 18 attributes of PFC and the three conditions of each attribute be used to develop a simple additive model. The three conditions can be numerically ranked or scored on a scale of 1 to 3, where “1” is not properly functioning, “2” is at risk, and “3” is properly functioning (based on criteria in NMFS 1996). Thus, the higher the score the better the habitat condition. As an example, a stream with 18% fines would receive a score of “2” for the sediment attribute. In the simplest case, one could sum scores across all attributes. In this case, the highest possible score would be 54 (i.e., all attributes are properly functioning); the lowest would be 18 (i.e., all attributes are not properly functioning). Credit could be awarded for each unit increase in the total score.

In the simple case, each attribute has the same relative importance or “weight” on the total score. However, in some situations, a few attributes may be more important than others. In this more complex case, each attribute could be multiplied by some weighting factor. Those attributes that are considered more important could be given more weight than those considered less important. For example, removing barriers and improving connectivity may be more important to the survival of an ESA-listed stock than disturbance history. In this case, the weighting factor for barrier removal may be “2”, while the factor for disturbance history may be “0.75.” In other words, barrier removal is 2.7 times more important than disturbance history. The additive model would take the form:

$$\textbf{Total Habitat Score (THS)} = \Sigma W_iX_i = W_1X_1 + W_2X_2 + \ldots + W_{18}X_{18},$$

where “W” is the weighting factor (relative importance) for habitat attribute “X”.

In this appendix we do not propose weighting factors for each attribute because weights may vary across basins or watersheds. In addition, the ranges of conditions for assessing whether the stream is properly functioning, at risk, or not properly functioning (defined in NMFS 1996) are not absolute. They may be adjusted for different basins or watersheds.

We believe the additive models provide an objective way to calculate credits for habitat restoration and protection. We see four different scenarios for which credits would be awarded: (1) protect and preserve healthy habitat, (2) restore or enhance existing habitat, (3) remove habitat stress, and (3) immediate enhancement. Next we show how the habitat-based approach can be used to assign credits for each of the four scenarios.

If relatively healthy habitat is secured and protected from future land uses, we would not expect to see increases in survival or even production of ESA-listed stocks. However, the fact that an area of healthy habitat in properly functioning condition is protected from future development means that crediting is warranted. In this scenario, credits are estimated as the difference between the current THS (under healthy conditions or at PFC) and what the future THS would be if the area was not secured. The latter requires an hypothesis or projection of the THS if development was allowed in the area. The easiest way to assess what THS would be if the area was developed is to locate a suitable reference area that is developed. THS would be calculated for the developed area and used as the projection estimate for the secured area. We should think that these developed areas are readily available.

In some cases, existing areas may be restored or enhanced. Here we are thinking about areas in which managers actually alter the stream and its channel (e.g., adding LWD, connecting off-channel habitat, adding refugia, planting riparian vegetation, etc.). In this case, credits are assigned based on the difference between THS before restoration and THS after restoration. A related management action may be the removal of ecosystem stress (e.g., cattle grazing) without actually implementing habitat-altering actions (e.g., not adding LWD, riparian plants, refugia, etc.). Because beneficial results will not be realized in the short-term, credits cannot be estimated as the difference between THS before and THS immediately after removing the stress. Thus, some projected future condition must be estimated. Again, suitable reference areas may provide the projected condition. If suitable reference areas are unavailable, professional judgment could be used to estimate projected THS. Another alternative is to estimate THS repeatedly through time and add credits as the difference between THS before and THS after increases over time. The latter does not allow for awarding full credit in the short-term.

The final scenario assumes that management actions result in immediate benefits. For example, removal of barriers, adding nutrients, and purchasing water rights all constitute immediate benefits. These actions may not result in immediate responses in survival of ESA-listed stocks, but in the long-term they should increase stock production. Crediting can be based on the difference between THS before and THS after implementation of the management action. In some cases, however, the difference score may not adequately capture the magnitude of the management action and thus would award too little credit. For example, the removal of a barrier that opens several miles of stream to ESA-listed stocks would not realize a large difference score using the above protocol. In this case, weighting would be necessary. That is, managers could apply a weight to physical barriers that is related to the amount of habitat or stream miles opened to ESA-listed stocks. It seems to us that weighting is a valid method of estimating credits for management actions that result in immediate benefits.

The habitat-based approach, using additive models, assumes that improved habitat conditions (moving toward PFC) result in increased survival in ESA-listed stocks. This assumption is an important attribute of EDT. Therefore, it may be possible to convert the gains in THS to gains in survival or production using EDT. We recognize, however, that some of the biological rules used in EDT are provisional and need to be validated with research.

In the next section, we propose several interim PS and PM for the tributary, hydropower corridor, and estuary/ocean habitat zones. We classify each PS and PM according to their position within the hierarchy (see Section 2.1). In general, we first offer either Tier 1 (broad-scale fish population response) or Tier 2 (life-stage specific survival) PS, followed by one or more Tier 3 (biological and physical/environmental responses) PS. As we noted above, only in the tributary habitat zone do we describe PS and PM at different spatial scales.

3.0 Interim Performance Standards and Measures

In this section we propose several interim, habitat-based PS and PM. For each habitat zone, we first generally describe habitat characteristics and possible factors affecting current conditions. Next we propose one or more PS. We then provide a rationale for biological and ecological criteria and identify management actions that could be implemented to meet PS. These actions are general and may not be implemented within all areas of a given habitat zone. Finally, we propose several interim PM. We emphasize PM based on indices of habitat conditions because they are routinely measured and form the basis for specifying PS. In addition, these characteristics will be manipulated by managers and can directly affect the production of listed stocks.

