Tom Karier
Chair
Washington

Frank L. Cassidy Jr.
"Larry"
Washington

Jim Kempton
Idaho

Judi Danielson
Idaho

Northwest Power and Conservation Council

Joan M. Dukes
Vice-Chair
Oregon

Melinda S. Eden
Oregon

Bruce A. Measure
Montana

Rhonda Whiting
Montana

August 6, 2006

MEMORANDUM

TO: Council

FROM: Steve Waste, Manager for Program Analysis and Evaluation

SUBJECT: Guidance for Developing Monitoring and Evaluation in the Columbia River Basin Program

Action

Staff is presenting the revised guidance for review by the Council and provisional use pending additional ISRP/AB review if desired by the Council.

Recommendation

Staff recommends continuing to implement the approach set forth in the guidance document that has already informed the project selection process for Fiscal-Year 2007-2009. Staff also recommends a final review by the ISRP and ISAB to determine whether the document provides sufficient guidance for shaping the development of a coordinated approach to monitoring for the Program and the region.

Background

The prior draft of the monitoring guidance was reviewed by the ISRP and ISAB who recommended shortening it and reworking it to address the four questions provided to them by Council. In response, the guidance has been significantly shortened and reorganized to address the four questions and incorporate the recommendations of the ISRP and ISAB review, and the ISRP Programmatic Review.

Analysis

The guidance document explains the steps necessary for developing the capacity to collect monitoring information in a consistent, statistically valid manner that, ultimately, could support the determination of changes over time in set of core indicators. By pursuing this approach, the Council can develop a mechanism for evaluating the cumulative benefits of projects at the subbasin and province scales. Chapter I describes the monitoring objectives of the Program; the broad management questions that address them; and the types of monitoring necessary to answer the questions. Continuing to move from the broad to the specific, Chapter II describes each type of monitoring, specific objectives, ongoing activity, and future priority monitoring tasks.

851 S.W. Sixth Avenue, Suite 1100
Portland, Oregon 97204-1348
www.nwcouncil.org

Steve Crow
Executive Director

503-222-5161
800-452-5161
Fax: 503-820-2370

Guidance for Developing Monitoring and Evaluation as a Program Element of the Columbia River Basin Fish and Wildlife Program

Northwest Power and Conservation Council

August 2006

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I. Introduction

Biological Objectives of the Fish and Wildlife Program

The Council's Columbia River Basin Fish and Wildlife Program is one of the largest regional efforts in the nation to mitigate impacts of hydropower dams on fish and wildlife. The 2000 Program established a basinwide vision for fish and wildlife along with four overarching biological objectives:

- A Columbia River ecosystem that sustains an abundant, productive, and diverse community of fish and wildlife
- Mitigation across the basin for the adverse effects to fish and wildlife caused by the development and operation of the hydrosystem
- Sufficient populations of fish and wildlife providing abundant opportunities for tribal trust and treaty right harvest and for non-tribal harvest
- Recovery of the fish and wildlife affected by the development and operation of the hydrosystem that are listed under the Endangered Species Act (ESA)

The principal method of achieving the program's biological objectives is through mitigation projects to improve conditions for fish and wildlife that have been affected by the Columbia River hydrosystem. In order to assess progress toward the program's biological objectives, it is necessary to assess the progress of projects through monitoring and evaluation.

Monitoring and Evaluation Objectives of the Fish and Wildlife Program

- Measure the survival of salmon smolts and adults through the hydrosystem and of wildlife throughout their ranges
- Evaluate whether hatcheries are achieving their stated goals
- Assess the performance of the program and its target populations relative to project, subbasin, and province objectives
- Evaluate changes in the condition of aquatic and terrestrial habitats
- Quantify the effects of harvest on salmon populations
- Identify where and why there are program performance problems, and identify the most effective actions needed to correct them
- Establish a baseline for evaluating individual subbasin and province objectives

Monitoring and Evaluation Objectives for the Provinces

The Council administers the program at three levels: subbasin, province, and Columbia River Basin. Projects are implemented at the subbasin level, subbasins are grouped within provinces, and provinces are grouped within the Columbia Basin. Basinwide objectives were provisionally adopted by the Council in the 2000 Fish and Wildlife Program (see Appendix D of the program).

The program calls for province level objectives. The process of developing, negotiating, and gaining regional acceptance of province level objectives would occur through a program amendment process that should begin in 2006. These objectives will be developed from the knowledge gained from subbasin plans and monitoring of population-based indicators. Province level objectives can provide the targets against which to evaluate the cumulative benefits of individual project actions. To compare progress across provinces will require that data be gathered on a set of core indicators. The indicators which must be relatively small, consistently easy to measure, and relevant to the biological objectives being evaluated. A substantial amount of data on the provisional set of core indicators proposed by Council staff (see Appendix A) is already being collected by the program's mitigation projects and many entities outside of the program.

The majority of ongoing monitoring is at the project level. In aggregation, data from this project monitoring can support analyses at larger geographic scales, such as at the province and basinwide levels. These analyses require consistency in data protocols, collection methods, and evaluation. This guidance document lays the foundation for collecting monitoring information in a consistent, statistically valid manner that ultimately could identify positive or negative changes over time in set of core indicators at the province scale.

The first priority for assessment of data across the province or basinwide scale would be data on fish and wildlife population status and trends both for natural spawning and hatchery produced fish. The second priority would be the habitat condition indicators that will enable comparison of watershed conditions in the future with the assessments that were used for subbasin planning. Habitat indicators should be implemented one at a time beginning with data that is easiest to assemble from the pool of data already collected and the value of the data for future subbasin assessments.

Council staff recommends that the evaluation of the core indicators be reported in an Annual Report on the Fish and Wildlife Program. The Columbia Basin Fish and Wildlife Authority will produce an initial summary report for 2006. The staff expects content to evolve as province objectives are defined and adopted into the program and specific indicators are confirmed. Success will require a support from a data management system that can provide access to the data sets developed through monitoring efforts, on a timely basis, for analysis.

