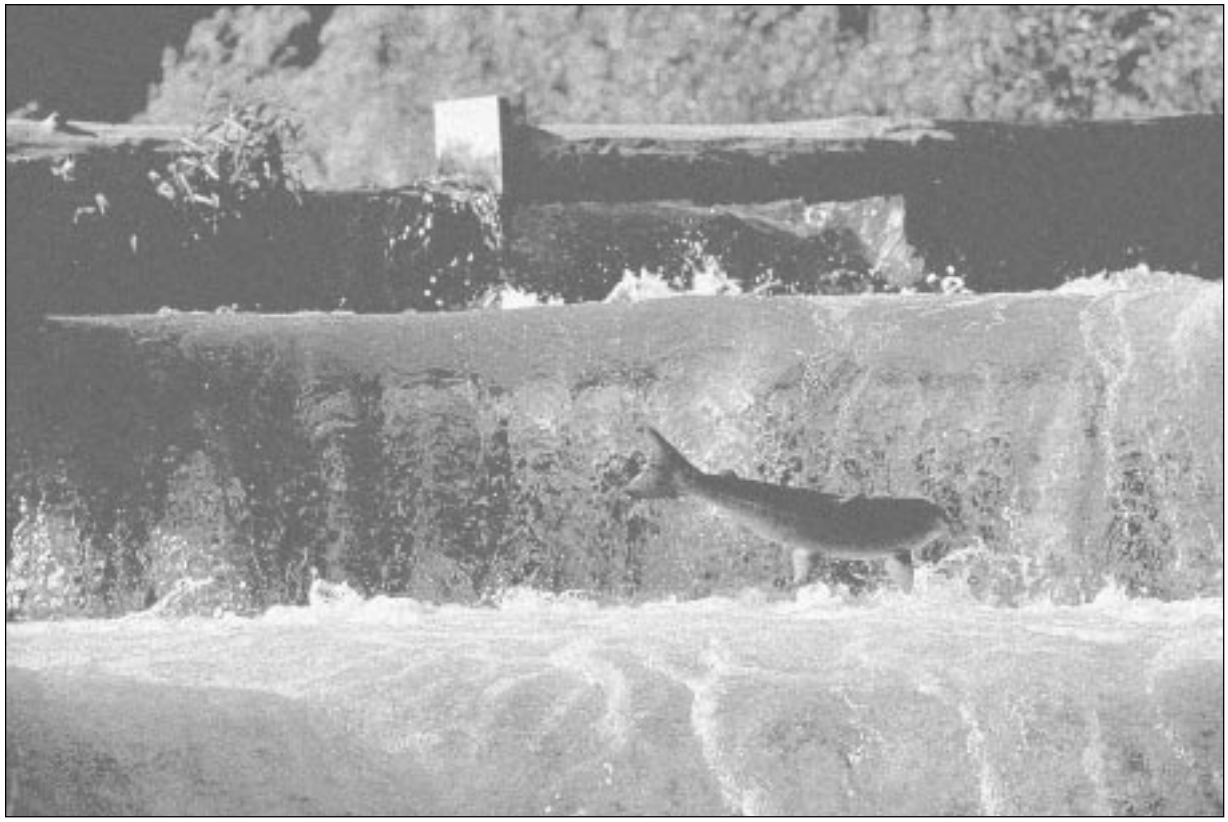
Endangered Species Act 2001 Progress Report for the Federal Columbia River Power System



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10 Overview of the 1-Year Implementation Progress Report

A. Purpose and Scope of the Progress Report

This is the first annual Progress Report developed by the federal Action Agencies — the Bonneville Power Administration (BPA), U.S. Army Corps of Engineers (COE), and Bureau of Reclamation (Reclamation) – documenting fish recovery measures taken in the Columbia River Basin in fiscal year 2001. These measures were implemented based on recommendations of the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) under the Endangered Species Act (ESA).

In all, the Action Agencies took hundreds of actions in 2001 to benefit endangered salmon, steelhead, bull trout, and sturgeon in the Columbia River Basin. While numerous and spread throughout the Basin, the actions were part of an organized, scientifically based plan to aid endangered fish populations. These efforts represent the beginning of a 10-year commitment to achieve biological objectives and performance standards for the Federal Columbia River Power System (FCRPS).

Overall, implementation of the 2000 NMFS and USFWS Biological Opinions (BiOps) is on track and expected to meet 2003 benchmarks. Although hydropower operations and juvenile fish survival were affected by the year's record drought and the declaration of power emergencies, and although schedules for some actions have slipped, the vast majority of actions recommended by the BiOps were implemented as anticipated.

The 2001 Progress Report includes the following sections:

Section 1 — Overview of 2001 Progress
A summary of the most notable measures implemented.

Section 2 — 2001 Population and Performance Conditions
A summary of 2001 adult returns and juvenile outmigrant "abundance" indices, as well as prevailing conditions in the hydrosystem and power markets.

Section 3 — Strategies and Substrategies
Discussion of 2001 survival rates of juvenile and adult fish; summaries of projects and measures implemented for the hydrosystem, habitat, hatcheries, harvest, resident fish, and Research, Monitoring; and Evaluation (RM&E) programs.

Section 4 — Variances and Modifications of the 2000 Biological Opinions
During 2001, the Action Agencies sometimes found it necessary to make adjustments to implementation of certain RPA actions. Those variances and modifications are noted in this section.

Section 5 — Conclusions and Adaptive Management
Key conclusions and recommendations for more effective actions to achieve performance standards.

Appendix A
Detailed results of dam passage and estuary research during 2001.

Appendix B
A seasonal summary of drought (i.e., extremely poor water conditions) and power emergency developments.

Appendix C
A more expansive list of measures taken in 2001, including a cross-reference to the BiOp Reasonable and Prudent Alternative (RPA) actions each project targets.

B. 2001: A Transition Year

Because the BiOps were not issued until December 2000, nearly the midpoint of fiscal year (FY) 2000–2001, the Action Agencies had less than 12 months to initiate and implement fish conservation measures. While some projects were already underway in anticipation of the BiOps, many have just begun and results are still being determined. Overall, however, we consider implementation to be on track with only a few exceptions. Those areas needing more work are further discussed in Section 4.0 (as well as in the Action Agencies' Endangered Species Act 2002 Annual Implementation Plan for the Federal Columbia River Power System. Next year's Progress Report will have more results available and results more directly associated with the provisions of the new BiOps and our implementation plans.

The start-up nature of our 2001 efforts was somewhat influenced by the federal budget cycle and **congressional appropriations**. Because the federal budget and appropriations cycle is a 2-year process, COE and Reclamation were not able to adjust budget requests in response to BiOp actions in FY 2001. As we proceed to implement the BiOps, Reclamation and COE will continue to identify funding needs and submit adequate budget requests.

Other changes are expected in **subbasin and recovery planning**. Projects implemented in FY 2001 did not have the benefit of completed Northwest Power Planning Council (Council) subbasin assessments, provincial reviews, or guidance from the recovery planning of established technical recovery teams. Projects implemented after FY 2001 should benefit from our participation in those efforts.

In 2001, the Action Agencies also initiated a number of projects that have **lead times** — requiring extensive planning and coordination prior to implementation. As a result, some of the actions we began in 2001 — for example, the Safety-Net Artificial Propagation Program — will not be fully implemented until 2003 or beyond.

Finally, **poor water conditions and power market aberrations** affected our implementation of several water management flow and spill measures in 2001. Near-record low runoff conditions provided poor in-river conditions, particularly for juvenile migrants. At the same time, deregulation of the utility industry and the failure of California's restructuring set the stage for power supply deficits that challenged the reliability of the entire West Coast power system, further threatening spill measures for fish. This was a situation that had grown over a decade, but did not become apparent until the extreme low water conditions of 2000–2001 (see box). In combination, the drought, power shortages, and resulting record high prices for power complicated our ability to conduct full spills and still reliably meet regional load and maintain public health and safety. Difficult decisions — and sometimes unpopular tradeoffs — had to be made.

Fortunately, the adverse water conditions of 2001 have subsided and reliability and economic issues seem to be improving, in part due to BPA and regional efforts to balance electricity supply and demand, including additional investments in infrastructure.

The purpose of our 2002 Implementation Plan and draft 2002–2006 Implementation Plan is to continue our efforts to bring the FCRPS into greater alignment with BiOp recommendations, including more substantial achievement of biological performance standards.

Region's Power Supply Deficit Result of Growing Demand, No New Infrastructure

How did a regional power supply deficit appear to materialize overnight? Since the early 1990s, growth in demand averaged 1 percent annually without any significant increase in generation or transmission capacity. Pending deregulation dampened infrastructure investment by both utilities, which saw uncertain future loads, and independent developers, who didn't know when they could begin competing for retail customers. Also, between October 1994 and September 1999, the Pacific Northwest experienced water conditions that were 26 percent higher than the average of the last 61 years on record, masking the gap between available power supply and growing demand. In fall/winter 2000, water conditions abruptly reversed, and the region's dearth of generation became all too apparent.

C. Summary of 2001 Progress and Results

This section summarizes notable progress and results in 2001. A full list of projects and actions implemented is included in Appendix C.

It is important to note that 2001 implementation activities were based on still-evolving scientific knowledge about the Columbia Basin. That is why several projects during the year focused on research studies to enhance our analytical capability and refine future actions (discussed in RM&E sections throughout this report). However, while these studies are ongoing, the effectiveness of actions taken in 2001 can only be measured using the best and most recent empirical information available. As our scientific knowledge improves, the results of these efforts may be interpreted differently. We will continue to evaluate new information and add to our information base throughout the 10-year implementation horizon.

Planning and Coordination Efforts

Because this was the Action Agencies' first opportunity to address the BiOps, a great deal of effort was spent on implementation planning and coordination with states, tribes, potential partners, and other stakeholders. These efforts included:

- **Completion of the 2002 Implementation Plan (1-Year Plan) and Draft 2002–2006 Implementation Plan (5-Year Plan)** — As called for in the BiOps, these plans establish a general framework of priorities, strategies, and substrategies to achieve specific performance standards. We will continue to refine this planning approach to better inform and incorporate regional planning processes. Ultimately, we hope to facilitate a more comprehensive and integrated planning approach to achieve the region's multiple fish and wildlife objectives.
- **Refining Performance Standards** — The Action Agencies worked with NMFS to further develop the implementation plans' four-tier performance standard framework, including standards specifically geared to hydrosystem survival in the NMFS BiOp. In our draft 5-Year Plan, we further describe next steps to develop physical/environmental and programmatic performance standards.
- **Development of a Scientific Framework** — Underlying all standards and strategies is a scientific framework developed by the Action Agencies that allows for effective data management and progress reporting. In addition, the Independent Science Review Panel (ISRP) provides independent reviews of all BPA-funded projects to ensure clearly articulated objectives, sound scientific methods, and independent assessment of expected results.
- **Development of an RM&E Program** — The Action Agencies developed a proposed structure for a comprehensive RM&E program that will provide information to assess the effect of mitigation efforts. An Action Agency and NMFS RM&E Oversight Workgroup was formed and took initial steps toward the development of this program.
- **Coordination With Regional Stakeholders** — The Action Agencies coordinated the release of the draft 5-Year Plan with states, tribes, and others. This included a formal comment period and numerous discussions at the Regional Forum Teams, Regional Executive roundtables, and individual outreach meetings. The 2002 1-Year Plan was also discussed with the Regional Forum Teams. Throughout the power emergencies of 2001, the agencies coordinated extensively with the Regional Forum Teams, Regional Executive Roundtables, Council, and individual outreach efforts. These efforts are described further in Appendix B.

Hydrosystem Actions

Multiple hydrosystem actions were taken in 2001 to address the BiOps. Due to challenging conditions posed by the drought and power emergencies, river operations were carefully discussed and designed within the NMFS Regional Forum Teams. Weekly discussions between the Action Agencies, fish managers, states, and tribes took place from late December through August. Decisions on how best to balance the protection of juvenile migrants while assuring power reliability were often difficult.

Emphasis was also placed on juvenile fish passage improvements at Bonneville and The Dalles dams, where fish passage survival is particularly an issue. Prototype surface bypass technologies were advanced with the construction and initial hydraulic testing of a removable spillway weir (RSW) at Lower Granite Dam. Other noteworthy 2001 dam modifications involved adult passage enhancements and water quality improvements. COE district offices also developed their first long-range (5-year) preventive maintenance plans for FCRPS fish passage facilities.