3.1 Tributary Habitat

This habitat zone can directly or indirectly affect the production, abundance, distribution, and population structure of ESA-listed anadromous stocks. This zone includes tributaries within the current range of listed anadromous stocks within the Columbia River Basin. Here, the objective is to restore habitat conditions so that listed anadromous stocks will increase in abundance and distribution (lead to recovery).

Various land uses have negatively affected habitat conditions throughout this habitat zone. For example, water withdrawals, unscreened diversions, hydro-development, livestock grazing, timber harvest, mining, stream channelization, roads, urbanization, introduction of exotic species, and recreation have reduced the production of listed stocks and degraded their spawning and rearing habitat (National Research Council 1996; ISG 1996). These activities have also affected downstream habitat conditions. By improving habitat conditions within this zone, it is reasonable to assume that fish production will improve.

Habitat restoration should focus first on securing and protecting ecologically healthy areas. As we noted earlier, these areas include important headwaters, diverse riparian areas, biotic refuges, and biological hot spots. For other more disturbed areas within the tributary habitat zone, restoration should focus on water quality and quantity, connectivity, riverine-riparian habitat diversity, channel condition and dynamics, and watershed condition (elements of PFC). We stress that habitat actions address the causes rather than just the symptoms. As such, actions should concentrate on improved land and water husbandry as the key to improved fish habitat quality. For example, improper livestock grazing damages riverine-riparian habitats, decreasing listed-stock productivity. Examples of habitat degradation from grazing can be found in the upper Salmon River drainage, Bear Valley Creek, Marsh Creek, Camas Creek and several others (Chapman et al. 1991). Here, restoration should focus on removing grazing from sensitive riverine-riparian areas. This is an holistic watershed approach rather than a site-by-site, "micro-management" approach.

Tier 1 Performance Standards:

> Adult chinook and steelhead annual population growth, escapements, or abundance will increase measurably (specific targets will be based on CRI analysis or other appropriate analysis). A positive trend in these factors must be observed within 10-15 years after management actions are implemented. These metrics are affected by all Hs, not just habitat.

Tier 2 Performance Standards:

> Egg-smolt, juvenile migration, and adult survivals will increase measurably (specific targets will be based on CRI analysis or other appropriate analysis). A positive trend in egg-smolt survival must be observed within 10-15 years after

management actions are implemented. These metrics are affected by all Hs, not just habitat.

Tier 3 Biological Performance Standards:

Sub-Basin—Abundance, distribution, condition factor, and survival of juvenile steelhead and chinook will increase in sub-basins were these factors are currently low. For chinook and steelhead, average egg-smolt survival will equal 5% (3-7%) and 2% (1-3%), respectively. In areas where egg-smolt survival cannot be reasonably assessed, respective parr-smolt survivals will range from 25-40% and 20-35% within selected sub-basins.

Watershed or Stream—Within selected watersheds or streams where average condition factor, abundance, distribution, and life-stage specific (e.g., egg-parr, parr-smolt, prespawn) survival of chinook and steelhead is low, mean condition factor, abundance, and life-stage specific survival will increase measurably.

Tier 3 Physical/Environmental Performance Standards:

Sub-Basin—Within each selected sub-basin, the suite of habitat restoration actions implemented must result in some measurable increase in life-stage specific survival of listed-stocks (say, e.g., 10-15% increase; actual percentages will be based on CRI analysis). EDT[5] and sub-basin assessments can be used to estimate which restoration actions will likely result in some percent increase in life-stage specific survival or production within a given sub-basin. Specific PS will be written for each of the environmental factors that EDT and sub-basin assessments identify as contributing most to the increased life-stage specific survival or production of the listed stock. The process will proceed as follows (we use 10% only as an example):

(1) EDT estimates current sub-basin survival (S_0) or production (P_0) based on current habitat and sub-basin conditions.
(2) Information from sub-basin assessments or watershed analysis identifies factors currently limiting fish production and distribution within the sub-basin.
(3) EDT re-estimates survival (S_1) or production (P_1) assuming limiting factors have been lifted or removed.
(4) If the ratio of estimated survival (or production) using improved conditions to estimated survival (or production) under current conditions is greater than 1.10 (i.e., $S_1/S_0 > 1.10$), then sub-basin specific Tier 3 PS will be written for each habitat action that increased the estimated survival, production, and distribution of listed stocks.
(5) If the ratio is less than 1.10 (i.e., $S_1/S_0 < 1.10$), the process repeats steps 2 and 3 until the ratio is greater than 1.10.

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[5] In this Appendix we refer frequently to the use of EDT. We see merit in this tool if it is simplified (i.e., reduce the number of variables in the model), assumptions justified, and it is applied at the sub-basin or watershed scale. Other analytic tools such as SWAM could also be used.

Watershed or Stream—Within each selected watershed or stream, the suite of habitat restoration actions implemented must result in a measurable increase in survival (e.g., 10%) of listed-stocks. Again, EDT and sub-basin assessments can be used to estimate which restoration actions will likely result in a measurable increase in survival within a given watershed or stream. The process will proceed just as it did for coarse-scale analysis (i.e., $S_1/S_0 > 1.10$). The only difference is that in this case EDT focuses on actions that will improve survival of local populations (demes). At the sub-basin scale, EDT focuses more on actions that improve survival of ESUs. In addition to EDT analysis, suitable reference areas, where available, will be used to assess restoration progress. These reference areas will also provide information on potential conditions, which will be used to guide EDT analysis and adjust PS and PM.

EDT can be used to estimate survival or production of anadromous stocks. Thus, EDT provides a useful tool for fine-tuning coarse-scale PS. However, we recognize that the biological rules currently used in EDT are provisional. Research is needed to validate some rules.