Management Questions and Types of Monitoring in the Fish and Wildlife Program

Monitoring and evaluation designs and actions depend on a clear definition of key management questions. In Table 1 key management questions of the fish and wildlife program are matched with the relevant types of monitoring. These management questions overlap with those of other regional entities and local, state, federal, and tribal governments. The Pacific Northwest Aquatic Monitoring Partnership (PNAMP) has developed a regional monitoring framework to identify the parties with overlapping management questions and to clarify their roles and responsibilities. The PNAMP framework can facilitate:

- Common management questions and relevant information needs
- Common research, monitoring, and evaluation categories, designs, and protocols that strengthen communication and networking of regional programs
- Common understanding of responsibilities and cost sharing

The PNAMP framework also provides an organizing structure for identifying the types of monitoring needed to answer particular management questions for the region. The framework, developed through ongoing regional coordination efforts that the Council has supported since 2004, can be found at: Appendix A: RM&E Management Questions, Information Needs, and Cost Sharing Agencies (BPA 11/14/05).

Current Monitoring Activity in the Fish and Wildlife Program

Current levels of monitoring are reported in Table 2, which displays the numbers of projects and their costs by type of monitoring. Figure 1 depicts the proportion of funding for each type of monitoring in Fiscal-Year 2006.

The geographic distribution of monitoring in the Columbia River Basin by type is depicted in Figure 2. (Figures 1 and 2 are based on the Fiscal-Year 2006 start-of-year budget recommendations.)

Table 1. Management Questions and Types of Monitoring in the Fish and Wildlife Program

Management Questions	**Types of Monitoring**
Are juvenile and adult survival through the dams meeting passage objectives? What are the delayed effects of transportation and migration through the hydrosystem?	Hydrosystem Survival
Does supplementation help rebuild populations?	Hatchery Effectiveness
What are hatchery numbers of salmon and steelhead relative to naturally spawning populations?	Hatchery Status and Trend
Are resident and anadromous fish and wildlife populations meeting objectives for abundance, productivity, and diversity?	Population Status, Trend, and Distribution
Are ecosystems improving or degrading relative to the conditions subbasin plans called for?	Habitat Status and Trend
What types of projects are effective at addressing limiting factors?	Habitat Project Effectiveness
Is the Columbia estuary ecosystem improving or deteriorating relative to desired conditions?	Estuary Habitat Status and Trend
What is the harvest impact on Columbia populations of listed anadromous fish?	Harvest Trend
Are the individual actions in the various subbasins achieving the objectives at the basin and province levels?	Basinwide and Province Evaluation

Table 2. Council Recommendations for monitoring and evaluation projects in Fiscal Year 2006

Category	FY06 Budget Recommendations	Number of Projects
Anadromous Fish Population	$ 8,035,387	20
Resident Fish	$6,099,855	13
Hydrosystem Survival	$4,534,428	7
Habitat Project Effectiveness	$4,110,348	4
Hatchery Effectiveness	$1,567,040	5
Estuary	$1,311,000	3
Wildlife	$127,461	1

Figure 1. Current monitoring in the fish and wildlife program by type and cost, based on Fiscal-Year 2006 start-of-year budget recommendations

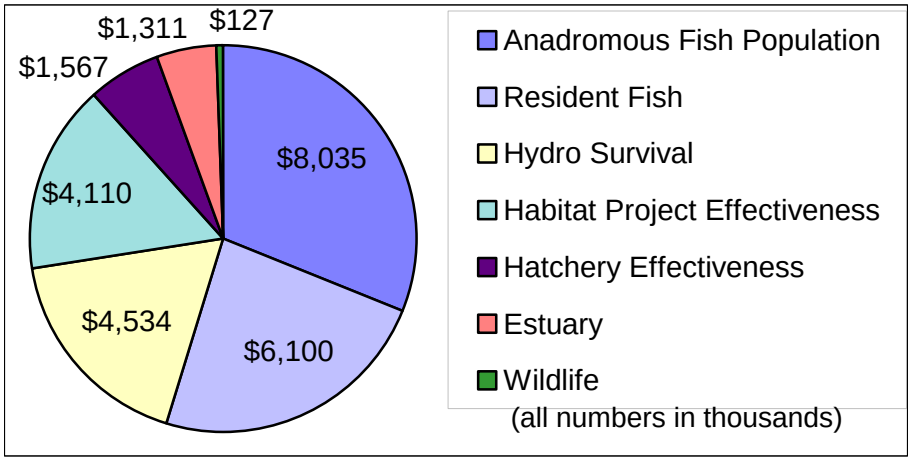
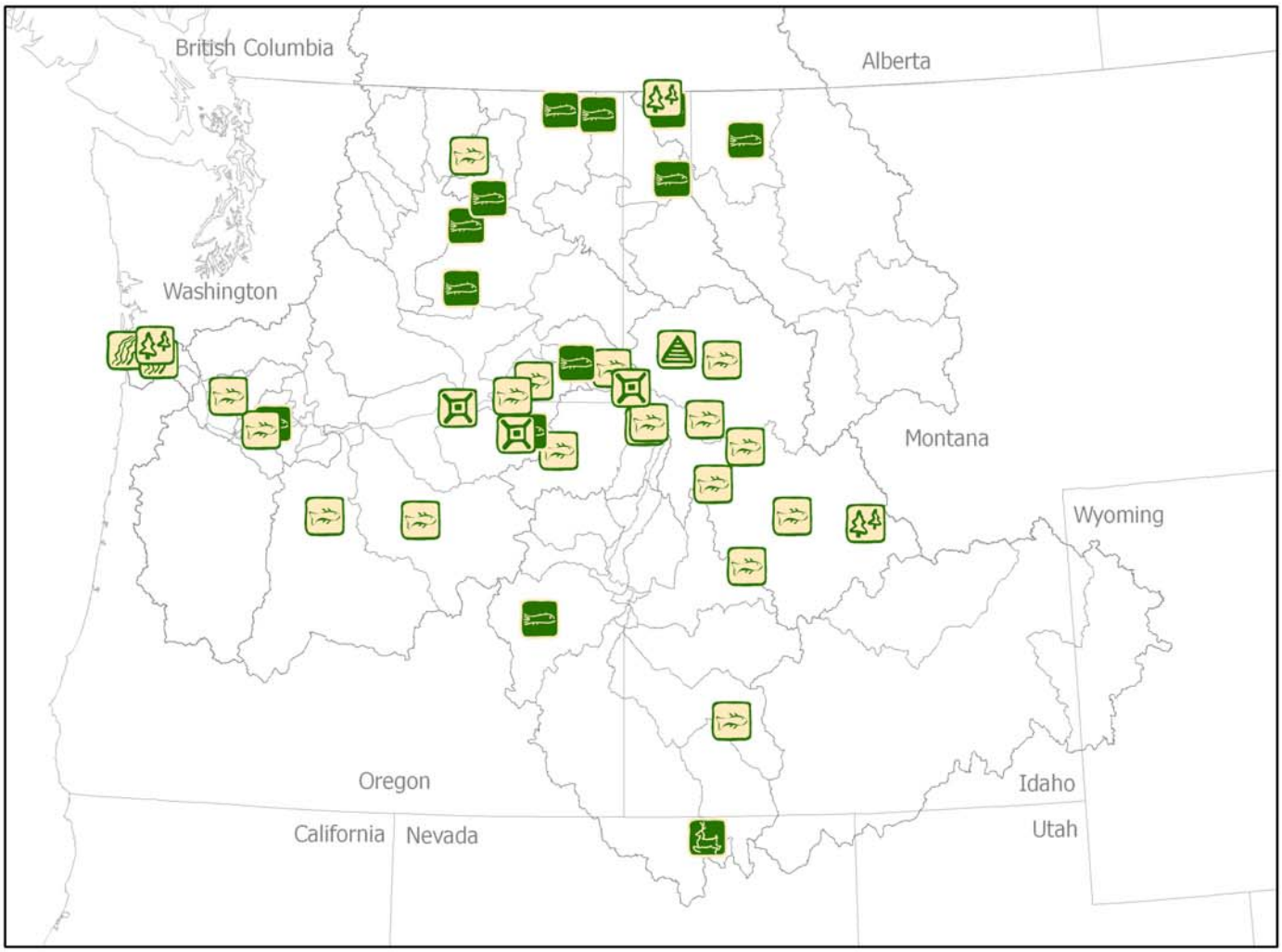