Configuration Improvements

The Action Agencies continued implementation of studies and modifications of hydraulic structures to improve juvenile and adult fish survival. Key accomplishments in 2001 include:

Bonneville Dam

- Completing a comparative analysis of long-term fish passage improvement options. This analysis will facilitate regional and federal decisions on the best course of action to achieve juvenile and adult passage standards at Bonneville. It may also serve as a model for making capital improvement decisions at other dams such as The Dalles and Lower Monumental, which also have relatively low passage survival rates.
- Completing design for Bonneville's second powerhouse corner collector, which will begin construction in 2002. The corner collector is expected to increase juvenile survival at Bonneville by 1 percent.
- Installing spillway flow deflectors to reduce dissolved gases and improve juvenile passage.
- Installing and testing an adult passive integrated transponder (PIT tag) detection system.

McNary Dam

- Installing spillway flow deflectors to reduce dissolved gases and improve juvenile passage.

Chief Joseph Dam

- Designing flow deflectors for spillways.

Dworshak Dam

- Securing funds to complete modifications to the water supply system for Dworshak National Hatchery, enabling these improvements to be completed in 2002. This action will allow hatchery operations to use warmer water than the current cold water released from Dworshak Dam. The drafting of cold water from Dworshak helps moderate water temperatures in the Upper Snake River to benefit summer migrants.

Lower Granite Dam

- Completing construction and initiating testing of an RSW. A substantial advancement in surface bypass systems, the intent of the RSW is to reduce spill volumes while increasing spill efficiency, which may boost juvenile survival. The RSW will be biologically tested in 2002.

Ice Harbor Dam

- Finalizing design and awarding contracts for adult fishway auxiliary water supply improvements to reduce the potential for adult passage delays.
- Installing an additional (instead of redundant) pump in the north shore fish ladder to reduce the potential for adult passage delays.

The Dalles Dam

- Testing powerhouse intake trashrack exclusion devices as a means to improve project fish passage efficiency.

Water Management and Fishery Operations

The NMFS BiOp anticipates a range of water conditions and modifies fish flows, spill, and transportation strategies accordingly. The extreme drought and power emergencies of 2001 tested these provisions and, while it is too early to draw final conclusions, they appear to have worked as expected. Water management actions that were taken during the year include:

- **Juvenile Fish Passage** — Fish passage systems continued to operate at all eight dams on the Lower Columbia and Snake Rivers throughout the migration season, providing safer, nonturbine routes for juvenile fish to migrate past dams.
- **Spawning and Emergence Flows** — Providing spawning and emergence flows for chum salmon below Bonneville Dam and for non-listed fall chinook at Vernita Bar in the Mid-Columbia River.
- **Fish Transportation** — Maximizing fish transportation to improve survival. Between 90 and 95 percent of Snake River spring and summer migrants were transported to below Bonneville Dam. At McNary Dam, where transportation normally occurs only in the summer, spring migrants were transported on alternate days, resulting in transport of some 40 percent. All summer migrants collected in the McNary bypass system were transported.
- **Spring Spill** — Providing targeted spring spill timed to optimize juvenile passage benefits (taking into account that most Snake River fish were transported rather than migrating in-river). Spill was provided at Bonneville, The Dalles, John Day, and McNary dams. While the volume of spring spill was roughly 18 percent of that called for in the NMFS BiOp (due to power emergency conditions), it benefited roughly half of listed in-river migrants from the Upper Columbia River.

- **Summer Spill** — Providing limited summer spill at The Dalles and Bonneville, due to power emergency conditions. NMFS and regional salmon managers prioritized spill at these projects to provide the greatest survival benefits. Because of 2001 water conditions, the volume of summer spill was only about 27 percent of that recommended in the BiOp. The primary beneficiaries of summer spill were non-listed Columbia River chinook.
- **Hatchery Release Spill** — Providing limited spill targeted to benefit Spring Creek Hatchery chinook releases during 3 days in early March, prior to the normal fish passage season.
- **Flow Augmentation** — Retaining in-stream about 1,100 cubic feet per second (kcfs) of water to improve Columbia River flows during the summer, including 133,000 acre-feet (kaf) as a result of drawing down the upper 5 feet of Banks Lake.

Scoping and environmental studies were also initiated for:

- **Flow Enhancement** — An Environmental Impact Statement (EIS) for the Libby VarQ flood control proposal, a new flexible formula for conserving water in the winter months at Hungry Horse and Libby dams.
- **Flow Augmentation** — An EIS for the proposed additional 5-foot drawdown of Banks Lake to further increase Columbia River summer flows.
- **Transmission Improvements** — The proposed Schultz-Hanford Transmission Line which would remove a transmission bottleneck and increase flexibility for spill operations to enhance progress of the juvenile fish passage survival performance standard.

Operations and Maintenance (O&M) Actions

Rehabilitation of adult fishways was the priority for O&M in 2001. These improvements will help ensure that fish ladder equipment failures do not delay adult passage. Projects include:

Ice Harbor Dam

- Designing and fabricating new entrance gates at the Ice Harbor fishway, as well as designing a butterfly valve hydraulic system replacement, rehabilitating a fishway pump, and initiating the design of new gate hoists.

John Day Dam

- Preparing design for fishway pump rehabilitation.

Lower Monumental Dam

- Rehabilitating fishway pumps.

The Dalles Dam

- Purchasing steel bulkheads for fishway entrances and new bulkheads for dewatering fishways, and purchasing diffuser gratings for installation in 2002.

Another noteworthy O&M project in 2001 was completion of a **5-year O&M and preventive maintenance plan** as called for in the BiOp.

Power Emergency Response

To alleviate the impacts of extreme conditions on the hydrosystem and minimize effects on fish, BPA pursued both immediate and long-term actions to reduce electricity demand. These include:

- **Load Buy-downs** — Achieving load reductions through buy-downs of Direct Service Industry (DSI), irrigation, and some end-use customers. Savings, respectively, totaled 543, 61.5 and 75 average megawatts (aMW). (See Table 2A.)
- **Water Acquisitions** — Saving up to 500,000 acre-feet of water in-stream, an additional benefit of irrigation buy-downs.
- **Energy Conservation** — Promoting regionwide energy conservation measures, with results far exceeding expectations.
- **Power Exchanges** — To augment supply, BPA negotiated one-for-two power exchanges with California, requiring return of 1 MW within 24 hours and a second MW within the month for every MW provided to them.

Other power emergency-response measures include:

- **Predator Control** — Increasing rewards to encourage greater catch of northern pikeminnow, to reduce predation and offset the effect of reduced spill.
- **Special Habitat Improvement Projects** — Funding 20 additional projects through the Action Plan Initiative to implement projects aimed at helping fish affected by the power emergency.
- **Water Supply System/Temperature Improvements** — As noted previously, funding repairs to the Dworshak National Fish Hatchery Water Supply System to be operational for the 2002 water year.

Future improvements to prevent similar emergencies were also advanced:

- **Power Resources** — BPA's additional load reductions, newly acquired renewable resources, and additional investment in infrastructure should improve long-term reliability for the federal system. On a regional level, additional resources and conservation efforts will also help stabilize the regional energy landscape.
- **Rate Structure** — To further reduce future economic risks, BPA's new rate structure includes cost recovery adjustment clauses (CRACs) allowing BPA to adjust power rates as frequently as every 6 months in response to changing costs of energy purchases necessary to meet firm load.

Habitat, Hatchery, and Harvest Actions

Habitat Protection and Improvement Projects

In 2001, the Action Agencies accomplished a wide array of habitat improvements to address Endangered Species Act (ESA) objectives, including the purchase of water rights, riparian conservation easements and wildlife reserves, and the funding of irrigation improvements and physical habitat restoration efforts in the tributaries, mainstem, and estuary. Habitat projects were conducted throughout the Columbia River Basin, including the following subbasins: Yakima, Deschutes, Tucannon, Umatilla, John Day, Walla Walla, Grande Ronde, Methow, Salmon, Asotin, Coeur d'Alene, Clearwater, Columbia Lower Middle, and Columbia Lower. (See Map 1 for province locations.) From this broad range of effort, several high points warrant special attention:

Tributary Habitat Actions

The Independent Scientific Advisory Board's "Review of Salmon Recovery Strategies for the Columbia Basin" identified both immediate and long-term habitat priorities. Increasing **water quantity** and **reducing blockages** to fish passage, as noted by the ISAB, were two immediate priorities of BiOp implementation. Shifting to an ecosystem-based management approach is a long-term priority.

In 2001, the Action Agencies addressed tributary habitat priorities by:

- **Securing Increases in Water Quantity** — For example, BPA funded the Umatilla Basin Project flow enhancement effort to provide increased flows during critical migration periods.
- **Improving Fish Passage at Blockages** — For example, Reclamation worked with landowners to eliminate or redesign several irrigation diversions, such as building screens at the LaFortune/Powell and Wilson Creek/Bull Ditch diversions (Yakima Subbasin).
- **Acquiring or Protecting Currently Productive Non-federal Habitat** — At risk of being degraded within several subbasins, including Oxbow Ranch, Ames Creek, and Wagner Ranch (John Day Subbasin).

Mainstem Habitat Actions

Operations during the winter and spring provided favorable habitat conditions for chum and fall chinook spawning and protection of redds both downstream of Bonneville Dam and in the Hanford Reach. Other notable steps the Action Agencies took in 2001 include:

- **Spawning Habitat Study Below Bonneville Dam** — Initiation of a reconnaissance level study to assess the potential effectiveness of both pumping and/or physical habitat modifications downstream of Bonneville Dam (i.e., on Hamilton and Ives islands) to improve mainstem conditions for chum and fall chinook. This study will determine whether a more detailed feasibility level study should be performed to further develop habitat improvement alternatives.
- **Habitat Rehabilitation** — Improving mainstem conditions for fish by rehabilitating Duncan Creek in Washington (including stocking with chum).
- **Predator Control** — Promoting the increased catch of northern pikeminnow through higher reward incentives.

Estuary Habitat Actions

COE and BPA worked with the Lower Columbia River Estuary Program (LCREP) to identify habitat improvement and research needs in the estuary. In 2001, the local, state, and federal agency partners who comprise LCREP submitted proposals through the Council provincial review process to respond to NMFS estuary RPA actions. Selected projects will be funded in 2002. COE also began a general investigation study of the Columbia River from river mile 0 to 145.

Coordination Actions

These efforts were complemented by efforts to: (1) integrate new processes with existing ones, such as recommendations developed by the Federal Habitat Team to improve the subbasin planning process; (2) improve overall coordination by addressing the state and tribal concerns; and (3) provide technical assistance and support to project partners.

Emergency Response Habitat Actions

The Action Plan Initiative funded 20 habitat projects to:

- **Bolster Water Quantity** — Provide flow acquisition and supplementation in the Yakima River and Simcoe Creek (Yakima Subbasin), Deschutes River (Deschutes Subbasin), John Day River (John Day Subbasin), Touchet River (Walla Walla Subbasin), Lostine River (Grande Ronde Subbasin), Lemhi River (Salmon Subbasin); and
- **Aid Fish Passage** — Improve passage and install fish screens on the Methow River (Methow Subbasin) and Lemhi River (Salmon Subbasin).

Hatchery Actions

In 2001, the Action Agencies moved forward on artificial propagation measures, focused on developing a marking plan, and initiated hatchery reform efforts. (See Map 2 for general locations of hatcheries.) Highlights include:

- **New Safety Net Program** — Initiation of the Safety-Net Artificial Propagation Program (SNAPP) through BPA funding of a SNAPP coordinator to work with relevant agencies and tribes. The program's purpose is to develop a list of 38 salmon and steelhead populations that will proceed to the first step of the SNAPP process, extinction risk analysis.
- **Captive Brood Stock Program** — Continued BPA funding of ongoing captive brood stock or captive rearing safety-net programs for threatened Salmon River, Grande Ronde, and Tucannon River spring/summer chinook salmon populations and endangered Snake River (Redfish Lake) sockeye salmon.
- **Marking Strategy Committee** — Establishing an oversight committee to guide and coordinate development of a comprehensive marking strategy for artificially produced Columbia Basin salmon and steelhead. This will provide vital data on the origins of fish taken in fisheries, or observed in spawning grounds or at counting sites.
- **Hatchery Genetic Management Planning** — Initiating development of Hatchery and Genetic Management Plans (HGMP) for Leavenworth, Entiat, and Winthrop hatcheries, to aid recovery of listed salmon and steelhead through hatchery reform. Proposals to develop HGMPs for the 11 Lower Snake River Compensation Plan hatcheries were submitted through the Council provincial review process.
- **Existing Hatchery Production** — Continued support of tribal and other harvests, consistent with the needs of listed fish, through the funding and operation of 22 FCRPS mitigation hatcheries in Idaho, Washington, and Oregon.

Harvest Actions

The Action Agencies initiated two new projects and continued two more to address the BiOps' five harvest-related RPA actions. Highlights include:

- **Gear Testing** — Commencement of studies to test the efficacy of tangle-tooth nets and floating trap nets to catch spring chinook alive in the Lower Columbia River, to aid revival and release of wild fish and the retention of hatchery fish.
- **Lost Fishing Net Study** — Funding a study above Bonneville Dam to determine the existence and impact of lost fishing nets on adult salmon.
- **Gill Net Exchange Program** — Continuation of a larger mesh gill net exchange program in fall tribal commercial fisheries to reduce incidental capture of larger listed steelhead.