Rationale for Biological and Ecological Criteria:

Stocks of chinook salmon and steelhead have declined in the Columbia River Basin, hence the reason for ESA listing. Therefore, it is reasonable to propose interim PS based on annual population growth or abundance (Tier 1 PS) and life-stage specific survival (Tier 2 PS). Because the status of listed stocks and the health or degree of degradation of each selected sub-basin or watershed will differ, we will rely on the results of CRI (or some other appropriate method) to quantify "measurable increases." At this time it appears that a "measurable increase" in survival should be at least 10%. Any improvement in survival less than 10% is very difficult to detect or estimate. Because Tier 2 survivals are affected by all Hs, the cumulative effects of actions within all Hs will result in proposed survival increases.

Tier 3 Biological PS are intended to increase abundance, distribution, condition factor, and survival of listed stocks. The literature suggests that egg-to-smolt survival of spring chinook salmon varies widely. Survival can range from 1.35% to 22.0% (summarized in Chapman et al. 1995). The literature suggests that parr-to-smolt survival of chinook ranges from 9-50% (Chapman et al. 1995). On the other hand, egg-to-smolt survival of steelhead ranges from 0.16% to 3.61% (summarized in Chapman et al. 1994). For the South Fork Salmon River, Thurow (1987) assumed an egg-to-smolt suvival of 1% for steelhead under poor spawning conditions, (e.g., poor quality spawning habitat, abnormal flows, abnormal temperature regimes, and redd superimposition), 1.5% under average conditions, and 2% under optimal conditions.

Chinook and steelhead require cool, clean, connected, and complex habitat (Bjornn and Reiser 1991). These are all aspects of PFC (NMFS 1996). These fish typically grow and survive best in streams with summer temperatures less than 15°C and winter temperatures greater than 0°C. They prefer streams that are free of toxic pollutants (e.g., heavy metals, urban runoff, and other point- and nonpoint-source pollutants) and lack high levels of fine sediments and high turbidity. Chinook and steelhead are most often found in complex habitats. For example, juvenile chinook salmon are closely associated with large woody debris (LWD). During an eight-year study in the Chiwawa River basin, Washington, Hillman and Miller (1999) found that sites with LWD made up on average only 13% (range, 10-17%) of the total stream surface area in the basin, but supported on average 60% (range, 25-74%) of all juvenile chinook in the basin. Although LWD appears to be an important component of salmonid habitat in lower-gradient alluvial valleys, it may be less important in higher-gradient fluvial canyons where large boulders provide habitat complexity. Steelhead often rear in these higher-gradient reaches. Both species also require suitable stream flows for rearing, spawning, and migration. Finally, they require a network of connected spawning and rearing habitat patches. Patches of suitable spawning and rearing habitats can become fragmented or disconnected by physical barriers (e.g., dams, dewatering) or chemical barriers (e.g., pollutants, temperature).

Management Actions:

1. Preservation. Identify, secure, and protect existing areas where high ecological integrity and natural ecosystem processes persist. Here the goal is to prevent further ecological damage. These systems should also be studied so that we can better understand natural processes such as sediment budgets, LWD recruitment rates, and resilience and resistance. A good understanding of natural patterns, processes, and pathways will guide restoration in disturbed systems. In addition, information from these less disturbed systems can be used as benchmarks or performance targets for other more disturbed areas. Examples of systems in Idaho that have limited anthropogenic affects include portions of the Lochsa and Selway drainages, portions of the Middle Fork Salmon River drainage, and tributaries of the Salmon River such as Chamberlain and Bargamin creeks.

2. Stream Flows. Irrigation diversions in spawning and rearing areas should be screened. Flows should be augmented in areas where dewatering reduces connectivity and decreases survival of both adult and juvenile fish (e.g., Lemhi and Pahsimeroi rivers). Flows suitable for spawning, rearing, and movement should be maintained. Free movement of juveniles is required in fall as they seek winter habitat. In addition, selected diversion structures should be removed or modified to allow fish passage.

3. Grazing. Livestock grazing should be prohibited in riverine-riparian areas. Recovery of these areas to full capacity to produce smolts is important even where seeding (escapement) is low. Prohibition should begin immediately on public lands. Incentives may be required on private lands.

4. Forestry. Timber harvest and road building should be reduced and in some cases removed from riverine-riparian areas. Some ecologic-geomorphic guilds (i.e., certain

combinations of soils, aspect, geology, topography, channel migration zones, and sensitivities) mandate no land-use activities in riparian areas. Other less sensitive guilds may permit activity near or within riparian zones without damage to aquatic habitat. Assessment of riparian sensitivities is needed to implement appropriate management actions in riparian zones.

5. Nutrients. Replace nutrients in tributaries that formerly were brought by salmon returning from the sea. Juvenile salmonids benefit from nutrients released from carcasses, and the cycling of marine nutrients through ecosystems was an important factor before escapements dropped off dramatically.

6. Exotics. Aggressive action by state and federal agencies is needed to halt the spread of exotic (non-native) species in areas that can be used by native species. Management actions should focus on improving conditions for native species and reducing populations of exotic species. Although habitat restoration may improve conditions for salmonids, exotic species may displace native species from these restored areas.

7. Mining. Administrative action should be taken to reduce mining-caused damages to spawning and rearing streams. This means that regulatory agencies should place very high priority on assuring that future mining is done safely and effectively. Enforcement of existing water quality standards is warranted.

Implementation of Management Actions:

In general, preservation of watersheds that are relatively undisturbed and provide "healthy" ecosystems are ranked highest. Of the disturbed watersheds, those that have the greatest potential for habitat improvement and recovering ESA-listed stocks are ranked higher than those that provide little benefit to listed stocks. Thus, the Plan does not necessarily attempt to salve the worst degraded or most visibly altered areas.