Figure 2. The geographic distribution of monitoring in the Columbia River Basin by type (see next page).

Columbia Basin Fish and Wildlife Authority

Monitoring and Evaluation Projects in the Columbia River Basin FY 2006



Legend

M&E Category

- Anadromous Fish Population Monitoring (2)*
- Estuary Monitoring
- Habitat Project Effectiveness Monitoring (1)*
- Hatchery Effectiveness Monitoring (2)*
- Hydro Survival Monitoring (6)*
- Resident Fish Monitoring (1)*
- Wildlife Monitoring

** Number in parenthesis indicates unmapped Mainstem/Systemwide Projects*

Map Created by: CBFWA
Map Date: August 2, 2006
Project: NAD 1983 UTM Zone 11N
Data Source: CBFWA (Project Information), BPA (Province/Subbasin), NPCC (M&E Project List)

II. Monitoring Recommendations for the Council's Fish and Wildlife Program

Chapter I described the overarching biological objectives of the program, the broad management questions that address them; and the types of monitoring necessary to answer the questions. Continuing the approach of moving from the broad to the specific, this chapter describes each type of monitoring, specific objectives, ongoing activity, and future priority of monitoring tasks.

A. Hydrosystem Survival

Description of Monitoring - Monitoring and evaluation related to the Columbia-Snake River hydropower system are important elements of the program. These efforts include monitoring of the effectiveness of new and/or existing fish passage facilities; monitoring spillway survival and spill effectiveness at each mainstem dam to optimize spillway passage; monitoring inriver juvenile and adult fish migration and survival with tagging and tracking technology, including routes of passage through each dam; monitoring of other factors contributing to mortality, such as predation; and monitoring various water quality parameters throughout the Columbia River system.

Objectives of Monitoring - Determine whether juvenile and adult anadromous fish survival through the mainstem Snake and Columbia River dams is meeting passage objectives. Determine the delayed, or latent, effects of fish transportation and migration through the hydropower system.

Ongoing Monitoring Activity – Hydrosystem monitoring activities in the program are coordinated with those funded under the U.S. Army Corps of Engineers' Anadromous Fish Evaluation Program (AFEP) and the Mid-Columbia Habitat Conservation Plan monitoring and evaluation program. Program funded activities have been reviewed by the ISRP and regional fish and wildlife managers in the current 2007-2009 process. Ongoing monitoring efforts include the smolt monitoring program, the reach survival estimates for the salmon and steelhead passage through Snake and Columbia River dams and reservoirs, the Comparative Survival Study, the various coded wire tag recovery and stock assessment monitoring efforts, and operation of the Lower Granite trap for adult salmon monitoring.

Future Priority Monitoring Tasks - The ISRP recommends a comprehensive regional review, within the next year, of the various tagging technologies being used in the Columbia Basin, with special consideration to the complex interactions among the smolt monitoring projects using PIT-tags, radio telemetry technology, coded wire tags, and acoustic, or sonic tags. The review is beginning in the Corps of Engineers' AFEP, but the Council may need to expand the scope of the review and/or ask for an independent scientific review of tagging technologies

B. Hatchery Effectiveness

Description of Monitoring – At present, monitoring the effects of artificial production on population health (hatchery performance) is a significant component of the monitoring budget and is generally conducted project-by-project.

Objectives of Monitoring - The ISRP and ISAB concluded that monitoring and evaluation of supplementation projects is critically important because the natural populations that may be lost if supplementation actually decreases their fitness are irreplaceable (ISRP and ISAB Document 2005-15).

- Determine the range, magnitude, and rates of change of natural spawning fitness of integrated (supplemented) populations (ISAB Review of Salmon and Steelhead Supplementation, Document 2003-3)

- Determine how these are these related to management questions, including the proportion of hatchery fish permitted on the spawning grounds, the broodstock mining rate, and the proportion of natural-origin adults in the hatchery broodstock

Ongoing Monitoring Activity – Some of the ongoing artificial production projects that include monitoring are already coordinating with other regional research, monitoring, and evaluation activities, for example:

- Idaho Supplementation Study (198909800)

- YKFP - Klickitat Subbasin Monitoring and Evaluation (199506335)

- Nez Perce Tribal Hatchery M&E (198335003)

- Umatilla Hatchery - M&E (199000500)

- Umatilla Basin Natural Production Monitoring and Evaluation Project (199000501)

The ISAB-sponsored workshop April 6-7, 2006, to coordinate monitoring within existing projects to address the recommendations in the ISAB 2003 review of supplementation and those in the ISRP and ISAB 2003 review of monitoring and evaluation in supplementation. Workshop participants agreed that a comprehensive assessment of supplementation would require a combination of two approaches. The first would involve analysis of data for a limited number of parameters collected from a large number of supplemented and unsupplemented streams across the Columbia basin. This analysis would assess long-term trends in population viability. For such an analysis, data would have to be collected from many more streams than are being studied currently (see CRITFC, 2006).