Progress and Results in Other Areas

Resident Fish Actions

Approximately 20 ongoing projects in 2001 addressed about 30 USFWS BiOp actions for protecting Kootenai River white sturgeon and bull trout. In addition, new projects focused on BiOp objectives were solicited by the Action Agencies and recommended for funding in 2002. A detailed list of projects and water management actions is provided in the Resident Fish and Hydrosystem Action Tables in Appendix C.

Specific accomplishments in 2001 include:

- **White Sturgeon Aquaculture and Monitoring** — Continuing the Kootenai River white sturgeon conservation aquaculture program and projects to monitor natural spawning and juvenile survival.

Map 1 — Columbia River Basin and Council Designated Provinces

The Action Agencies coordinate with state, tribal, and local entities for offsite measures through the Council's provincial reviews and solicitation processes.

- **Flows and Ramp Rates** — Aiding bull trout by adhering to ramp rates for drafting and providing minimum flows below Hungry Horse and Libby dams (on all but 15 days), despite the low water conditions.
- **Bull Trout Monitoring** — Continuing to monitor kokanee (bull trout prey) production in Lake Pend Oreille and beginning to monitor bull trout use of Dworshak reservoir.
- **VarQ —** As mentioned under *Water Management*, commencement of work on an Environmental Impact Statement (EIS) for the VarQ flood control proposal — a new flexible formula for conserving water in the winter months at Hungry Horse and Libby dams.

RM&E Actions

RM&E projects implemented in 2001 involved monitoring the effectiveness of recovery actions, status monitoring, and critical uncertainty studies. Highlights include:

- **Survival and Migration Monitoring** — Several adult and juvenile survival and migration-monitoring projects were implemented at the Columbia and Snake River dams. These projects included implementing and improving ongoing fish tagging and detection programs.
- **Monitoring of Predator Control** — Effectiveness monitoring continued for the Northern Pikeminnow Management Program.

- **New Assessment Projects**— New projects were implemented or initiated on juvenile and adult use of the estuary, plume, and near-shore ocean.
- **Hatchery Assessments** — Several projects were implemented to assess the effects of supplementation and hatchery management practices on wild fish production and genetics.
- **Habitat Assessments** — Project proposal requests were developed for tributary projects addressing the effectiveness of diversion dam removals, water augmentation, and diversion screens.

Predation Control Actions

Results of predation control programs in 2001 include:

- **Caspian Tern Predator Control** — Predation mortality of juvenile salmonids by Caspian terns was substantially reduced. Most Caspian terns nested on East Sand Island as a result of habitat improvements, with few nesting on their former colony site at Rice Island. This reduced tern consumption of salmonids in 2001 by about 50 percent compared to 1999 and about 20 percent compared to 2000. (An estimated 5.9 million smolts were saved.)
- **Northern Pikeminnow Predator Control**— Many more northern pikeminnow were caught, thanks to additional incentives offered under the Northern Pikeminnow Management Program's Sport-Reward Fishery program. The reward amount was raised to encourage greater catch, thereby reducing predation to partly offset the effect of reduced spill due to power emergencies. An estimated total of 240,000 northern pikeminnow were caught in 2001, of which roughly 40,000 can be attributed to the reward increase. That is an annual exploitation rate of about 17 percent and the highest annual catch and exploitation rate since the program's inception. The additional 40,000 fish caught equates to about 2.8 million juvenile salmonids not eaten across the pikeminnows' average life span.

The Bottom Line: Fish Survival in 2001

In the end, the Action Agencies' multiple actions described in this section helped offset, but could not overcome, the drought's and power emergencies' adverse impacts on fish. Record low flows caused some fish populations to suffer, although results were mixed and some population segments, such as the number of returning adults, reached historic highs. Here is a summary of how fish fared in 2001:

- **Adult Fish Survival** — Adult fish survival between Bonneville and Lower Granite dams was among the highest on record. This should further enhance the productivity of what already looks to be a very prolific year for returning adults.
- **Estimated Total System Juvenile Fish Survival** — Estimated total system juvenile fish survival (combined survival of both in-river and transportation fish), varied depending on the stock. Compared to the estimated overall average system survival rate (1995–1999) identified in the 2000 NMFS BiOp, total system survival for 2001 was within the range for Snake River spring juvenile migrants, somewhat lower for Columbia River chinook, and substantially lower for Columbia River steelhead. Based on the assumptions used in the analysis for this report, it appears juvenile fish transportation provided sufficient protection for fish during this year of poor water conditions and power emergencies. Pending availability of new information, it appears that the BiOp priority to increase transportation during low water years offers an appropriate alternative to in-river fish passage. Additional analyses based on future years' adult returns and associated delayed mortality will provide a more complete assessment of 2001 impacts.
- **In-river Juvenile Fish Survival** — In-river juvenile fish survival was relatively poor compared to that in recent years when river flows were generally above normal and flow and spill measures could be fully implemented. In-river survival from Lower Granite Dam to below Bonneville Dam was the lowest recorded in the past 9 years for both Snake River spring chinook and steelhead. High predation by terns downstream of Lower Monumental dam accounted for nearly a 14 percent loss of migrating juvenile steelhead. However, in-river survival of chinook was considerably higher and survival of steelhead slightly better than that observed in the low flow years of 1973 and 1977, due to extensive fish passage improvements installed at the dams over the years. Few Snake River fish and one-half or more of Columbia River fish migrated in-river.

Table 1A — Total System and In-river Survival in 2001, Alongside NMFS Performance Standards and Percentage of Those Stocks Transported

Results of total system and in-river survival in 2001, alongside NMFS performance standards and percentage of those stocks transported.

		SYSTEM SURVIVAL ESTIMATES			IN-RIVER SURVIVAL ESTIMATES		
Species	**% Transported in 2001**	**Post-season Modeled System Survival Ests.**	**Pre-season SIMPAS Model Survival Ests.**	**1995–99 Average Survival BiOp Perf. Std.**	**Empirical Survival Data NWFSC**	**Pre-season SIMPAS Model Survival Ests.**	**1995–99 Average Survival BiOp Perf. Std.**
Snake River Spring/Summer Chinook (Head LWG to BON tr) (LWG tr to BON tr)	90 – 95%	0.582 – 0.674*	0.557 – 0.644	0.548 – 0.604	0.264 0.276	0.235 – 0.263	0.496
Snake River Steelhead (Head LWG to BON tr) (LWG tr to BON tr)	90 – 95%	0.454 – 0.506*	0.455 – 0.508	0.490 – 0.525	0.038 0.042	0.291 – 0.333	0.516
Upper Columbia River Spring Chinook (Head MCN to BON tr) (MCN tr to BON tr)	40%	0.458 – 0.491**	n/a	0.664	0.415**** 0.50	0.49 – 0.55	0.664
Upper Columbia River Steelhead (Head MCN to BON tr) (MCN tr to BON tr)	40%	0.182– 0.195	n/a	0.677	0.126 0.25	0.54 – 0.62	0.677
Snake River Fall Chinook (Head LWG to BON tr) (Release to LWG tr)	95%*****	n/a	0.035	0.127	n/a 0.21***	0.027	0.143
Hanford Fall Chinook Home (MCN tr to BON tr)	50%	n/a	n/a	n/a	0.579	.291 – .315	n/a

NOTES:
* Includes assumption that differential delayed mortality of transported fish from Snake River dams in 2001 is same as identified in 2000 BiOp.
** Includes assumption that differential delayed mortality of transported fish from McNary is the same as it is for Snake River stocks.
*** Based on preliminary survival data for wild fall chinook collected by USFWS (Conner) in 2001.
**** Estimates shown are modeled; empirical data for UC stocks through McNary project are not available.
***** Of those fish surviving to Lower Granite, the first FCRPS dam.

20 2001 Population and Performance Conditions

A. Population Conditions (Adult Returns)

Last year's total adult returns to Bonneville Dam were the largest in recent history. Many factors contributed to these returns, including favorable environmental conditions in both freshwater and the ocean and benefits of recovery actions throughout the basin, including actions implemented under the Council's Fish and Wildlife Program and the 1995, 1998, and 2000 BiOps. An improved understanding of how these factors contribute to subsequent adult returns will be reported as new information becomes available.

Total System Adult Returns

In 2001, adult salmon and steelhead returns to Bonneville Dam were among the largest fish returns since counts began in 1938. That year, about 272,000 chinook passed Bonneville Dam, with the total upriver chinook run — including fish harvested below Bonneville Dam — estimated to be about 756,000 fish (Columbia River Fish Runs, Status Report, 2000). This total includes smaller male "jacks." The 2001 total above Bonneville Dam is estimated to be about 868,000 chinook adults (COE, Adult Fish Counts, 2001 Data Reports, as reported by Walla Walla District, electronic files and the UW DART Data Files).

At Bonneville Dam, the total adult fish passage was about 1,876,000 salmon and steelhead, as counted by Dec. 28, 2001 (see Figure 2.1). By comparison, the past 10-year average (1991–2000) was about 576,000 salmon and steelhead, indicating that the 2001 total adult fish runs are over three times greater than the previous 10-year average (COE, Data Reports, 2001).

Despite the substantial fish returns in 2001, the composition of the Columbia River fish stocks has changed greatly since 1938. In the earlier decades, many of the stocks were comprised largely of wild fish, whereas today, hatchery fish dominate most runs. The scientific community has considerable interest in potential differences between wild fish and hatchery fish; recently this matter has also come into question in the courts. Because the Columbia Basin hatchery program is such a large part of FCRPS mitigation, including ESA recovery, the Action Agencies intend to follow these developments closely.

While there are many uncertainties about the factors that contributed to last year's record returns and how these factors, including future ocean conditions, will impact subsequent years' returns, the Action Agencies remain cautiously optimistic that such returns are indicative of the future.

Figure 2.1 — 2001 Adult Fish Passage — Bonneville Dam

About 1,876,000 Salmon and Steelhead by December 28, 2001

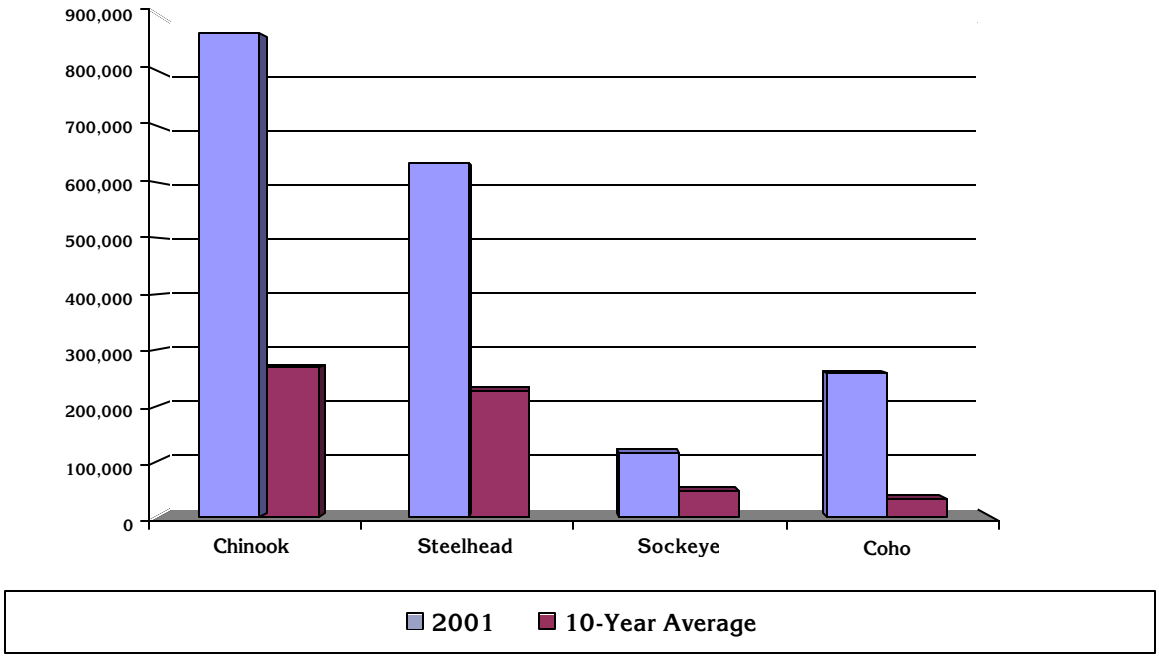
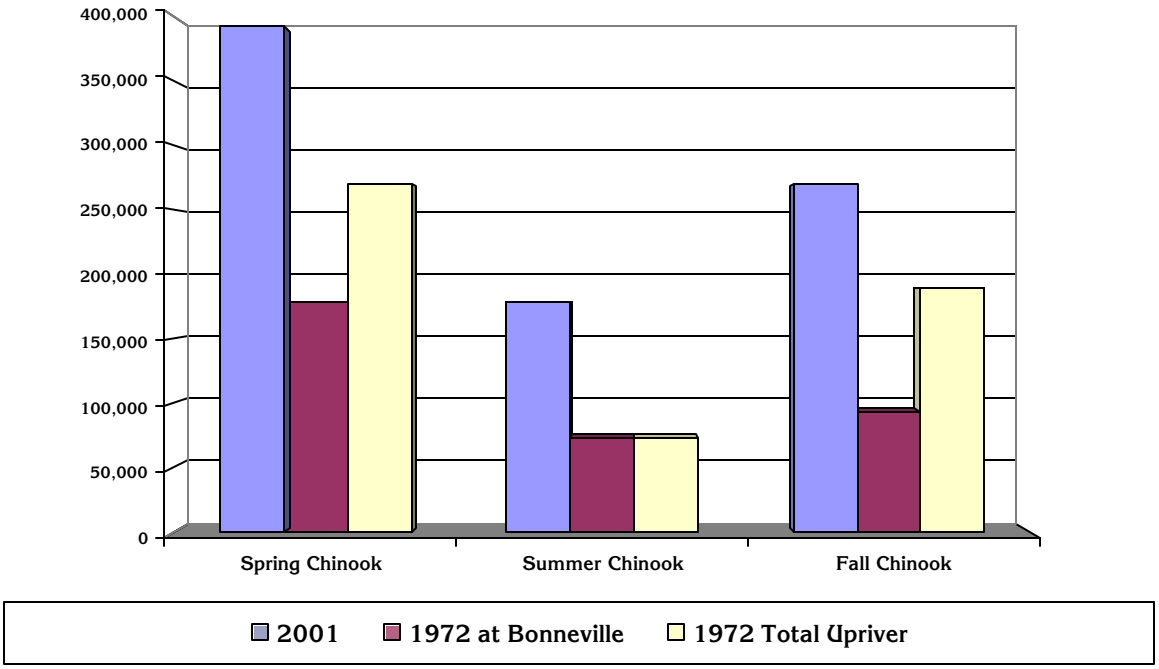