Results of prioritizing or ranking sub-basins and watersheds would logically lead to selecting the appropriate management actions. For example, fine sediment recruitment may limit ESA-listed stocks in some streams. Here, improving land management practices in the uplands, obliterating or relocating roads, or improving riparian and floodplain conditions may reduce fine sediment recruitment. Another system may be limited by low stream flows and high water temperatures. In this case, acquiring water rights and improving riparian conditions may improve flows and temperatures. Where barriers restrict fish distribution, improving fish passage at dams or through culverts may be the appropriate management action. In other streams, low flows may restrict movement, in which case acquiring water rights may be the appropriate action. Clearly, a large number of habitat management actions may be necessary to restore habitat conditions in sub-basins and watersheds. The important point here is that the Plan prioritizes actions so that habitat and fish receive the greatest benefit at the lowest cost.

Performance Measures:

We propose several PM for monitoring biological and environmental conditions. Each PM is linked directly to one or more PS.

Tier 1 Performance Measures:

Monitor escapements of adult chinook and steelhead at fixed index locations (e.g., dams and wiers), census chinook redds in index streams, estimate smolt production, and calculate SARs.

Tier 2 Performance Measures:

Estimate egg-smolt, juvenile migration, and adult survivals. This requires monitoring the effects of each H on egg production, smolt production, numbers of migrants, and numbers of adults.

Tier 3 Biological Performance Measures:

Sub-Basin—Assess the condition factor, abundance, distribution, habitat use, and egg-smolt or parr-smolt survival of chinook and steelhead within selected sub-basins.

Watershed or Stream— Assess the condition factor, abundance, distribution, habitat use, and egg-smolt or parr-smolt survival of chinook and steelhead within selected watersheds or streams.

Tier 3 Physical/Environmental Performance Measures:

Sub-Basin—Monitor environmental conditions specific to each habitat action implemented (based on EDT and sub-basin assessments) within the sub-basin. Depending on the actions implemented, PM could monitor:

(1) **Preservation Measures:**
- ►Accounting of the number of hectares or kilometers of healthy habitat secured and protected.

(2) **Water Quality/Quantity Measures:**
- ►Estimation of weighted mean temperatures within the sub-basin;
- ►Estimation of peak and base flows;
- ►Estimation of drainage network density;
- ►Estimation of total surface water withdrawal;
- ►Estimation of fine sediment recruitment and load;
- ►Identification of point and nonpoint-source pollution;
- ►Estimation of number of kilometers of streams meeting water quality criteria.

(3) **Physical Measures:**
- ►Estimation of number of kilometers of stream at PFC;
- ►Estimation of road density within the sub-basin;

►Estimation of riparian-road density;
►Census of dispersal or migration barriers.

Watershed or Stream—Monitor environmental conditions specific to each habitat action implemented (based an EDT analysis and sub-basin assessments) within watersheds or streams. Monitoring will occur in selected areas within treatment and reference streams. Depending on the action implemented, PM could monitor:

(1) Preservation Measures:
►Accounting of the number of hectares or kilometers of healthy habitat secured and protected.

(2) Water Quality/Quantity Measures:
►Estimation of local temperature regimes;
►Estimation of local peak and base flows;
►Estimation of fine sediment recruitment and load;
►Identification of point and nonpoint-source pollution;
►Estimation of number of kilometers of streams meeting water quality criteria.

(3) Physical Measures:
►Estimation of number of kilometers of stream at PFC;
►Estimation of riparian-road density;
►Estimation of instream habitat conditions (substrate composition, large woody debris, pool frequency and quality, width/depth ratio, and stream bank stability);
►Estimation of off-channel habitat and floodplain connectivity;
►Census of screens installed or improved;
►Census of dispersal or migration barriers.

Implementation of Performance Measures:

Standard monitoring protocols will be used to assess performance measures throughout the basin. EPA's Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers (Barbour et al. 1999) would be appropriate for assessing habitat and physicochemical parameters. Fish sampling protocols should follow methods described in American Fisheries Society's Fisheries Techniques (Murphy and Willis 1996). This publication describes methods for sampling fish of different sizes and ages. It also describes underwater census methods, which may be more appropriate for sampling ESA-listed species than the electrofishing methods described in the EPA document. Temperature monitoring could follow Idaho Division of Environmental Quality's protocols for placement and retrieval of temperature data loggers (Zaroban 2000). Barrier analysis could follow Washington Department of Fish and Wildlife's Fish Passage Barrier Assessment and Prioritization Manual (WDFW 1998).

It is necessary to select index areas for monitoring PM. If possible, at the fine scale (watersheds and streams), monitoring should occur in both reference areas (areas with no management actions) and treatment areas (management action areas). Reference areas represent baseline conditions and will be used to refine site-specific PS. This approach requires that reference and treated areas are as similar as possible (see National Research Council's Restoration of Aquatic Ecosystems 1992). Because the implementation plan requires a description of current habitat conditions and prioritizes watersheds for management actions, this information can be used to identify both treatment and reference areas. In areas where no suitable reference areas exist, monitoring data would be compared with pre-treatment data and published information.

3.2 Hydropower Corridor

This habitat zone extends from the head of Lower Granite Pool to the tailrace of Bonneville Dam. Both habitat-related and hydro-passage related conditions affect fish survival through this zone. Hydroelectric development has altered the nature of this riverine habitat more than any other anthropogenic actions. The transformation from a flowing river to a series of impoundments has dramatically altered the physical and biological features of the habitat. Furthermore, the operation of the dams can affect the physical characteristics in the reservoirs (e.g., total dissolved gas saturation).

In this section we focus on the environmental attributes within the reservoirs. Because Tier 1 PS and PM are affected by all Hs within the three habitat zones and were described in Section 3.1, we do not repeat them here.