The second approach would involve intensive monitoring of a limited number of stream systems to assess the short-term effects of particular supplementation procedures. This monitoring may use pedigree analysis to quantify individual reproductive success and would be carried out in streams where fish sampling could be well controlled, or possibly involve use of artificial spawning channels. Workshop participants expressed concern that the additional monitoring needed to produce a systemwide assessment would require budget increases for the various ongoing and proposed projects.

Future Priority Monitoring Tasks - Next steps for the ISAB supplementation-working group, convened at the workshop, will focus on these tasks:

- Develop a matrix of management characteristics for supplementation projects operating in the Columbia River Basin and categorize the projects into a few common types

- Develop a matrix of reference stream characteristics, and identify the supplementation projects for which each stream would provide a suitable reference

- Outline one or more comprehensive evaluation designs to collate information across supplementation projects, identifying for each design the particular management questions to be addressed, the monitoring data and analytical procedures to be utilized, and the subset of projects to be included

The Council should prioritize development of an integrated design for a coordinated regional approach to supplementation monitoring for completion and scientific review in 2007. A limited monitoring program that selects a representative sample of the hatchery projects would be most cost effective. Next steps are to:

- Link the program's supplementation effectiveness monitoring into a more integrated regional experiment

- Determine the level of funding for monitoring of hatchery performance against project objectives and effects on naturally spawning populations

C. Population Status, Trends and Distribution

Description of Monitoring – Population status and trend monitoring includes broad-scale, periodic monitoring and geographically localized, frequent monitoring to determine changes in conditions over time. It provides an opportunity for very simple monitoring of biological metrics such as spawner surveys or bird counts. For example, large-scale trend monitoring of fish populations might include juvenile fish counts in bypass systems at dams, adult counts at dams, redd surveys, and adult counts at weirs or a combination of these.

Objectives of Monitoring

Anadromous: The objective of anadromous fish populations monitoring is to assess the current status or change (trend) over time and whether the ESA-listed populations are meeting objectives for abundance, productivity and diversity, and distribution (these are the NOAA Viable Salmonid Populations criteria for recovery).

Resident Fish: The objective of resident fish populations monitoring is to assess the current status or change over time.

Wildlife: The objective of wildlife populations monitoring is to assess the current status or change over time.

Ongoing Monitoring Activity

Common Protocols for Monitoring Fish/Wildlife Population Status and Trends: The use of common protocols for the collection of fish and wildlife population status and trend data is a key step in the development of data that can function as a common currency and support analyses at larger geographic scales. For example, common protocols and standard monitoring designs can generate expanded, robust, and accessible information on adult escapement and smolt production. The development of data collection methods that will support statistically valid analyses and comparable results will require:

- Common monitoring approaches, including standardized protocols
- The ability to compare like data collected following different protocols
- Connections between protocols designed for different purposes, such as habitat assessment protocols for watershed management and protocols for fish population censusing

Projects that provide good examples of these include the Integrated Status and Effectiveness Monitoring Program (200301700), Okanogan Basin Monitoring and Evaluation Project (200302200), and the Upper Columbia Strategies (Hillman 2004).

Members of the PNAMP Fish Workgroup have been working cooperatively with For the Sake of the Salmon and the American Fisheries Society (AFS) to develop a manual of protocols recommended for use by fishery managers for assessing populations of resident and andromous fish. Since many protocols used by state agencies and tribes have not been formally published, the manual consolidates the protocols produced from the best field techniques, published and unpublished. The manual of PNAMP endorsed protocols is nearing completion and will be published by AFS in September or October 2006 and then available for regional use (see documents posted under Fish Population Monitoring at the PNAMP website (www.pnamp.org).

Future Priority Monitoring Tasks

- Develop common protocols for collecting population data

- Cooperatively develop common statistical site selection procedures for fish and wildlife populations
- Develop a sound trend monitoring procedure based on remote sensing, photography, and data layers in a geographic information system (GIS) format

Anadromous Fish: Recognizing that it is not feasible and affordable to monitor all populations of anadromous fish everywhere, a practical budgetary strategy is needed that will provide sufficient information for determining changes in the status of salmonid Evolutionarily Significant Units (ESUs). In August 2006, NOAA will release a delisting decision framework in support of developing research, monitoring, and adaptive management elements in recovery plans. Recovery plans, with NMFS assistance, will be identifying the desired status of individual populations which, when combined, will meet the ESU viability objectives of each plan. The distribution of population objectives across the ESU could shape the appropriate monitoring design and program. Thus, the Council's choices regarding the distribution of population monitoring sites should be informed by efforts to implement Biological Opinions and monitoring in support of recovery planning.

Resident Fish: Where population monitoring for resident fish is prioritized for funding through the program, the appropriateness of methods will continue to be reviewed by the ISRP. Therefore, staff does not propose a standard protocol at this time.

Wildlife:

- Prioritize census monitoring of wildlife populations to measure the response of target populations to the acquisition and management of habitat

- Conduct periodic surveys to determine the quality of habitat protected by the program

Currently, the program calls for granting habitat enhancement credits to Bonneville by monitoring project sites using the Habitat Evaluation Procedure (HEP) methodology. Yet the ISRP has cautioned the Council not to rely on HEP to estimate population response (ISRP 2005-14 Retrospective Report). HEP has been criticized for not providing an effective biological evaluation of project progress and for competing for funds that could be directed to conservation and mitigation actions.

Consequently, HEP should only be used in the future only as an accounting system for the mitigation agreements that underpin the program and should not play a role in biological monitoring. In the meantime, staff recommends using the HEP methodology as a mechanism for tracking Bonneville's obligations for wildlife mitigation while

continuing to review alternative procedures for monitoring population responses as proposed by the ISRP.

D. Habitat Monitoring

Habitat Status and Trend Monitoring

Description of Monitoring - Environmental status and trend monitoring is conducted to assess the current status or change (trend) over time, for example of watershed conditions, and includes broad-scale, periodic monitoring and geographically localized, frequent monitoring.