Figure 2.2 — 2001 Adult Chinook Passage — Bonneville Dam

About 1,876,000 Salmon and Steelhead by December 28, 2001



Record Run Comparisons

The 2001 fish runs also can be viewed relative to the run sizes for years when adult chinook salmon were in greater abundance. For example, in 1972, considered a "banner year" for spring chinook returns, the total upriver spring chinook run was approximately 270,000 fish (including lower river harvest), with about 178,000 fish crossing Bonneville Dam (Status Report, 2000). In 1972, the upriver fall chinook run was about 189,000 fish, with about 94,000 fish crossing Bonneville Dam; whereas in 2001, more than 391,000 spring chinook and 400,000 fall chinook (COE, Data Reports, 2001) passed above Bonneville Dam the end of the year. (See Figure 2.2).

While the spring chinook crossing Bonneville Dam consist of many runs migrating throughout the greater Columbia-Snake River system, much of the fall chinook run crossing Bonneville Dam are naturally-spawning, Mid-Columbia fish migrating to the Hanford Reach area. For several decades this run has generally prospered, and returns this year are expected to be among the highest on record, as is the case with returns throughout the Columbia Basin.

10-year Run Comparisons and Wild Fish

The 2001 fish returns counted at various projects substantially exceeded the previous 10-year average as well (see Figure 2.3). Using all chinook salmon counts, the relative increase between the 2001 and 10-year average runs by project is 222 percent at Bonneville, 248 percent at The Dalles, 305 percent at McNary, 887 percent at Lower Granite, and 228 percent at Priest Rapids (COE, Data Reports, 2001; UW DART, 2001).

Taking into account wild spring chinook runs destined for passing Lower Granite Dam, recent data indicate about 3 to 13 percent of the total adult run crossing over Bonneville Dam are wild chinook that will ultimately pass over Lower Granite Dam as well. Given the recent sharp increase in total chinook runs passing Lower Granite Dam, significant increases in wild fish numbers are also occurring.

Lower Granite Dam Adult Passage Rates

To date, fish runs at Lower Granite Dam have reached levels far exceeding the previous 10-year average run sizes. By Dec. 28, 2001, chinook counts were about 195,000 and steelhead counts were above 252,000 (see Figures 2.4 and 2.5) (COE, Data Reports, 2001; UW DART, 2001).

The chinook runs to date are composed of about 172,000 spring chinook, 14,000 summer chinook, and over 8,900 fall chinook. With the high numbers of fish crossing Lower Granite Dam, the count for wild fall chinook approached 2,500. In past years, the wild segment of the Lower Granite fall chinook run has been about 20 percent or more.

The count at Granite in the 1990s has ranged from a low of 78 fall chinook in 1990 to a high of 907 fish in 1999. However, NMFS recently revised the 907 figure to 560. The difference was due to reassignment of many "adults" into the smaller, yet sexually precocious male "jack" category. This revision would mean that only about 1,500 total fall chinook entered the Snake River in 1999. Annual counts of wild fall chinook over Granite Dam have not exceeded 1,000 since 1974, when the lower Snake dams were completed. With 2,500 Snake River fall chinook observed at Lower Granite in 2001, it will be more than double the largest escapement in a quarter century. It will also meet NMFS' previous delisting threshold of 2,500 fish. (NMFS BiOp, 1995).

The peak day for steelhead passage was Sept. 22, 2001, with a daily count of about 8,190 fish. Total estimates of wild Snake River steelhead returns are currently greater than 18,500.

While hatchery fish continue to comprise the majority of the run-at-large, wild fish have also benefited from improved conditions.

Fish Passage Above Priest Rapids Dam

Like the Snake River fish runs, the 2001 salmon and steelhead runs through the Mid-Columbia region are displaying large numbers of fish (see Figure 2.6). To date, salmon runs above Priest Rapids Dam amount to about 127,000 chinook, 109,000 sockeye, and 30,000 steelhead. At the Wells Dam much farther upriver, the chinook count is estimated to be about 50,000 fish, with approximately 74,000 sockeye crossing the dam as well (COE, Data Reports, 2001; UW DART, 2001).

Improved adult fish counts at the Mid-Columbia projects indicate the year's improved adult counts are a basinwide phenomena.

Adult Fish Harvest Levels — Indian and Non-Indian Commercial Fisheries

In 2000, tribal treaty fishers caught 52,000 fall chinook and more than 15,000 steelhead. In 2001, preliminary tribal harvest figures above Bonneville Dam (Zone 6) exceeded 111,000 fall Chinook and 28,800