Tier 2 Performance Standards:

Juvenile and adult migration survivals will increase measurably (specific targests based on CRI analysis or other appropriate analysis). These metrics are affected by all Hs, not just the hydro-system.

Tier 3 Biological Performance Standards:

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Tier 3 Physical/Environmental Performance Standards:

We propose PS for three water quantity/quality conditions:

(1) **Total Dissolved Gas:** Total dissolved gas (TDG) will not exceed 120% saturation.

(2) **Water Temperature:** Water temperatures should not exceed 70ºF (21ºC) at any time within the mainstem hydroelectric system.

(3) **River Discharge**: Flow targets specified in the 1998 NMFS supplemental Biological Opinion should be adopted as provisional performance standards for mainstream river discharge.

Rationale for Biological and Ecological Criteria:

There are several environmental conditions that are particularly sensitive to the operation of the hydroelectric system, and they are important in affecting salmonid survival (see discussion in Appendix 4C). Those include TDG, water temperature, and river discharge. All of these are regularly monitored throughout the system, making them informative and convenient performance measures.

The PS for TDG exceeds that specified by state and federal water quality criteria (110 %). However, fisheries mangers in the Region have been monitoring fish species for evidence of effects over the last decade. They have determined that levels up to 120% do not result in deleterious effects on migrating salmonids, and they have adopted 120% as a standard. We support this standard.

The PS for temperature represents the upper resistance value for juvenile and adult migration, as specified by Karr et al. (1992). Typically, water temperatures of this magnitude do not occur until late summer at certain locales within the system, usually restricted to the Snake and lower Columbia rivers. Principally juvenile fall chinook, adult steelhead, and summer chinook would encounter warm summer temperatures. To the extent that operations of the main-stem projects actually influence water temperature, operations should not increase water temperature beyond the proposed standard.

The PS for river flows is based on the 1998 NMFS supplemental Biological Opinion. That document prescribes river discharge targets for spring and summer periods, as well as defining the length of the target period. The efficacy of these targets is a topic of ongoing debate. We would rely on analytical forums such as PATH or the NPPC Framework to address and resolve this matter. This provisional standard may be revised pursuant to findings in those and other forums. Performance measures would be calculated as the average daily flow in cubic feet per second as measured at the target sites prescribed by NMFS. Those targets are as follows:

DAM	DATES	FLOW (kcfs)
LGR	3 April – 20 June 21 June – 31 August	85 – 100 50 –55
MCN	20 April –30 June 1 July – 31 August	220 –260 200
PR	10 April – 30 June	135

Management Actions:

Because hydro-operations can affect the physical characteristics of the reservoir, there are a numbers of management actions that can be influential. Most of these are readily apparent and are explicitly specified in Biological Opinions and fish passage plans for the Columbia Basin. To regulate gas saturation levels, spill caps have been prescribed and spillways have been structurally modified. Flow augmentation has been used as a management tool to meet flow targets. These are some obvious examples that have been employed for some time in the basin.

There are other habitat-related actions that do not directly affect environmental conditions within the reservoirs, but do have an affect on fish survival (particularly juvenile stages). Habitat is more than the physical space and conditions occupied by a species. Habitat has biological dimensions as well, such as food sources and plant and animal communities. Because the fish community is a characteristic of the reservoir habitat, it follows that the control of predatory species like northern pikeminnow can be classified as a habitat-related management action.

Another class of management actions parallels some we discussed previously in the tributary zone. This class involves actions that prevent the diversion of listed stocks from reservoirs. Specifically, entrainment into irrigation pumps deployed within the reservoirs. NMFS has established criteria for screening pump intakes. Ensuring compliance with NMFS screening criteria for all reservoir intakes qualifies as a reservoir habitat management action.

Tier 2 Performance Measures:

Monitor the survival of juvenile and adult steelhead and chinook within the hydropower corridor.

Tier 3 Biological Performance Measures:

Monitor the abundance, distribution, migration behavior, and habitat use of juvenile and adult chinook and steelhead in the hydropower corridor.

Tier 3 Physical/Environmental Performance Measures:

We propose only water quantity/quality measures:

(1) Total Dissolved Gas: Measure total dissolved gas (TDG) daily at the forebay and tailrace of each dam.
(2) Water Temperature: Measure water temperatures in the tailrace of each dam.
(3) River Discharge: Measure river flows at each dam.

Implementation of Performance Measures:

A sampling grid is already established for tracking TDG. TDG is continually monitored at permanent sampling stations in the impounded Snake and Columbia rivers. Monitoring sites include both forebay and tailrace locations at each dam. We propose the PM be calculated daily as the mean of the average forebay and tailrace readings at each dam.

The issue as to where water temperatures should be monitored has received considerable discussion following the release of the COE Snake River Draft EIS. Certain agencies have voiced concern that values typically reported at COE projects are based on measurements obtained within the powerhouse. They suggest that these may not be representative of the impoundments. To address this concern, we suggest that inriver sampling stations be established in the tailrace of each project. The performance measure would be calculated as the daily minimum, mean, and maximum temperature at each station.

Flow augmentation is the management action executed to achieve flow targets. This involves drafting storage reservoirs including Dworshak, Libby, and Hungry Horse. There are two drafting periods, one during the spring and the other during the summer. Summer drafting may conflict with PS established for listed resident fish species residing in those areas (see Appendix 4C).

We note that the proposed flow-related PS are not necessarily conducive to making the system more normative. If the overall goal was to move the river system toward a more normative condition, as described by the ISG (1996), then adopting some of the flow targets may be in conflict with that goal. Consider the point that both fixed flow targets and summer flow augmentation may be counter-normative. For example, sharp compressed peaks in spring flows and extremely low summer flows with relatively high water temperatures characterize the normative hydrograph in the Snake River. Implementing summer flow augmentation with cold water from Dworshak Reservoir is clearly counter-normative. However, the strategy does offer a survival advantage to all life stages of salmonids within the affected zone of the river. This situation emphasizes the need to clearly state the overarching goal, or objective, before prescribing and implementing management actions.