Objectives of Monitoring - In 2005 the Council completed subbasin plans, which were based on assessments that incorporated data on watershed conditions. The objective of Habitat Status and Trend Monitoring is to determine whether watershed conditions in subbasins are improving or degrading relative to the conditions identified in the first subbasin assessments.

Ongoing Monitoring Activity

Common Protocols for Monitoring Environmental Status and Trends: Because of the difficultly in combining data across monitoring programs, several members of PNAMP proposed, designed and provided funding for a comparison of commonly used protocols within the basin. During the summer of 2005, 12 streams within the John Day River Basin were independently evaluated by eight different monitoring programs in the Pacific Northwest (see Comparison of Data/Monitoring Groups in Appendix B). The goal of this study was to compare stream-monitoring protocols used by different monitoring groups within the Pacific Northwest. Protocols tested included those of nine major entities.

Initial findings from this study suggest that several aspects of stream surveys can be implemented so as to make results from one monitoring program compatible with others. Final results of the protocol test will be available by the end of 2006. For now, Council staff recommends that those conducting status monitoring of habitat characteristics employ one of the protocols tested recently because their precision and accuracy will be known and comparable to the others measured (see http:www.pnamp.org for PNAMP Protocol Comparison).

Common Site Selection Procedures: The Environmental Protection Agency has developed a program for ensuring that randomly selected sampling sites can be evenly distributed, called “probabilistic sampling,” through the Environmental Monitoring and Assessment Program or EMAP. Council staff recommends that the region adapt the EMAP framework for core habitat information. The states should be responsible for measuring habitat status on non-federal lands and the federal agencies for their managed lands.

Use of a common site selection process will help link state, federal, and tribal monitoring of habitat status and trends at the sub-basin level into an integrated sampling strategy. This will require the entities to coordinate in selecting sampling sites, but this coordination would improve monitoring efficiency across geographic scales. (Note that a randomized scheme may be appropriate for monitoring habitat, discrete water quality, macro-invertebrates, and relative abundance of juvenile fish, but be inappropriate for monitoring continuous water quality or smolt and adult life stages that should employ a census sampling scheme.)

Future Priority Monitoring Tasks

- Require, where appropriate, the use in program projects of PNAMP endorsed common protocols for monitoring populations and environmental status and trends

- Require, where appropriate, the use in program projects of a common site selection procedures

- Propose specific indicators for prioritizing data collection for fish and wildlife for confirmation by the Council and prioritize data for storage by Streamnet and the Northwest Habitat Institute

- Collect data for a core set of indicators, rather than all data that were used in subbasin planning

- Ask the Northwest Environmental Data Network (NED) to certify data collection protocols for use by the Collaborative Systemwide Monitoring and Evaluation Project (CSMEP) and PNAMP

Many fishery projects and proposals lack clear descriptions of sampling design or of procedures and criteria for assessing the outcomes of management plans (ISRP Retrospective Report 2005-14). Therefore, staff recommends:

- Using EMAP as a master sample design for population abundance and habitat indicators. Entities within the Columbia River Basin should cooperate in the adoption and application of random site selection procedures for habitat status and trend monitoring. Probabilistic site selection should be accomplished as soon as possible to avoid inherent biases in subjectively selected study sites. Indicator variables should be measured at the same sites, if possible. This would require common stratification techniques.

- The program can facilitate the implementation of EMAP by establishing a statistical design and analysis support function to provide input for the projects that have limited statistical expertise. The program currently funds some statistical design resources and more might be developed in low cost workshops and through CSMEP.

Habitat Project Effectiveness

Description of Monitoring - Monitoring should be conducted to assess how fish and wildlife productivity changes as actions are implemented or as habitat changes. However, simply monitoring change will not be sufficient; a treatment and control experiment is required to test the effectiveness of habitat restoration projects. Work to evaluate effectiveness of mitigation is being conducted through an approach called Intensively Monitored Watersheds (IMW).

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Objectives of the Monitoring - Determine how effective different types of habitat mitigation projects are at addressing limiting factors.

Ongoing Monitoring Activity - The Council began monitoring the effectiveness of habitat actions in 2004 when it approved three pilot studies to conduct intensive monitoring of tributary habitat in the Columbia River Basin (Jordan et al. 2003, Hillman 2004; WA SRFBa; and WAIMW 2004). IMW work sponsored by other entities is also ongoing in Washington, Oregon, and California. Members of PNAMP and other entities working with support from the Pacific Coastal Salmon Recovery Fund (PCSRF) have identified additional watersheds for the intensive monitoring of mitigation project results.

The PNAMP Effectiveness Monitoring Workgroup has convened a subcommittee on IMWs to coordinate this parallel activity. The IMW subcommittee has produced a guidance document titled, "Establishing a Network of Intensively Monitored Watersheds in the Pacific Northwest." Concurrently, the Bonneville Environmental Foundation is also supporting similar work in the Chinook River, in the lower Columbia estuary, and in the Kootenai River Basin. Cost information was available for a subset of the IMWs underway and is presented in Table 3. (A more detailed breakout of the estimated costs of IMWs is presented in Appendix C.)

Table 3. Preliminary overview of annual estimated costs for on-going PNAMP phase 1 Intensively Monitored Watersheds.

Funding entity	Total estimated or projected annual cost	Number of IMWs
BPA	$2.55M	3
WA SRFB	1.75M	4
OSU and partners	0.7M	1
ODFW/OWEB	0.642M[1]	5
BOR	0.505M	2
CDFG	0.353M	1
ODF and partners	0.320M[2]	1
Total	$6.82M	17

For example, coordination between the Oregon Watershed Enhancement Board and the Washington Salmon Recovery Funding Board to monitor and evaluate livestock exclosure effects on habitat restoration has increased sample size, reduced time for obtaining results, and generated cost savings. It is anticipated that over time the results of these monitoring projects will provide the basis for best management practices for future mitigation projects and that additional project-scale monitoring will not be as necessary.

Future Priority Monitoring Tasks

- Two of three planned IMWs are being implemented with Council program funds and a third is being designed

- Limit other habitat project-specific monitoring to a "soft cap" of 5 percent

Implementing IMWs will require developing a regional network of controlled studies of habitat mitigation in watersheds. IMW projects require both a long-term commitment to placing sufficient projects in the experimental watersheds for testing, and a long-term commitment to not conduct mitigation actions in the control watersheds.