Figure 2.3 — 2001 Adult Chinook Passage — 5 Columbia River Dams

About 868,000 Chinook Total by December 28, 2001

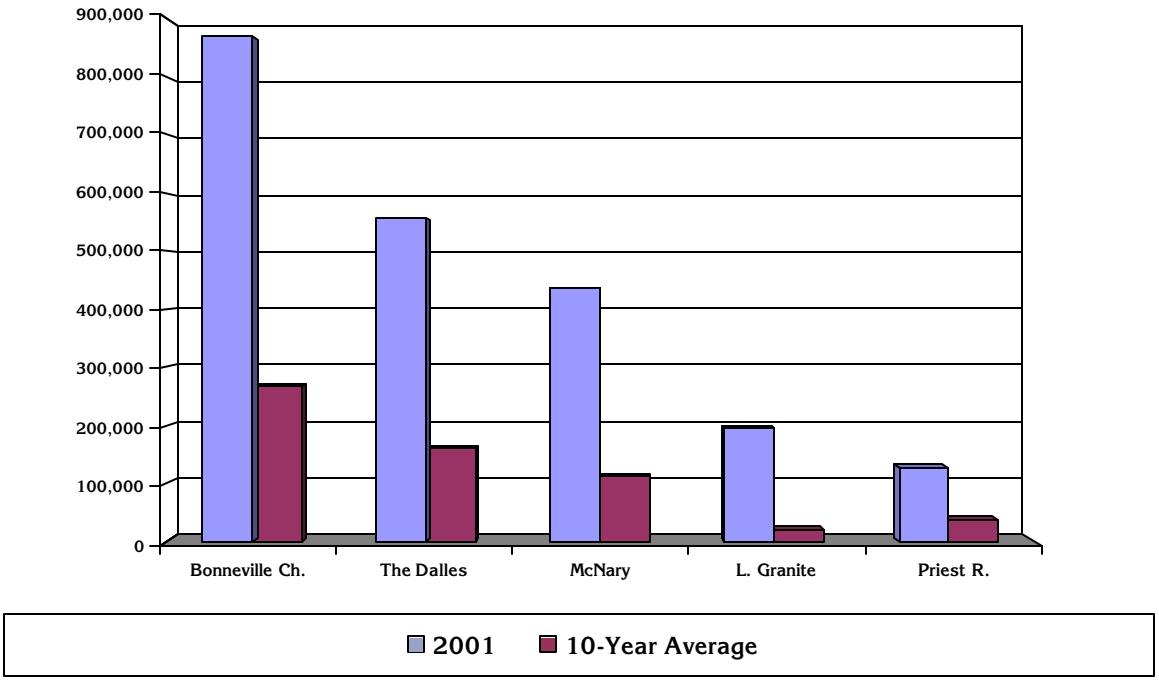


Figure 2.4 — 2001 Adult Fish Passage — 5 Lower Granite Dam

About 447,000 Chinook and Steelhead by December 28, 2001

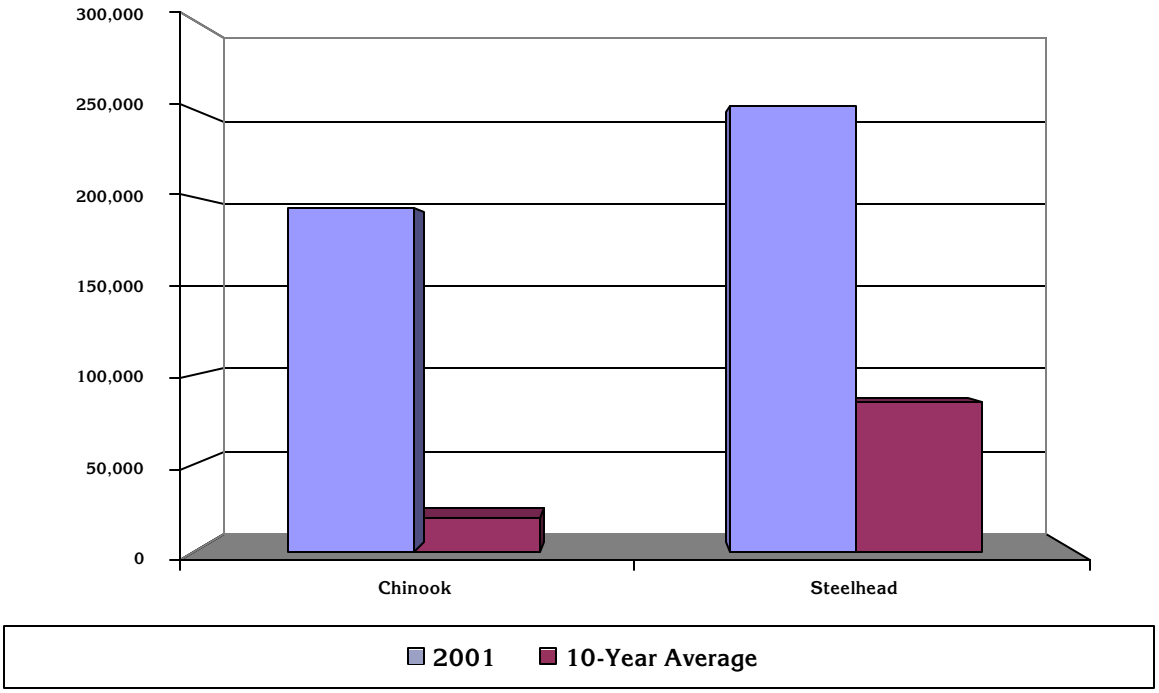


Figure 2.5 — 2001 Adult Chinook Passage — Lower Granite Dam

About 195,000 Total by December 28, 2001

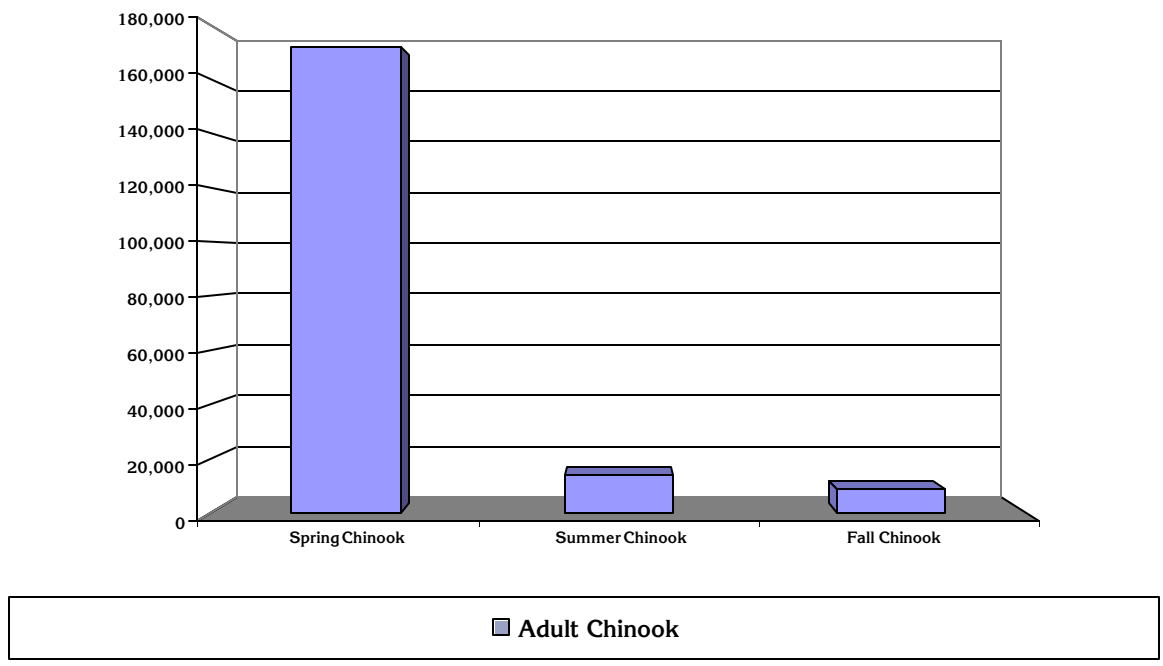
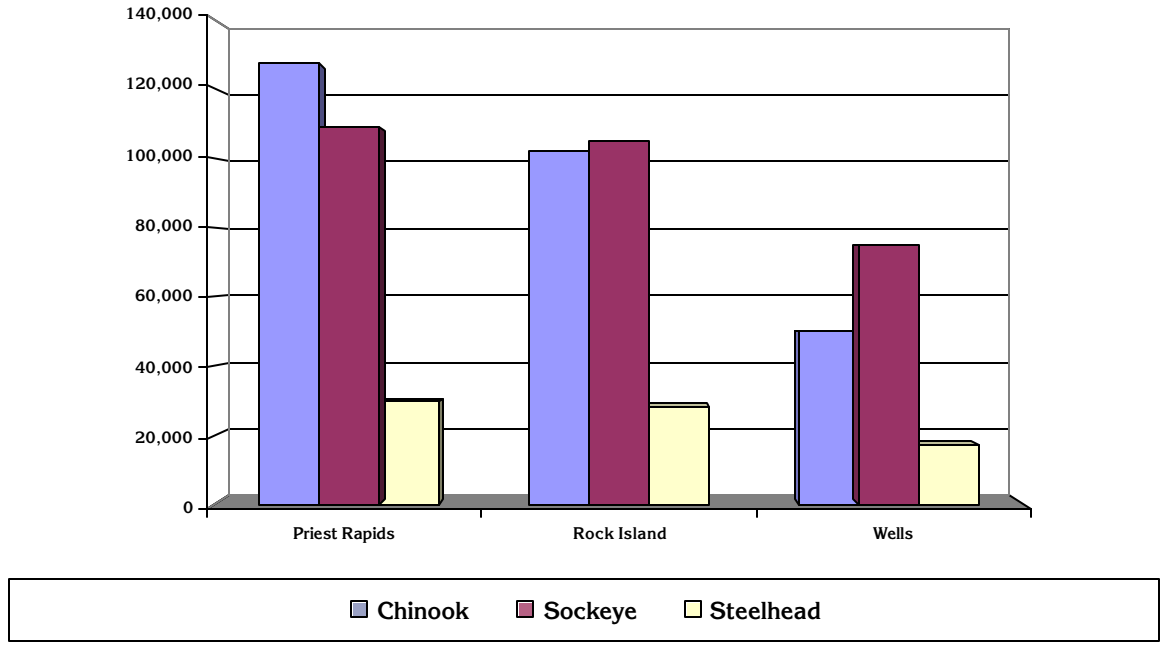


Figure 2.6 — 2001 Adult Chinook Passage — Mid-Columbia Dams

By December 28, 2001



steelhead by the end of September, about double the previous year. For spring fisheries on chinook, tribal harvesters caught 54,584 fish, the second largest catch since 1938 (WDFW, ODFW status report).

The 2001 fall chinook catch for non-Indian commercial and sport fisheries has been estimated at about 45,600 fish, based on available Columbia River Compact reports (Joint Staff/TAC Report, Oct. 5, 2001). This reflects the commercial activity in Zones 1-5 and the sport fisheries both below and above Bonneville Dam. Most of the sport fisheries catch occurred below Bonneville Dam at Buoy 10 and in the lower river reach. Additional numbers for sport steelhead catch are pending fish agencies' calculations. In addition, a limited commercial fishery on spring Chinook occurred in 2001, as well as a mark-selective sport fishery in the lower river.

B. Population Conditions (Juvenile Out-migrants)

Information (graphic and narrative) will be developed on the relationship between the abundance of adults and the abundance of juveniles for available stocks over the next 3 months.

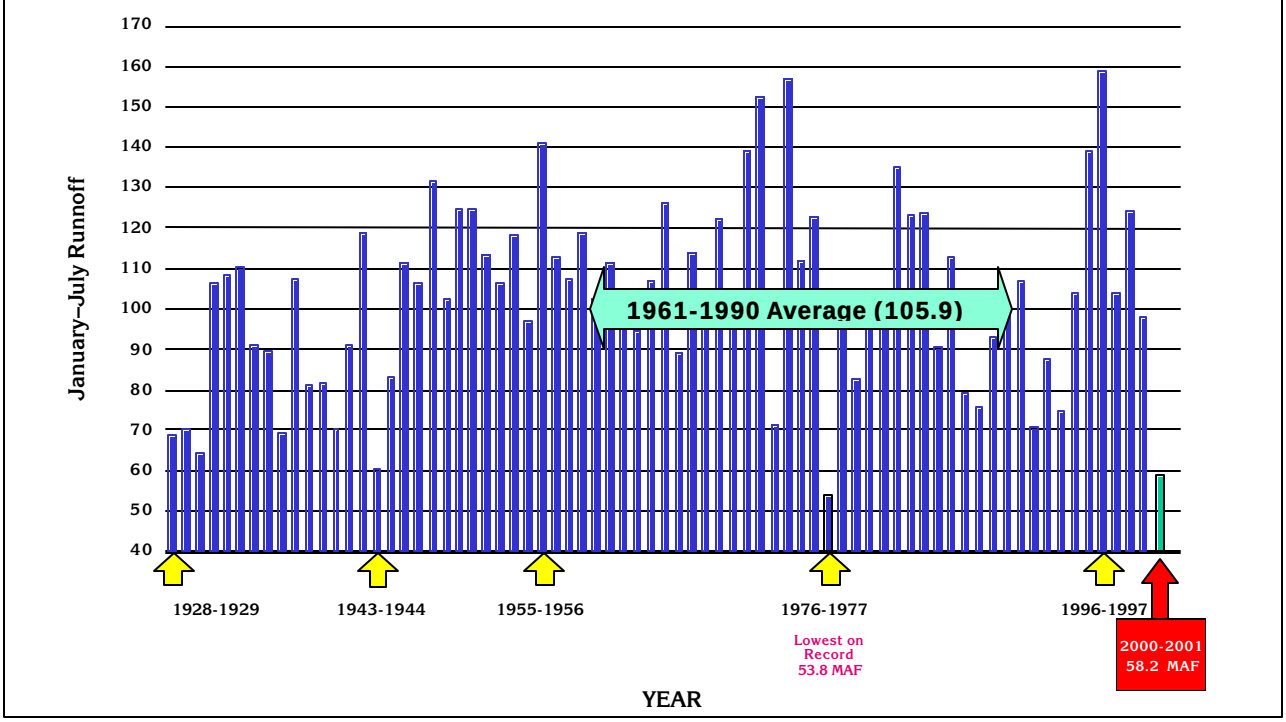
C. Performance Conditions

In many ways, the 2000–2001 FCRPS operating year was unprecedented. Several extreme conditions combined to impact the region: historic low water conditions; breakdown of a newly deregulated energy market in California, which also experienced an unusually high number of thermal plant outages; and an imbalance between demand and supply on the West Coast. As a result, wholesale power prices skyrocketed. In the midst of these trying conditions, the Action Agencies began implementing the 2000 BiOps.

Here is a closer look at the drought and volatile power market that affected 2001 implementation.

Figure 2.7 — January–July Runoff at The Dalles

January–July runoff in the Columbia Basin varies widely from year to year, with an average of 105.2 MAF. The lowest runoff recorded was 53.8 MAF in 1977 and the highest 159 MAF in 1997.



Drought Conditions

Hydrologically, the Columbia River Basin is characterized in two important ways: annual runoffs vary widely, and storage capacity is limited. The Northwest depends on runoff water from snowmelt to provide flow for fish migration and spawning, fuel for the region's hydroelectric generators, and other purposes. With less runoff, there is less flexibility in operating the FCRPS for its multiple purposes, such as releasing water for fish. Yet runoff can vary widely from year to year. (See Figure 2.8.) Unregulated flow at The Dalles varies from 36,000 to 1.24 million cubic feet per second (cfs), a 1:34 ratio, compared to 1:2 and 1:25 ratios in St. Lawrence and Mississippi river basins, respectively.

This would be less of an issue if water storage was large relative to annual runoff. The Columbia Basin, however, has storage capacity for only 30 percent of the region's average annual runoff. This makes it particularly vulnerable to droughts. In contrast, dams on the Missouri and Colorado systems can hold two to three times the annual runoff, so even in bad water years their vast storage can meet operational needs.

Power Markets

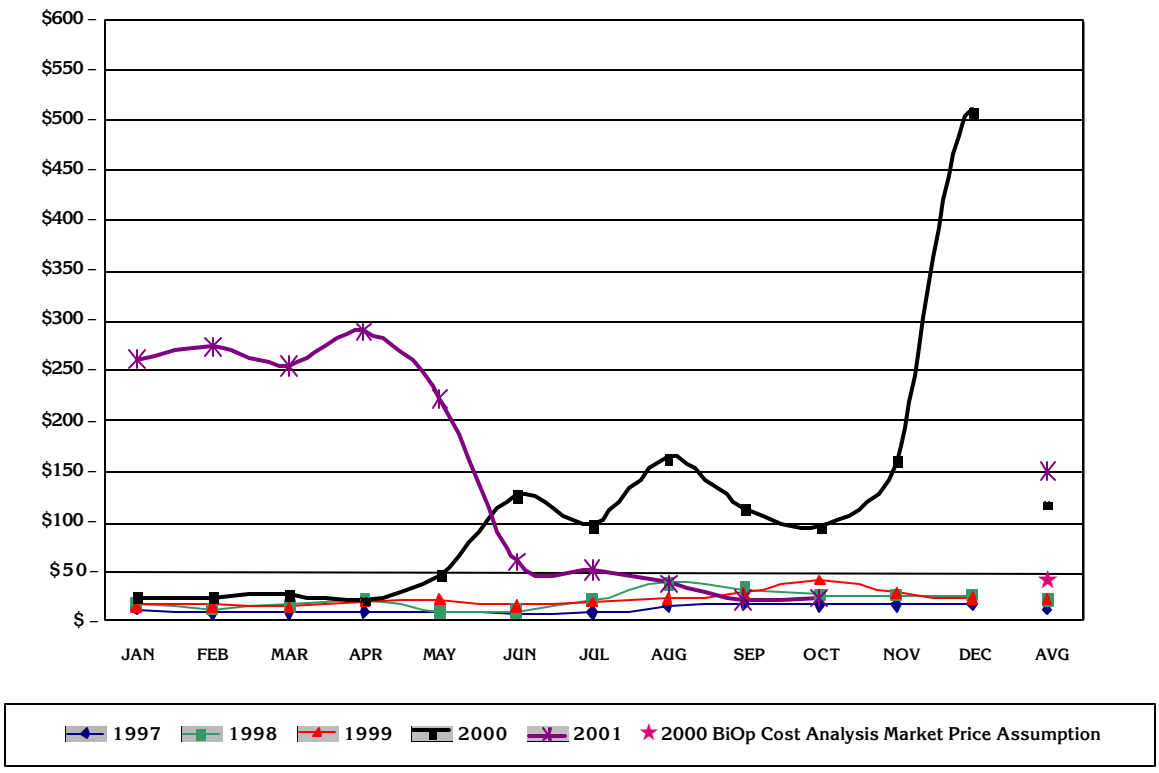
Water year 2001 was the second lowest on record, with a January–July runoff volume of 58.2 million acre-feet (MAF) at The Dalles. This exceedingly low runoff, 57 percent of average, created unfavorable conditions for migrating salmon and steelhead at the outset. Fortunately, the NMFS BiOp anticipates varying runoffs and emphasizes certain strategies in low-flow years, such as maximum transport of Snake River fish.