3.3 Estuary-Ocean

As defined by Weitkamp (1994), the Columbia River Estuary extends from the east end of Puget Island (RKm 75) beyond the river mouth, including the plume that projects offshore. The habitat in this area has been altered by a diverse array of anthropogenic activities including upstream dam construction and operation, dredging, diking, pollution, etc. (Weitkamp 1994). Diking has reduced connectivity with backwater areas. This, in conjunction with wetland loss, dredging, and water management (dam operations), has altered physical and ultimately biological processes in the estuary (Sherwood et al. 1990).

The estuary is a critical habitat zone because every ESA-listed anadromous ESU either passes through or resides there at some time. Chum salmon and ocean-type chinook spend the most time in estuarine waters (Johnson et al 1997; Weitkamp 1994). Even so, most fall chinook of up-river origin (e.g., the listed Snake River population) generally pass through the estuary within 6 days according to studies cited by Weitkamp (1994). The author further notes that only fall chinook emanating from streams downstream from Jones Beach may remain in the estuary for up to several months. Although chum residence times in the Columbia Estuary have not been estimated, based on other systems, 4-32 days represents a common range (Johnson et al. 1997).

Tier 1 Performance Standards:

Refer to Tier PS in Section 3.1.

Tier 2 Performance Standards:

Estuary-ocean survival will increase measurably (specific target will be based on CRI analysis or other appropriate analysis). A positive trend in estuary-ocean survival should be observed within 10-15 years after management actions are implemented. These metrics are collectively affected by all Hs.

Tier 3 Biological Performance Standards:

Specifying biological PS for the estuary is challenging. Most ESA-listed populations spend a brief time in this zone, either as juveniles or adults. There are no survival estimates for any species or life stage as they reside within or traverse this habitat zone. Thus, estuarine-related effects on stocks of interest are unknown. This limitation precludes us from specifying meaningful biological PS at this time.

Tier 3 Physical/Environmental Performance Standards:

We believe that PS based on estuarine environmental conditions offer the most utility to resource managers, although the standard we offer is generic in nature. We propose that at a minimum there should be no net loss, and preferably a measurable increase in complex habitat types and improved connectivity among them. Toward this end the preservation, restoration, and reconnection of wetlands, sloughs, side-channels, and backwater areas are beneficial efforts.

Rationale for Biological and Ecological Criteria:

Since the late 1800s there have been pronounced anthropogenically-induced changes to the physical structure of the Columbia River estuary (Sherwood et al. 1990). The construction of jetties, dikes, and pile dikes, the dredging of navigation channels, as well as the filling of wetlands have altered estuary morphology and function. According to Sherwood et al. (1990), approximately 68 x 10^6 m^3 of sediment has accumulated in the estuary due largely to those actions.

In recent decades the seasonal river discharge patterns have been dramatically altered. Water management has dampened peak flows and reduced minimum flows (Sherwood et al. 1990). In concert, these two classes of activities, land use and flow regulation, significantly altered the habitat and thus may be candidates for restoring estuarine structure and function. Strategies that target land-use actions may be more expeditious to implement than flow regulation. At least three factors appear to limit our ability to appreciably alter existing flow patterns and intensity: flood control rule curves, fishery flow augmentation efforts that call for increased summer discharge, and the need to maintain navigation channels (natural or intentional flooding will shift bottom sediment).

There are additional considerations regarding the biological function of the estuary. Species community composition, which can be considered an important habitat component, differs from that prevailing historically. Sherwood et al. (1990) noted that the collective anthropogenic activities shifted the food web from macro detritus derived from emergent vegetation to one derived from phytoplankton. Additionally, exotic species have taken hold. A notable example is the robust population of American shad. The extent to which the new community may affect salmonids has not been established. However, conventional wisdom dictates that historical community structure was more conducive to salmonid production. In support of this contention, NMFS, in their March 1995 Proposed Recovery Plan, identified the reduction of American shad populations as a recovery measure because shad eat and compete with juvenile salmon (NMFS 1995).

Management Actions:

We present a number of management actions as candidates for improving estuarine structure and function:

(1) Secure and protect existing tracts of land consisting of wetlands, sloughs, channels, or backwaters.
(2) Curtail or restrict further filling and diking of the estuary.
(3) Survey previously diked areas and/or filled wetlands and identify areas that could actually be reclaimed and restored.
(4) Purchase reclaimable areas and reconnect estuary, wetlands, sloughs, and backwater areas.
(5) Evaluate the impacts of importing LWD to strategic sites in the estuary and implement where appropriate.

Tier 3 Physical/Environmental Performance Measures:

All of our proposed PM fall under the Tier 3 physical/environmental class. We do not propose tracking specific environmental conditions, i.e., temperature, flow, etc. Instead, we recommend that the quantity of preserved or restored habitat areas be emphasized as PM. In the short term (5 years), land acquisitions and/or restoration may be minimal. However, as a measure of progress, the number of formal interagency agreements or contracts with private parties to acquire or redevelop areas may suffice as candidate PM. In the long–term the actual accounting of acres protected or restored should be emphasized.