It is possible to extend the testing of intensively monitored watersheds for resident fish populations. For example, there is similar work being carried out on the Kootenai River in Montana and Idaho. Further, projects from various ecoregions to monitor wildlife population responses should also be considered. A monitoring and evaluation plan developed several years ago by the Kalispel Tribe was reviewed and approved by the

1 Partial cost only; restoration costs and all monitoring costs not yet included.
2 First year cost only; study plan being developed.

ISRP and could serve as a template for designing a wildlife monitoring component for the program.

E. Estuary

The Columbia River estuary and plume play an important ecological role in the performance of salmon and steelhead populations in the Columbia River Basin. More than simply serving as a corridor for passage between the river and the Pacific Ocean, the estuary provides rearing and refuge habitats for various life history stages of salmon and steelhead. Although use of estuary habitats by juvenile fish varies by species and life history stage, all Columbia basin salmon and steelhead migrating to and from the ocean use the estuary and plume in some fashion.

Description of Monitoring - As called for in the program, the Columbia River estuary and plume have been treated as a planning unit in subbasin planning and project selection. The 2000 and 2004 Biological Opinions also assigned to the federal action agencies some of the responsibility for monitoring of the estuary. Monitoring the conditions of the estuary will involve a number of other funding partners so Council staff will focus on the appropriate role for Bonneville funding in the Fiscal-Year 2007-2009 project selection process. In the Council's program monitoring in the estuary addresses fish population status and trends monitoring, action effectiveness monitoring, and implementation and compliance monitoring.

Objectives of Monitoring - Determine the ecological importance of the Columbia River estuary, near-shore environment, and oceanic plume to the viability and recovery of salmonid populations in the Columbia Basin. Determine whether the Columbia estuary ecosystem is improving or deteriorating relative to the desired conditions.

Status and Trend Monitoring: Determine the status and trends of monitored indicators that are ecologically significant to listed salmon and steelhead in the lower Columbia river, estuary, plume, and near shore ocean. Evaluate the status and trends of the following:

- Stressors for ecosystem controlling factors at an estuary-wide scale
- Factors controlling ecosystem structures and processes at site and estuary-wide scales
- Ecosystem structures at site and estuary-wide scales
- Ecosystem function: juvenile salmonid performance at the site scale

Action Effectiveness Monitoring: Use quantitative studies of habitat restoration actions to assess whether the restoration of factors controlling ecosystem structures and processes at

site and landscape scales results in improved ecosystem functions, e.g., juvenile salmonid performance.

- Measure the effects of individual habitat restoration actions at project sites relative to reference sites and evaluate post-restoration performance based on project-specific goals and objectives

- Estimate the collective effects of habitat conservation and restoration projects in terms of cause-and-effect relationships between ecosystem controlling factors, structures, and processes affecting salmon habitats and performance

Ongoing Monitoring Activities - The Lower Columbia River Estuary Partnership (LCREP) has taken a lead role in organizing mitigation and monitoring activity in the estuary. NOAA Fisheries, the Corps of Engineers, Bonneville, and LCREP collaborated with Pacific Northwest National Laboratory to develop the Federal Columbia River Estuary Research, Monitoring, and Evaluation Program.

NOAA Fisheries, Bonneville, and the Corps of Engineers are using this program as a means to achieve their overall goal for the Columbia River estuary, which is to understand, conserve, and restore estuary habitats to improve the performance of endangered and threatened salmon and steelhead populations. The federal estuary monitoring effort involves 32 ongoing projects, ranging from water quality monitoring to estimate smolt survival. In addition to the program, these projects are funded by the Corps of Engineers, EPA, Oregon Department of Environmental Quality, and Washington Department of Ecology, among others.

Future Priority Monitoring Tasks for All Partners

- Determine whether the off-site mitigation program of habitat mitigation in the Columbia River Estuary, is improving habitat conditions for salmon and steelhead

- Determine the annual ocean conditions, long-term forecasts and implications of climate change affecting ocean conditions and how they are affecting salmon and steelhead survival

- Quantify the ecological importance of the estuary and near shore ocean in terms of the relationships between salmon population performance and ecosystem structures, ecological processes, life history patterns, and genetic conditions

- Prioritize habitats and locations for conservation and restoration in the estuary

- Determine the effects of toxics on salmonid performance in the estuary

F. Project Implementation/Compliance Monitoring

Description of Monitoring – Project implementation monitoring determines whether projects were carried out as planned. This is generally carried out as an administrative review and is a low-cost monitoring activity that should be included for all mitigation projects. In calling for project proposals for funding in Fiscal-Year 2007-2009 the Council proposed a 5 percent soft cap for dollars spent on implementation monitoring within a project. (The amount could be higher if warranted by special circumstances.)

Objectives of Monitoring – Project implementation monitoring documents the type of management action, the location, and whether the action was implemented properly or complies with established standards. Project compliance monitoring of mitigation projects assesses contract compliance and provides a form of post-project auditing of project performance.

Ongoing Monitoring Activity – Council staff recommends that Bonneville continue to use the same PCSRF metrics in conjunction with any other additional requirements the agency may need for its Pisces project reporting system.

Future Priority Monitoring Tasks – This should include an evaluation of how the accomplished tasks relate to those proposed.

G. Harvest Monitoring

Description of Monitoring – Programs to monitor specific populations typically have used coded-wire tags (CWTs) to identify exploitation patterns, and to estimate exploitation rates and survival after release. However, tagging also could involve PIT tags or active acoustic tags to allow fuller life cycle monitoring.

Objectives of Monitoring – There is an essential need for annual monitoring of data in all production units or, at least in a sub-sample of units, that may be used as representative indicators of the affects of harvest on productivity and abundance (see recommendation on core monitoring data in the ISAB Report on Harvest Management of Columbia River Salmon and Steelhead, 2005-4).

Data sets for many fish management units in the Columbia River Basin are difficult to locate and have frequently involved major assumptions. Establishing quantitative monitoring within ESUs is therefore necessary for a credible harvest management system.