Because the Pacific Northwest depends on hydropower for nearly three-quarters of its power supply, BPA plans to meet load based on "critical water conditions" to ensure reliability. Critical water conditions are defined as the worst streamflows on record; for the Columbia River Basin, that was the 1928–1932 period. In the past, BPA has been able to meet winter load by buying power from California. In 2000–2001, however, that option became increasingly difficult for two reasons:

- Power throughout the West Coast was in short supply. While this was commonly blamed on

Figure 2.8 — Dow Jones Mid-Columbia Monthly Average Flat Prices

This figure shows Dow Jones monthly average prices at the Mid-Columbia trading hub from January 1997 through December 2001.



California's power crises, in part because power traditionally imported from California in the winter was not available, the shortage was actually a culmination of the region's lack of investment in new generation and transmission facilities over a decade.

- Record — up to tenfold — increases in wholesale power prices were seen in the power market (see Figure 2.9). As a result, BPA power costs vastly exceeded the high end of the range ($174 to $579 million) assumed for implementation of the BiOps — surpassing the maximum as early as January. BPA power purchases in all of FY 2001 (October 2000 — September 2001) totaled nearly $2.3 billion, more than eight times the FY 1997 — FY 2000 12-month average of approximately $275 million. To provide the additional spill stipulated in the NMFS BiOp would have cost $728 million, assuming Dow Jones month average prices at the Mid-Columbia trading hub during the April–August spill period. Appendix B contains an in-depth look at the real-time information that was available and that drove in-season decisions about implementing water management actions in 2001.

The combination of generation scarcity and skyrocketing power prices posed serious power reliability and financial issues for the region. To protect the region from power outages and financial consequences, BPA took extraordinary steps to reduce loads and increase power supply throughout 2001 and in the future 2002–2006 rate period. Actions included buying down power sales contracts with DSIs and irrigation customers, negotiating load reductions with all customer classes, accelerating implementation of multiple conservation programs, and working with governors and regional partners to promote regionwide conservation efforts. (See Table 2A.)

The combined low water and power reliability conditions also forced BPA to use the power emergency provisions in the NMFS BiOp. Emergencies were declared three times over the winter (Dec. 11–12; Jan. 18–Feb. 5; and Feb. 12) and for an extended period in the spring and summer (April 3–Oct 1). Further discussion of power emergency declarations is included in Appendix B.

In 2001, BPA took a number of steps to reduce loads for 2001 to improve regional reliability and mitigate rate impacts.

Table 2A — Summary of Dry Year and Power Emergency Actions FY 2001–2006

ACTIVITY	FY 2001	FY 2002	FY 2003	FY 2004–2006
Short-Term Buy-Downs Focused on Power Emergency				
Irrigation Load Buy-Downs (includes Utility Program and Snake River Program) (April–Sept 2001)	11.5 aMW* 80,000 to 100,000 acre-feet of water saved			
Columbia Basin Project Irrigation Leases (April–Sept 2001)	50 aMW 300,000 to 400,000 acre-feet of water saved			
End-Use Load Reductions** (Dec–Sept 2001)	75 aMW			
DSI Load Reductions	543 aMW			
1:2 Power Exchanges with California	500 MW-mos***			
Demand Exchange Program (DEMX)	463 MW potential from 12 customers	same		
Rate Mitigation Efforts				
Load Reductions from DSIs		934 aMW	581 aMW	47 aMW
Load Reductions and Power Buy-Backs from IOUs		651 aMW	619 aMW	619 aMW
Load Reductions from Public Utilities		530 aMW	130 aMW	25 aMW

* aMW = average megawatts. One aMW is equivalent to the energy produced by continuous operation of one megawatt of capacity over a period of time.
** End-Use load reductions were only for FY 2001 since new power sales contracts were in place beginning FY 2002.
*** MW-mos = megawatts supplied over the course of a month.

3.0 Strategies and Substrategies — 2001 Results

A. Hydrosystem

In 2001, the Action Agencies continued to implement recovery measures for the hydrosystem through strategies to configure dams, manage water, and operate/maintain fish passage facilities to enhance fish passage and survival. The accomplishments of measures implemented to support these strategies are reported in this section, following a discussion of juvenile and adult fish survival.

There are more BiOp actions for the hydrosystem than for other categories because of the hydrosystem focus resulting from listings under the Endangered Species Act (ESA). Roughly half the hydrosystem measures in 2001 focused on dam modifications, while the other half addressed operations. Due to the drought and power emergencies, changes were made in spill operations and transport studies and one engineering study. In summary, 2001 hydropower actions addressed more than 140 NMFS and USFWS RPAs as follows:

- Adult passage enhancements addressed RPAs 6, 50, 60, 70, 107, 110, 112–114, 116, 120, 123, and 127–129.
- Juvenile passage improvements addressed RPAs 6, 35, 53, 61–63, 65–67, 69, 70, 72–74, 79, 80, 82–87, 94, 96–99, 101, 122, 134, 138, 140, and 144–147.
- Resident fish enhancements addressed RPAs 8.1.f; 8.2.a.8 and 9; 8.3.d; 8.4.a and b; 10.A.1.1; 10.A.1.2; 10.A.1.4; 10.2; 10.4 and 5; 11.A.1.1a and b; 11.A.1.4.a and b and d; and 11.A.2.1.b and d; 11.A.3.1.a; and 11.A.3.2.a.
- Water management improvements addressed RPAs 3, 14, 18–26, 28–32, 34–41, 54, 58, and 131–133.
- O&M enhancements addressed RPAs 6, 22, 40, 55-57, 91, 93, 109, 114, 120, 125, 126, 144–146, and 191.
- Temperature and dissolved gas improvements addressed RPAs 5, 33, 71, 76, 82, 83, 132, and 134–136.
- Project configuration RM&E addressed RPAs 34, 45–47, 49, 52, 53, 60, 81, 95, 107, 108, 111, 113–119, 181, 182, 185, 191, and 195.

2001 Fish Survival in the FCRPS

Adult Fish Survival

Survival of adult spring and summer chinook was approximately 99 percent per project, among the highest survival rates on record. This estimate is based on adult PIT tag detections at Bonneville Dam and Lower Granite Dam in 2001. Limited and preliminary analyses indicate adult spring and summer chinook conversion from Bonneville to Lower Granite for fish destined above Lower Granite was approximately 80 percent. The harvest rate for the combined fisheries in the reach from Bonneville to Lower Granite was approximately 14 percent of fish passing Bonneville Dam. As a result, the minimum survival rate would be approximately 94 percent, which calculates to an average per project survival rate of approximately 99 percent (assumes seven projects).

This occurred despite the fact that some of these adult fish migrated when stream temperatures in July and August exceeded 24°C (near lethal for salmonids) for several days (Schiewe Memo, Sept. 10, 2001). Similar assessments are not yet available for adult fall chinook or steelhead.

Juvenile Fish Survival

Total System Survival

Total juvenile system survival, which includes both in-river and transported migrants, is essential for evaluating 2001 performance because most fish were transported. Under the NMFS BiOp, juvenile fish transportation is maximized in the Snake River when flows are less than 85,000 cubic feet per second (kcfs). Consequently, maximum transportation was implemented in 2001 and 90 to 95 percent of Snake River chinook and steelhead arriving below Bonneville Dam were transported. Transportation at McNary was also implemented every other day during the spring as a risk management strategy, given near-record low runoff conditions. Transportation was then maximized at all four transport projects (Lower Granite, Little Goose, Lower Monumental, and McNary dams) during the summer.

In response to regional interests and the NMFS BiOp (RPA action 44), COE increased the seasonal use of barges to reduce the number of juvenile fish transported by trucks. In 2001, about 2.5 percent of all transported fish were carried in trucks versus about 5 percent in 2000 and higher percentages in some previous years.

Assessments of total system survival are dependent on assumptions about delayed mortality due to transport, or D-value (see box). The NMFS estimates that the direct survival rate of transported juveniles is approximately 98 percent. From adult returns in past years, NMFS (2000) estimated D-values for Snake River stocks are 0.63 to 0.73 for spring chinook, 0.52 to 0.58 for steelhead, and 0.24 for fall chinook. In the case of Columbia River stocks transported at McNary Dam, NMFS assumed a range of D-values, from those used for Snake River stocks above to values of 0.8 to 1.0 based on historical estimates.

In most years, assumptions about D-values could have a major impact on the net survival benefit anticipated by transporting juveniles around the hydrosystem. For example, if the D-value was truly 0.55, then years when in-river juvenile survival through the system is near this value, as was the case in 1998 and 1999, transportation may provide less benefit than under conditions where in-river survival is considerably less than the assumed D-value. However, given that estimated in-river survival in 2001 was significantly less than the assumed D-values, the decision to transport as many juveniles as possible was a sound risk management strategy.

Delayed Mortality (D-Values) Defined

While the purpose of transporting fish is to circumvent direct mortality from passage through dams and reservoirs, some transported fish populations may experience mortality after release below Bonneville exceeding what may have occurred if they had not been transported. This mortality is termed differential delayed transportation mortality and is represented by the so-called D-value. “D” is the post-Bonneville Dam survival ratio of transported fish vs. in-river fish. A D-value of 1.0 indicates post-Bonneville survival is the same for transported and in-river migrants. A D-value of 0.63 to 0.73, as assumed for Snake River spring chinook, indicates that post-Bonneville survival of those transported fish is 63 to 73 percent of that of post-Bonneville in-river migrants.

Table 3A — 2001 NMFS Estimates of Total System Survival

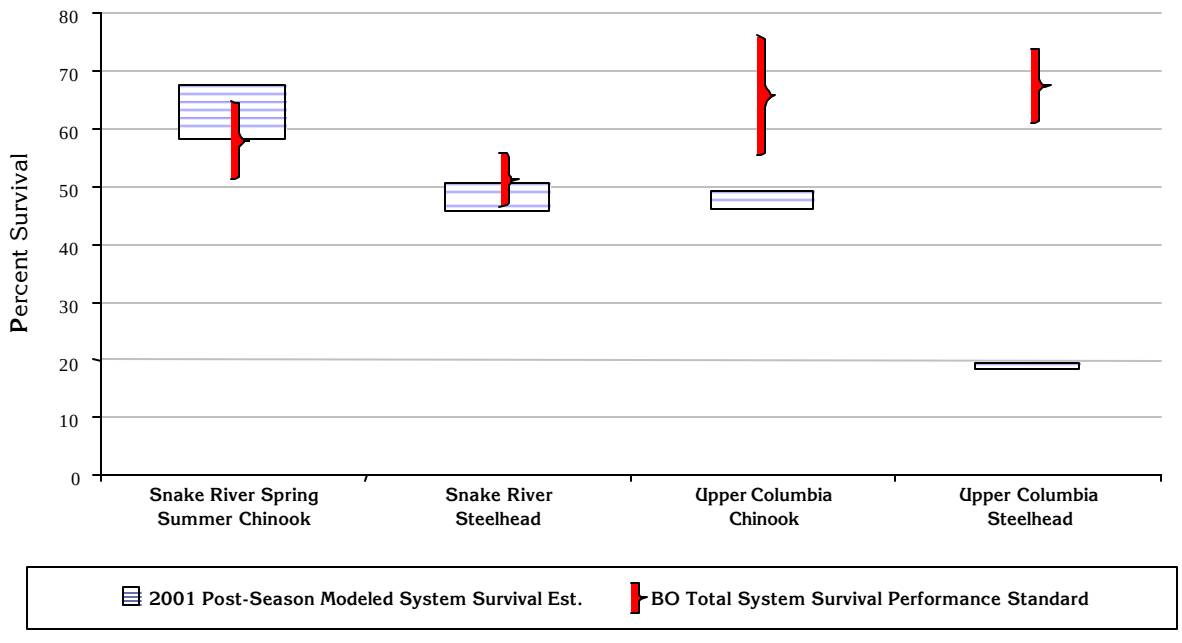
TOTAL SYSTEM SURVIVAL (%)

	1995–99 Average Survival[1]	Pre-Season SIMPAS Model Survival Estimates[2]	Post-Season Modeled Survival Estimates[3]	Total System Survival Performance Standard[4]
Snake River Spring/Summer Chinook (head of Lower Granite to Bonneville tailrace)	57.6 (54.8–60.4)	55.7–64.4	58.2–67.4	51–65
Snake River Steelhead (head of Lower Granite to Bonneville tailrace)	50.8 (49.0–52.5)	45.5–50.8	45.4–50.6	46–55
Upper Columbia River Chinook (McNary tailrace to Bonneville tailrace)	66.4	n/a	45.8–49.1	55–76
Upper Columbia River Steelhead	67.7	n/a	18.2–19.5	61–74
Snake River Fall Chinook	12.7	3.5	n/a	8–16
Hanford Reach Fall Chinook (McNary tailrace to John Day tailrace)	n/a	n/a	n/a	n/a

[1] From NMFS BiOp Table 9.2-3; range reflects assumed "D" values.
[2] From NMFS in-season survival analysis.
[3] From NMFS survival analysis; range reflects assumed "D" values.
[4] From NMFS BiOp Table 9.7-5; range reflects combination of water conditions and assumed "D" values.