We suggest the following physical/environmental Tier 3 PM:

(1) Record the number of formal interagency agreements or contracts with private parties to purchase land or redesignate use thereof. (short-term)

(2) Enumerate the acres of wetlands, sloughs, or backwaters reclaimed or connected through dike removal or other physical restructuring. (long-term)
(3) Estimate the increase in LWD above baseline levels attributable to artificial importation. (short- to long-term)

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APPENDIX C

Summary of Scientific Assessments

NOTE: This appendix summarizes the analytical approach, results, and associated uncertainties of quantitative modeling assessments that have estimated population level survival requirements and expected benefits of actions for the ESA-listed anadromous fish populations (some of the uncertainties related to resident fish are provided in Section 8.4.9 of the draft Implementation Plan). Much of this information is presented in more detail in various parts of the NMFS BO. Our intent is to summarize the assumptions and issues underlying this Implementation Plan structure to: 1) help focus and prioritize needed research, 2) emphasize the need for continued refinement of performance standards, and 3) identify the critical importance of a strong RM&E program, performance tracking, and adaptive management to insure the Plan is successful.

1.0 The NMFS 2000 FCRPS Biological Opinion Assessment

1.1 General Analytic Approach

The general analytic approach used by NMFS for the assessment of survival improvements required to meet extinction risk and recovery criteria is identified in NMFS' BO, Section 6.1.2 and Appendix A. In this assessment, NMFS used the CRI analysis for 10 ESUs (McClure, et al., 2000 a, b, c) and a QAR modeling approach for the two Upper Columbia River ESUs (Cooney, 2000) to estimate population trends (1980-present), defined as the median annual population growth rate.

The CRI analysis fits an exponential growth model to running sums of estimated spawners. The QAR analysis uses a model fit to spawner-to-spawner recruitment data. NMFS estimated the change in population growth rate (lambda) necessary to reduce extinction risk to 5 percent in 24 and 100 years. That change in population growth rate was then translated into a needed change in life-cycle survival. For stocks with interim recovery abundance levels identified, NMFS also estimated the change in population growth rate and per-generation survival for the eight-year geometric mean abundance to grow from the current abundance level to greater than the recovery abundance level in either 48 or 100 years with a 50 percent or greater probability. For stocks lacking an interim recovery abundance level, NMFS determined the minimum survival change necessary for the median annual population growth rate to be > 1.0. NMFS used the maximum survival requirement calculated from all of these criteria to identify the needed change in survival to avoid jeopardy.

NMFS developed an RPA set of actions, that when combined with the ongoing and anticipated measures outlined in the *Basinwide Salmon Recovery Strategy*, are likely to meet the survival requirements defined above. NMFS used a combination of quantitative and qualitative information regarding the expected benefits of the RPA and the additional improvements in habitat, hatcheries, and harvest expected from Federal and non-Federal parties. The RPA actions include specific hydro actions and associated performance standards that must be met by 2010, along with offsite mitigation measures in the other Hs.

Quantitatively NMFS assessed the effects of the RPA hydro specific actions, using a fish passage model called SIMPAS, in combination with a quantitative assessment of harvest rate changes, relative to the 1980-1997 average survival conditions based on PATH passage model estimates (Appendix D, NMFS BO). From this combined survival change, NMFS determined additional per-generation survival improvements needed to achieve indicators of the NMFS' jeopardy standard for each ESU. NMFS then determined, using qualitative methods and professional judgment, that the combination of RPA offsite mitigation actions and the additional improvements in habitat, hatcheries, and harvest expected from other Federal and non-Federal parties would account for these additional needed survival improvements (NMFS BO, Section 9.7.2).

Given critical uncertainties in the analyses (see below), NMFS does not place a great deal of weight on the quantitative analyses that define the additional non-hydro survival requirements (Section 9.2.2.2.2, NMFS BO). The NMFS BO anticipates refinement in the current methods of assessing population growth rates (and the associated life-stage specific survival requirements) by March 1, 2005, based on additional research, peer-reviewed literature, and collaboration with the Action Agencies and other Federal, state and Tribal fish agencies (NMFS BO, page 9-46).

1.2 General Results of the NMFS Biological Opinion Assessment

Estimates of current and expected annual population growth rate, estimates of the survival change resulting from the RPA hydro and/or harvest actions, and additional per-generation survival increases that are needed to meet NMFS jeopardy criteria are summarized in Tables 9.7-6 through 9.7-17 of the NMFS BO. These results are further summarized below in Table 8.1 for the ESU aggregate level. The results include several different assumptions about the effectiveness of the RPA actions and the reproductive success of hatchery-origin spawners for hatchery supplemented ESUs, resulting in "Low" and "High" categories for the various NMFS estimates. These high and low assumptions are summarized in the Chapter 9 tables and Appendix A of the NMFS BO.

The survival increases due to the RPA and the additional survival requirements vary widely among the various ESU aggregates. Significant survival improvements are expected from hydro and harvest actions for ESUs located in the Snake and Upper and Middle Columbia Rivers above Bonneville dam. The additional survival increases beyond the hydro and/or harvest actions are expected from a combination of Action Agency offsite mitigation actions and additional improvements in habitat, hatcheries, and harvest from other Federal and non-Federal parties.

Table 1. Estimates of the survival change resulting from the RPA hydro and/or harvest actions and the additional per-generation survival increases that are required from a combination of RPA off-site mitigation actions and additional improvements in habitat, hatcheries, and harvest expected from other Federal and non-Federal parties.

	% Survival Change Due To RPA Hydro/Harvest		**Additional % Survival Change Required**	
Spawning Aggregation	**Low**	**High**	**Low**	**High**
Snake River spring/summer chinook	30	38	46	89
Snake River fall chinook	49	86	0	44
Upper Columbia River spring chinook	36	54	32	58
Upper Willamette River chinook	0	0	9	65
Lower Columbia River chinook (below Bonneville)[1]	0	0	132	231
Snake River steelhead	50	61	58	260
Upper Columbia River steelhead	39	59	26	193
Mid-Columbia River steelhead	21	25	92	218
Upper Willamette River steelhead	0	0	37	69
Lower Columbia River steelhead	0	0	53	171
Columbia River chum	0	0	0	0
Snake River Sockeye	NA	NA	NA	NA

[1] Numbers for the entire aggregate were unavailable so averages over available population-level estimates were used instead.