Ongoing Monitoring Activity – Fishery program stock assessments to date have focused on hatchery production, and most of the information about migratory behavior, run timing, harvest interceptions, and other characteristics have been obtained by the tagging of hatchery salmon and steelhead with CWTs. It has been assumed that wild populations are behaving in the same manner. If stock identification could be accomplished through DNA analysis and incorporated by fishery managers such as the Columbia River

Compact, the Pacific Salmon Commission, and the Pacific Fishery Management Council, then other population diversity characteristics could be tracked more easily. Major progress already has been made with Chinook salmon, but significant information gaps remain for coho and steelhead.

Future Priority Monitoring Tasks

- Monitoring is needed of the indirect, delayed, or direct mortality levels associated with harvest of anadromous fish populations in the Columbia River and its tributaries, to determine whether a declining trend is due to the environment or to exploitation rates

- The Council should evaluate the use of DNA micro-satellite technology to document the genetic makeup of naturally produced populations

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IV. Appendices

Appendix A. Provisional set of "core indicators" proposed as basis for evaluating the program's progress towards provincial objectives

Evaluation of the program based on the monitoring of a core set of physical and biological indicators signals a shift towards a more ecological approach to management, as recommend by the ISAB in their Review of Salmon Recovery Strategies for the Columbia River Basin (2001-7) and by Williams (2005).

- water temperature
- benthic macro-invertebrate assemblages
- passage, flow
- large woody debris
- sedimentation
- upland use
- habitat categorization
- stream morphology
- ecological attributes important to resident fish
- species abundance for juvenile, smolt, and adult life stages and distribution
- fish survival or ocean productivity indicators
- annual population growth rates
- hatchery releases and return rates
- harvest rates
- adult and juvenile passage survival through the mainstem dams

Appendix B. Comparison of Data/Monitoring Groups

This appendix describes the relationships among several programs related to data management and fish and wildlife monitoring. Program descriptions are abbreviated approximations. For specific details, contact the program directly. (Developed by Bruce Schmidt of Streamnet, January, 2006.)

	PNAMP	NED	CSMEP	PNW RGIC	Streamnet*	PNWQDX*
Primary purpose	Develop standardized approaches to aquatic monitoring.	Assist entities in the region toward developing a wide scale, data sharing network	Design a monitoring approach for fish populations in the Col. Basin.	Regional coordination on development of key base geospatial data layers	Develop databases in fish mgt. agencies, standardize fish data regionally, disseminate fish data, and library.	Regional system to organize and disseminate water quality data, as part of a national system
Primary focus	Identify, develop, evaluate and recommend standard aquatic monitoring approaches and protocols, including design, site selection, field sampling and data management aspects.	Promote development of a collaborative approach for sharing environmental data, encompassing data management from collection through dissemination.	Develop agreement among the management agencies on coordinated monitoring of fish populations. (Vision may be similar to Fish Population Monitoring workgroup in PNAMP, but limited to Columbia Basin. They are coordinating.)	Assisting regional stakeholders by coordinating, promoting and enabling the development, distribution and maintenance of regionally and nationally significant geospatial datasets	Serve as a data delivery mechanism for primary fish management data. Data services to FWP. Act as surrogate for agencies that do not have internal mission to disseminate their data. Uses a centralized database and online data query system.	Serve as a data delivery mechanism for water quality data from the primary environmental agencies. Uses a distributed approach based on agreed-to data standards.
Data management focus	Data management is only a **portion** of the focus, mostly to facilitate sharing of data within and between PNAMP work groups. Some members have a desire for broad sharing	Data management is the **primary** focus. Intent is to facilitate broad scale discovery and sharing of data and improvement in end-to-end data management.	Data management is only a **portion**. Focus is agencies coordinating their sampling efforts. Will determine how much existing data is suitable for meeting the primary objective.	Data management is the **primary** focus. Deals with development of standardized data layers and making them available.	**Primary**. Sharing regionally standardized and georeferenced data is primary focus for a specific set of data types related to fish. Desire to expand focus to more data types.	Data management is the **primary** focus. Sharing regionally standardized water quality data is the primary purpose.
Geographic scope	Pacific Northwest	Pacific Northwest, potential to include Pacific rim.	Columbia Basin	Pacific Northwest	Columbia Basin + some coastal. Sister project in California (CalFish)	Pacific Northwest, but links with national system
Data scope	Aquatic monitoring data, incl. aquatic habitat, project effectiveness, fish populations & estuaries	Could encompass any type of environmental data.	Focus is on fish population monitoring sampling	Primarily base layers, such as hydrography, roads, etc.	Fish related data. Focus is on the primary management types of data collected by the management agencies.	Water quality, soil and sediment quality, tissue analyses, and population data

* These are examples of specific data projects, which differ primarily in data content. Other specialized data projects would include PTAGIS, RMIS, Fish Passage Center, DART, PacFIN, RecFIN, IBIS, various project tracking systems, various habitat related databases (e.g., NW Forest Plan Effectiveness Monitoring Program, ODFW AIP), etc. This is not a complete list.

Acronyms and projects referred to in appendix above.

Acronym	Title	Data focus/interest	Contact	Phone	Email
CSMEP	Collaborative Systemwide Monitoring and Evaluation Project	Fish population monitoring	Frank Young	503-229-0191	frank@cbfwf.org
DART	Data Access in Real Time	Second tier data of a wide variety	Jim Anderson	206-543-4722	jim@cbr.washington.edu
FPC	Fish Passage Center	Mainstem flows, smolt releases and timing, dam passage survival, etc.	Michelle DeHart	503-230-4288	mdehart@fpc.org
FWP	Fish and Wildlife Program of the Power & Conservation Council and BPA	Balancing power production with fish and wildlife needs	Doug Marker	503-229-0191	dmarker@nwcouncil.org
IBIS	Interactive Biodiversity Information System	Wildlife life history information	Tom O'Neal	541-753-2199	habitat@nwhi.org
NED	Northwest Environmental Data-network	No specific data type. Focus is mechanisms of sharing data.	Stewart Toshach	206-860-3495	Stewart.Toshach@noaa.gov
NFPEMP	NW Forest Plan Effectiveness Monitoring Program	Forest ecosystem function: old growth, aquatic & terrestrial habitat, socio-economic health, tribal resources, implementation	Roberto Morganti	503-808-2254	Rmorganti@fs.fed.us
PacFIN	Pacific Fisheries Information Network	Ocean commercial fish harvest data	William Daspit	206-526-4072	william_daspit@psmfc.org
PNAMP	Pacific Northwest Aquatic Monitoring Partnership	Monitoring data related to fish populations, habitat, estuaries, and restoration project effectiveness.	Jennifer Bayer	509-538-2299 x 273	jennifer_bayer@usgs.gov
ODFW AIP	ODFW's Aquatic Inventories Project	Stream habitat assessment data	Kim Jones	541-757-4263 x 260	Kim.Jones@oregonstate.edu
PNW RGIC	Pacific North West Regional Geographic Information Committee	Various regional scale base GIS layers, such as hydrography, roads, etc.	Debra Kroeger	541-471-6616	dkroeger@fs.fed.us
PNWQDX	Pacific Northwest Water Quality Data Exchange	Water quality, soil and sediment quality, tissue analyses, and populations	Curtis Cude	503-229-6086	CUDE.Curtis@deq.state.or.us
PTAGIS	PIT Tag Information System	PIT Tag marking and recovery	Carter Stein	503-595-3116	carters@psmfc.org
RecFIN	Recreational Fisheries Information Network	Ocean recreational fish harvest	Russell Porter	503-595-3107	russell_porter@psmfc.org
RMIS	Regional Mark Information System	Coded Wire Tag marking and recovery, release information	Ken Johnson	503-595-3144	ken.johnson@psmfc.org
StreamNet	The StreamNet Project	Fish related data, primarily management data collected by the management agencies.	Bruce Schmidt	503-595-3113	bruce_Schmidt@psmfc.org