Figure 3.1 — Total System Survival Comparison

EST. 2001 ACTUAL VS. BIOP PERFORMANCE STANDARD



Overall, based on the assumptions used in this analysis, juvenile fish transportation appears to have provided an adequate level of protection for fish during this year of near-record low runoff and modified operations resulting from power emergencies. Additional analysis, including adult returns in future years and associated D-values, will provide a more complete assessment of how 2001 flow conditions and hydropower operations affected juvenile out-migration. In a recent presentation to the Council, the NMFS Science Center suggested that future adult returns from 2001 out-migrants may not be as bad as some have predicted. The Science Center attributes this to improved estuary/near ocean conditions as evidenced by the number of marine predators and alternative prey species observed in recent years. (NMFS Science Center, Feb. 6, 2002.)

Snake River Chinook

Preliminary estimates of total system survival for Snake River yearling spring and summer chinook from the head of Lower Granite to below Bonneville Dam range from 58 to 68 percent (see Table 3A). This includes combined transported and non-transported smolts and is based on differing delayed mortality assumptions for transported fish identified in the NMFS 2000 BiOp. This estimate of system survival for juvenile migrants was within the range of pre-season Simulated Passage Model (SIMPAS) survival estimates prepared during the 2001 power emergency conditions. It is also on the high end of the range of the 1995–1999 average system survival rate identified in the 2000 NMFS BiOp.

Snake River Steelhead

Preliminary estimates of total system survival for Snake River steelhead ranged from roughly 45 to 51 percent (see Table 3A), or within the range of the pre-season system survival estimates and at the low end of the range of the 1995–1999 average system survival rates identified in the NMFS BiOp. Despite transport of more than 90 percent of the steelhead, the slightly lower system survival estimate was the result of low in-river survival rates observed in 2001 for those fish not transported. The NMFS Science Center hypothesized that the in-river steelhead migrants lost their urge to migrate and residualized in lower river reservoirs (NMFS memo, Sept. 10, 2001.) It was also hypothesized that some out-migrants stayed in tributaries upstream of the hydrosystem due to insufficient migrational cues associated with low tributary flows and lack of precipitation.

Columbia River Chinook and Steelhead

Estimates of system survival of listed Upper Columbia River (UCR) spring chinook, assuming that Snake River D-values apply to Upper Columbia stocks, were between 46 and 49 percent (see Table 3A), or about 70 percent of the 1995–1999 average system survival rate identified in the NMFS BiOp. System survival estimates for UCR steelhead range between 18 and 20 percent, which is only about one-quarter the average system survival rate identified in the NMFS BiOp. Again, this is due to the apparent low in-river survival of steelhead observed in the Lower Columbia in 2001.

In-river Juvenile Fish Survival

Less than 10 percent of juvenile Snake River fish and 65 to 80 percent of Columbia River fish migrated in-river in 2001. As expected, survival rates for these fish were substantially less than the multi-year average for both Snake River and Columbia stocks. The low survivals were likely due to a combination of factors, including low natural flows, poor tributary conditions, prolonged travel time, poor water quality, high predation rates, lack of spill, and reduced turbidity.

Snake River Chinook Migrants

Survival for in-river Snake River yearling chinook migrants from the head of the Lower Granite project to the Bonneville Dam tailrace was estimated at 26 percent (NMFS, 2001). This estimate is within the range of the pre-season SIMPAS in-river survival estimates but only about half the average system in-river survival rate since 1995.

Snake River Steelhead Migrants

For Snake River steelhead migrating in-river, only about 3.8 percent survived from the head of the Lower Granite project to the Bonneville tailrace. This juvenile steelhead survival rate is about 12 percent of the pre-season SIMPAS survival estimates and only 7 percent of the average system survival rate since 1995. It is possible steelhead lost their urge to migrate and residualized in the lower reservoirs. Although residualized steelhead might not have died, in past years only a small proportion of the presumed residualized PIT tagged steelhead were observed to successfully migrate the following spring. (NMFS memo, Sept. 10, 2001).

The difference in in-river survival between the 2001 migration year and previous low-water migrations is worth noting. In the case of chinook, in-river survival in 2001 was approximately an order of magnitude higher than observed in low water years of 1973 and 1977, suggesting that configuration and operational

changes have resulted in substantial improvements to survival. On the other hand, steelhead survival in 2001 appears to be only slightly greater than what it was prior to the survival improvements since 1973/1977. Given that there are no apparent differences in survival mechanisms between chinook and steelhead, this would suggest other non-survival mechanisms affected steelhead, such as behavior.

The distinction between survival mechanisms and potential behavioral responses is important. It appears that FCRPS actions have been effective at improving in-river survival under extremely low runoff conditions. However, these extreme conditions and associated higher than normal water temperature may also have behavioral effects on migrants, particularly steelhead, so the passage survival improvements themselves have less effect on these fishes' migration success within such a dry year. Steelhead have the capacity to de-smolt when water temperatures are elevated. When this occurs, there would be an apparent decrease in within-year survival because they are less apt to migrate, as evidenced by large numbers of steelhead in streams and reservoirs. Future monitoring and evaluation will provide data to determine if any residualized steelhead successfully outmigrate at some later date.

Predation losses of in-river migrants, particularly steelhead, may also have been significant in 2001. With the high proportion of Snake River fish transported, the number of in-river migrants below Lower Monumental was relatively low compared to recent years. In addition, there was little turbidity in 2001, making in-river migrants more susceptible to visual predators. Preliminary analysis of PIT tags recovered on Crescent Island (located in the McNary reservoir) suggests tern-related steelhead mortality downstream of Lower Monumental Dam was at least 14 percent.

Snake River Fall Chinook

Survival of wild, juvenile Snake River fall chinook from release to the tailrace of Lower Granite Dam was estimated at 21 percent, the lowest in recent years, with a range of 35 to 71 percent since 1995 (USFWS). Survival of hatchery fall chinook from release to the tailrace of Lower Granite Dam was also the lowest in recent years, ranging from 2 to 40 percent (NMFS, 2001). Based on these survival estimates, the percentage of fish that survived to the FCRPS and were available for transportation was very low. Further, for three out of the six groups of fish released at Pittsburg Landing and for one out of six groups released at Billy Creek, too few fish were observed downstream to even make survival estimates.

Survival of river-run subyearling chinook salmon, mostly of Hanford Reach origin, from the McNary to John Day tailraces averaged about 58 percent in 2001 (NMFS 2001). This is lower than estimated survival through this reach in 1999 (78 percent) and 2000 (66 percent), but higher than survival in 1998 (41 percent). Thus, there is no clear evidence that for this reach (two dams and reservoirs), 2001 hydrosystem operations decreased the juvenile survival rate for Hanford subyearling fall chinook. Fall chinook are much more protracted in their migration to the ocean and as such, may be less dependent on discharge, at least in the Columbia, to get past the dams. The situation in the Snake may be different due to the very low average flow in summer and difficulty in finding flow cues to get past the lower Snake dams, especially in low flow years.

Flow conditions in the Snake River above the FCRPS may have affected juvenile salmon before arrival at Lower Granite Dam. For spring chinook and steelhead, the number of Snake River Basin hatchery fish arriving at Lower Granite dam was similar to or higher than in past years. For fall chinook, however, in-river survival was the lowest since studies began in 1995. Besides poor hydraulic conditions, higher water temperatures, and greater water clarity may partly explain these poor survival rates. Both conditions would favor increased predation; visual predators would be more active and successful. Also, flows from the Hell's Canyon Dam are slightly warmer than the temperatures of tributaries entering downstream of the dam, so increasing flows in Hell's Canyon may warm the water and inadvertently cause more predation. Overall, the net impact of the conditions and actions on fall chinook juvenile and adult survival rates requires continued investigation.

Spill Impact on Survival

Spill operations also contribute to in-river migration survival. During 2001, spill was modified in response to the power emergency declarations. Incremental analysis of the effect of various levels of spill on in-river and total system survival was conducted by NMFS to help inform spill decisions throughout the 2001 passage season. (See (Figures 3.2 through 3.5.) The limited spring spill that occurred in the Lower Columbia River was timed to coincide with the passage of wild juvenile spring migrants (see Figures 3.6–3.8). Limited summer spill was provided from July 24 to Aug. 31 at The Dalles and Bonneville dams in the Lower Columbia River near the end of the subyearling migration, which included some wild Snake River juvenile fall chinook.

Figure 3.2 — Relative Change in Spring Juvenile In-river Survival from 2000 BiOp Spill for Snake and Columbia River Fish

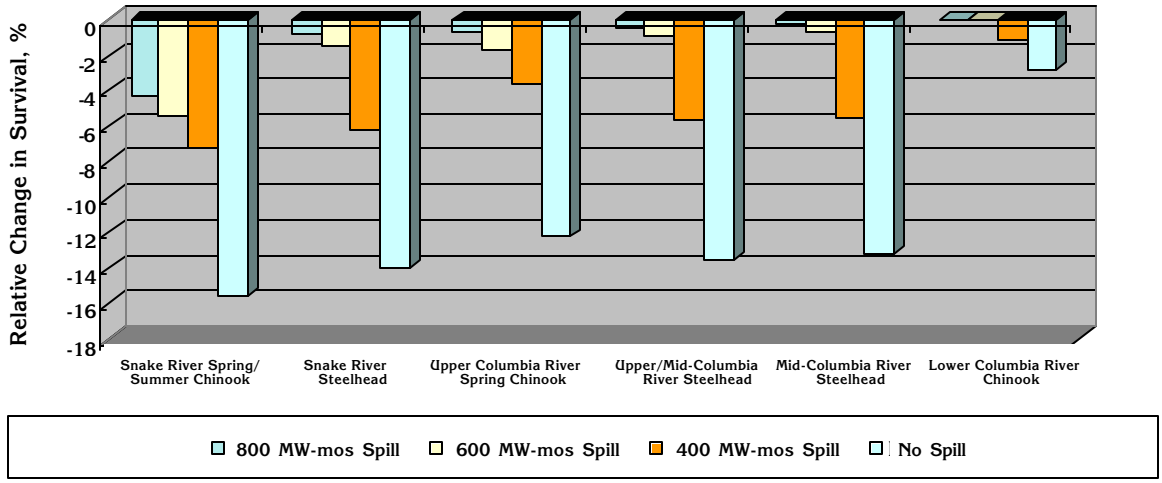


Figure 3.3 — Relative Change in Spring Juvenile Total System Survival from 2000 BiOp Spill for Snake River Fish

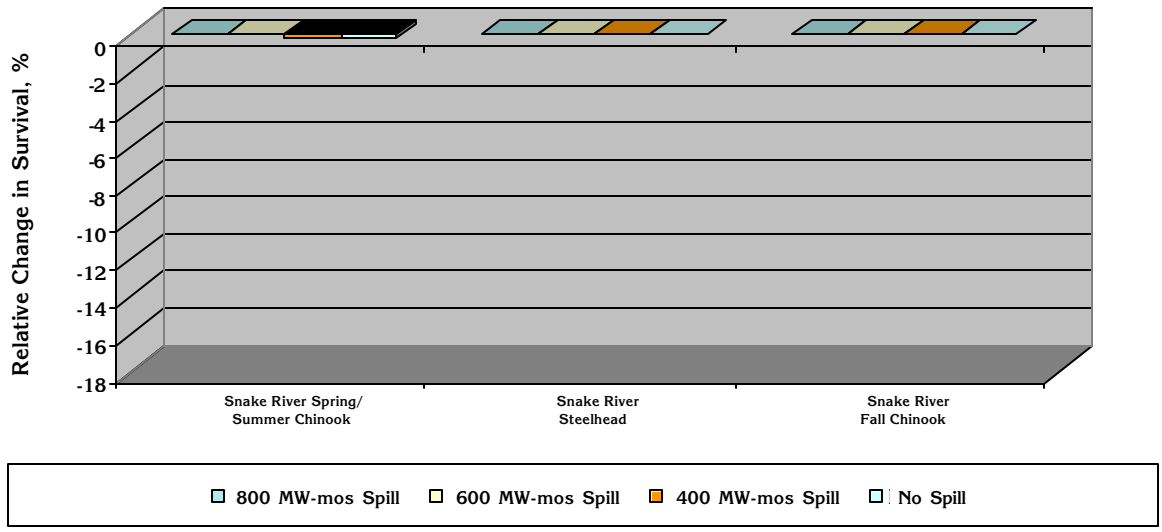


Figure 3.4 — Relative Change in Summer Juvenile In-river Survival from 2000 BiOp Spill for Listed/Unlisted Fish