1.3 Plan for Analyzing and Testing Hypotheses Assessments

The PATH process was a formal analytical program established by NMFS under the 1995 Biological Opinion [cite], using an Independent Science Review Panel, that tested various hypotheses regarding salmon survival and evaluated hydro management alternatives for Snake River spring/summer chinook and fall chinook. Participants included the Action Agencies, NMFS, USFWS, and regional state and tribal fish agencies. The PATH analyses used a broad set of hypotheses and two separate juvenile fish passage models (UW's CRiSP model and state and tribal FLUSH model) in combination with several Ricker life cycle models and a Bayesian Simulation life cycle model fit to spawner-to-spawner recruitment data (PATH, 1999; 1998). These analyses used similar recovery metrics to those used in the BO, but used a different metric for extinction risk.

Results of PATH comparisons to the NMFS BO show that projected population performance is highly sensitive to the historical years used in the analysis. PATH used a longer set of historical redd count data back to the late 1950's and early 1960's compared to the NMFS BO analysis using red counts back to 1980.

The general results from these assessments for the existing and currently planned level of mitigation showed:

Hydro Mitigation: Current juvenile in-river survival levels for both Snake River spring/summer and fall chinook migrants have increased by over 100 to 200 percent relative to historic passage conditions in the ‘70s and ‘80s.

Current hydro mitigation measures under all sets of alternative assumptions and hypotheses resulted in increasing population trends for both Snake River spring/summer and fall chinook due to significant improvements in recent and expected hydro survival relative to historic conditions (supported by NMFS White Papers, 2000) as a result of changes in flow augmentation, spill, bypass improvements, predator control, and transportation.

Fish Transportation: Over 90 percent of both Snake River yearling and subyearling migrants surviving to below Bonneville Dam are transported.

Direct survival to below Bonneville Dam including the transported fish is approximately 80 percent for yearling migrants and 70 percent for subyearling migrants. This direct passage survival is adjusted down in model analyses under a hypothesis that there is an additional delayed mortality for transported fish (D value). Future population projections are very sensitive to uncertainty about the magnitude of D, especially for fall chinook. D values in these analyses ranged from 0 to greater than 1 for both spring/summer chinook and fall chinook.

Survival and Recovery Thresholds: For Snake River spring/summer chinook, the probabilities of exceeding survival and recovery thresholds were very near or beyond the levels required to meet survival and recovery criteria when all possible hypotheses are given equal weight. If more weight is given to more current survival data or to hypotheses that show reductions in extra mortality (such as improvements in ocean conditions) the results are more optimistic. If more weight is given to hypotheses where extra mortality is here to stay, the results were more pessimistic.

For Snake River fall chinook, the probabilities of exceeding survival and recovery thresholds were beyond the targeted criteria with the exception of hypotheses that assume over 80 percent of the transported fish die after being released below Bonneville Dam. Under this set of hypothesized low D values, the recovery threshold criteria can still be achieved if transportation is stopped and fish are left in river.

Other-Hs: Additional measures outside of the hydro system, such as harvest restrictions for fall chinook or habitat improvements for some index stocks of spring/summer chinook, further increased the probability that populations would be above survival and recovery thresholds.

Critical Uncertainties: Key critical uncertainties requiring further research and monitoring were hypotheses about delayed post Bonneville mortality of both transported and non-transported fish and uncertainty in the measurement and expansions of redd count survey data that formed the basis of the analyses.

1.4 Mid-Columbia Quantitative Analytical Report Assessments

The Mid-Columbia QAR process was a cooperative scientific effort by NMFS, State, and Tribal Fishery Agencies, Mid-Columbia Public Utility Districts, COE, and BPA. The QAR provides an assessment of survival and recovery requirements of upper Columbia steelhead and spring chinook salmon ESUs. The results provided here are based on the most current draft report of April 3, 2000.

The primary model used in the QAR assessment was a variant of Botsford and Brittnacher (Conservation Biology, 1998, V. 12 No. 1, pp. 65-79) model fit to spawner-to-spawner recruitment data. For spring chinook, the draft report examined three overlapping time periods for population projections: 1980-1994, 1970-1994, and 1960-1994. Basically, the different calibration periods, after making some simple adjustments to account for changes over time in harvest and in-river survival, can be viewed as proxies for periods of better and worse climatic conditions. For steelhead the draft report uses only 1976-1992 due to data limitations and time constraints. Because past hatchery supplementation is a large part of steelhead spawning escapement, the draft examines three levels of hatchery spawner effectiveness: 1.0 (same effectiveness as wild-origin fish), 0.75, and 0.50 (half as effective).

Survival improvements required to meet extinction risk and recovery goals for spring chinook are very sensitive to the base period used in model calibration. For example, for Wenatchee spring chinook to have less than a 1 percent risk of extinction, a 95 percent improvement in life-cycle survival is needed if conditions from 1980-1994 persist into the future, while only a 5 percent increase is needed if future conditions are like those of 1960-1994. Results for both species suggest that if recent low survival rates (i.e. 1980-1994 for spring chinook and 1976-1992 for steelhead) are assumed to continue indefinitely, there is a high risk of extinction and hydro actions alone will not result in near-term survival or recovery of the upper Columbia ESUs.

The current results for steelhead are sensitive to the assumed effectiveness of past hatchery spawners. For example, for the Wenatchee stock to meet the above extinction risk criteria, a 77 percent increase in survival is needed if hatchery effectiveness is 1.0, while no increase is required if hatchery effectiveness is 0.5.