Appendix C. Preliminary overview of annual costs for PNAMP phase 1 Intensively Monitored Watersheds

Compiled by the PNAMP IMW subcommittee

PNAMP is working to identify, refine, and implement a network of Intensively Monitored Watersheds (IMWs) in the Pacific Northwest. This effort, outlined in "Establishing a Network of Intensively Monitored Watersheds in the Pacific Northwest" (PNAMP 2005), responds to the need to determine the extent to which restoration actions result in desired ecological outcomes, especially in terms of fish response. As outlined in PNAMP (2005), work began with setting the context, identifying the conceptual framework, delineating criteria against which candidate IMWs could be compared, and laying out a process for coordination. A total of 17 candidate IMWs were identified in PNAMP (2005) as part of the first phase of work.

Completing phase 1 will include compilation of detailed study plans for each phase 1 IMW, to include identifying the scope and nature of the management issues, monitoring questions, and restoration/recovery actions that would be tested in specific IMWs. Articulating the basis and nature of study designs and implementation schedules for each IMW will be key elements of completing phase 1.

Finally, key to completing phase 1 will be summarizing information on individual IMWs and an ongoing landscape classification effort, to determine the extent to which things like ecological strata, listed species, geography, and policy/management priorities are addressed by the PNAMP phase 1 IMW network.

Phase 2 will involve reviewing the results of phase 1 and identifying and addressing technical issues and policy needs, and making adjustments to the network as warranted.

As part of PNAMP's phase 1 IMW work, preliminary information on annual IMW costs is being compiled. Table 1 contains basic information available to date including: expected time frame, current estimated or projected annual costs for both the monitoring and restoration treatment components of each IMW (as applicable), and the average annual cost of the combined monitoring and restoration components by IMW and the network in total over the stated IMW timeframes. Predominant funding entities (not all-inclusive) are noted. Restoration costs would accrue even if IMW activities did not occur, assuming the restoration work reflected sufficiently high restoration priorities. (Note - restoration treatment costs are typically expended over a shorter duration than the longer-term costs of monitoring responses to those treatments.)

It is important to remember that cost information is preliminary and is intended for general comparisons only. Costs shown do not necessarily reflect all monitoring or restoration/protection actions or projects in IMWs, as they may be performed by various partnering entities. In addition, many cost projections are still being developed, and in-kind contributions from entities partnering in IMW work are not reflected.

Table 1. PNAMP Phase 1 Intensively Monitored Watersheds
(preliminary current, estimated or projected annual costs)

State	IMW or IMW complex	Time frame	Currently estimated or projected annual costs[3]		
			Monitoring	Restoration	Total[4] and source[5]
Washington	Lower Skagit estuary	10+ years – SRFB IMW program funding began in 2003	$1M per year for all combined	$1.5M per year for all combined (over 5 years)	WA SRFB - Ave. about $1.75M per year for all, over 10 years
	Hood Canal complex				
	Strait of Juan de Fuca complex				
	Lower Columbia complex				
	Wenatchee	10 years	$1.5M per year for Wenatchee ($900k) and Entiat ($600k)	$500k per year in Entiat only (for the first three years)	BPA – Ave. about $1.65M per year over 10 years
	Entiat				
	Methow	4 years	$250k per year	Under development	BOR – over $250k per year; total under development
Oregon	NF Scappoose	Under development	$642k per year for all combined (emphasis on fish monitoring to date)	Under development	ODFW, OWEB – over $642k per year; total under development
	Six Coastal Life Cycle Monitoring Basins (Nehalem River to Coos River)				
	EF and upper Lobster Ck				
	Cummins/Tenmile Creeks				
	Trask River	15 years	$320k for first year (study plan being developed)	NA	ODF and Weyco – over $320k per year; total under development
	Hinkle Creek (Umpqua River)	10 years	$700k per year	NA	OSU and partners – $700k per year

3 Cost information is preliminary and is intended for general comparisons only. Estimated or projected cost for some IMWs are still being developed. In addition, costs do not necessarily represent all monitoring or restoration/protection actions or projects in IMWs. For example, in-kind contributions from entities partnering in IMW work are not reflected.
4 Totals reflect monitoring and restoration costs annualized over the timeframe, depending on duration of treatments and total timeframes. Total cost figures are not simply additive for each IMW.
5 Shown are predominant funding entity(ies) only.

	Bridge Creek (John Day River)	10 years	$150k per year	$150k per year (for the first three years)	BPA – Ave. about $195k per year over 10 years
	SF John Day	4 years	$150k per year	$105k per year	BOR, BPA and others – Ave. $255k per year over 4 years
Idaho	Lemhi River (Salmon River)	10 years	$700k	To be determined	BPA – over $700k per year; total to be determined
California	Hollow Tree Creek (SF Eel River)	20 years	$43k per year for last five years	$342k per year	CDFG – Ave. about $353k per year over 20 years
TOTALS			$5.455M per year	$2.597M per year during years of treatment	Ave. $6.82M per year