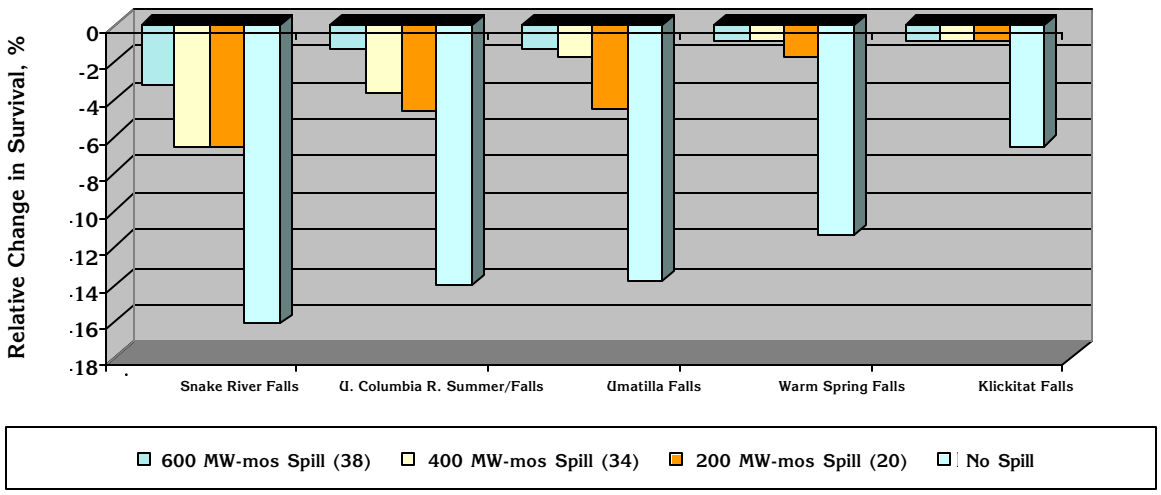


Figure 3.5 — Relative Change in Summer Juvenile Total System Survival from 2000 BiOp Spill for Listed/Unlisted Fish

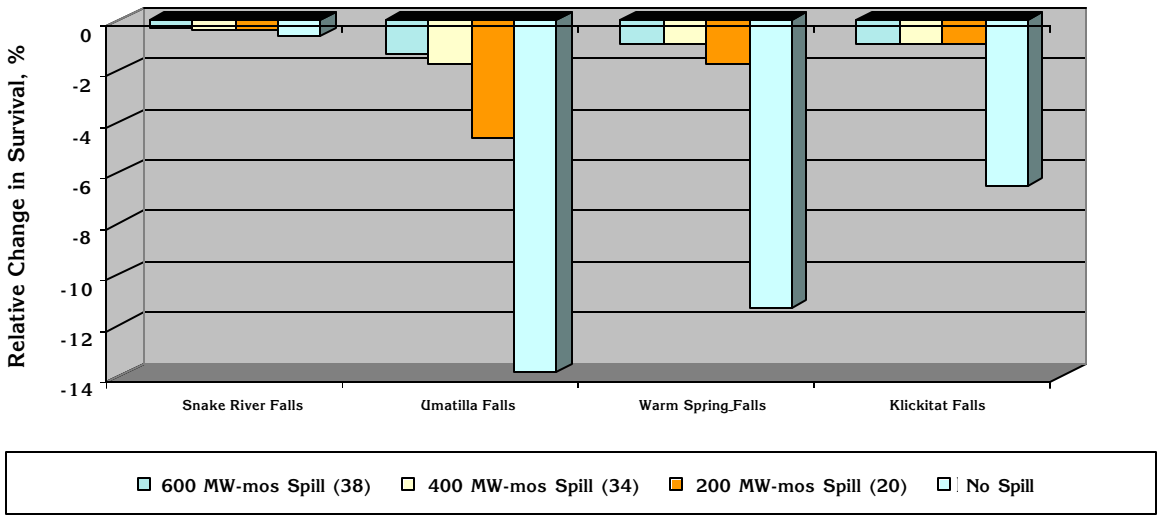


Figure 3.6 — 2001 Total Smolt Passage Index and Spill Discharge — Bonneville Dam

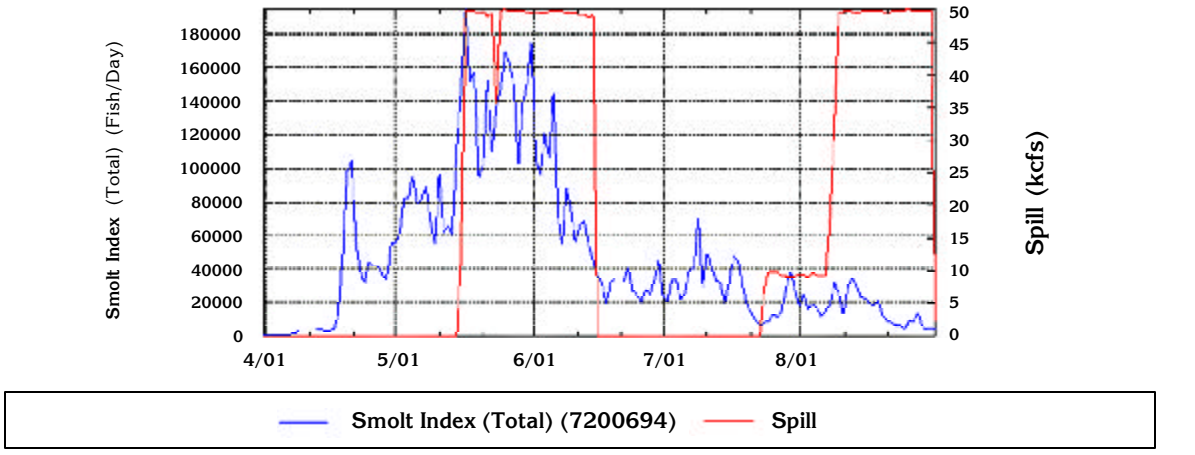


Figure 3.7 — 2001 Total Smolt Passage Index and Spill Discharge — John Day Dam

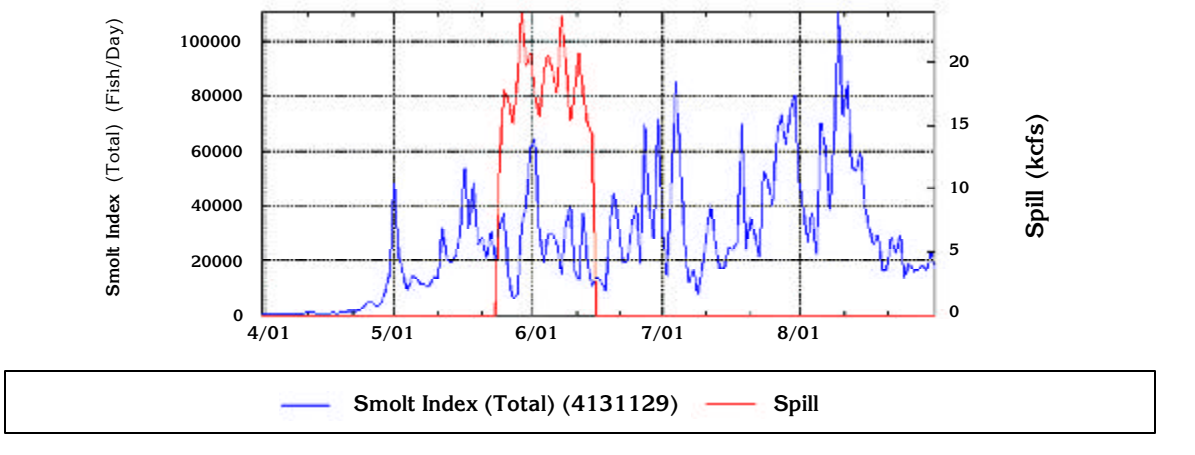
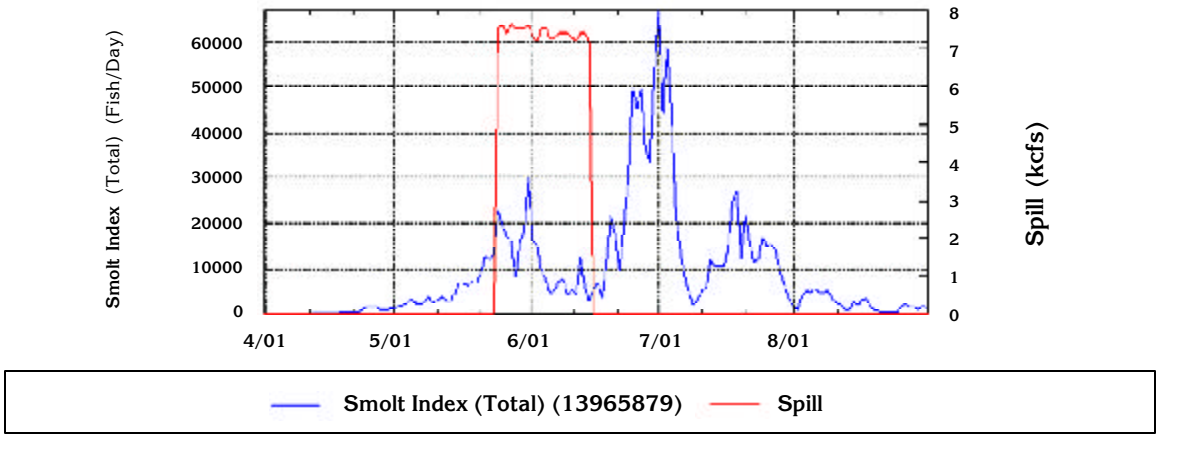


Figure 3.8 — 2001 Total Smolt Passage Index and Spill Discharge — McNary Dam



Run Timing

Run times were shorter for some stocks and longer for others in 2001. Here are the specifics of spring and fall fish run timing:

- **Spring Migration** — Juvenile fish migration timing in 2001 was generally later and shorter in duration compared to average historic passage indices. For example, run timing of yearling chinook at Lower Granite Dam during spring was delayed about 1 week and lasted only about 3 weeks compared to 4-½ weeks typically (based on the 10 to 90 percent passage dates). Steelhead passage at Lower Granite was slightly later than average and lasted about 4 weeks compared to 4-½ weeks historically. Run timing of yearling chinook at McNary Dam during spring was delayed about 2-½ weeks and lasted about 4 weeks compared to 5 weeks on average; steelhead passage was delayed about 1 week and lasted about 7 weeks, a little longer than average. However, run timing of yearling chinook at Rock Island Dam was 1 to 2 weeks earlier than average and lasted about 1 week longer; steelhead timing was delayed about 1 week and lasted about 6 weeks, near average.
- **Summer Migration** — Run timing of juvenile fall chinook during the summer migration at Lower Granite Dam was influenced by large hatchery releases and was about 1 week earlier than the historic timing of wild fish. While subyearling fall chinook passage at McNary Dam was near average in shape and duration, subyearling passage at Bonneville Dam was delayed more than 1 week and lasted about 1-½ weeks longer.

Strategy 1

Configure Dams to Enhance Fish Passage

Dam modifications to improve fish passage are carried out primarily through COE's Columbia River Fish Mitigation (CRFM) Program, which is funded through congressional appropriations. Funding in FY 2001 was $81 million. About three-quarters of the CRFM funding was used to continue development, evaluations, design, and/or construction of passage (configuration) improvements to facilities for juvenile and adult migrants at the eight Lower Columbia and Snake River projects, including water quality improvements. The balance of the appropriation was primarily used to continue research (RM&E) on adult and juvenile passage issues at and through these projects and in the estuary. (The research efforts funded under CRFM are discussed in Appendix A.) In all, there were 60 regionally prioritized measures funded under the CRFM program. Other improvements under development in FY 2001, but not funded under CRFM, included hatchery water supply modifications at Dworshak and flow deflectors at Chief Joseph Dam. (Appendix C provides a complete listing of the measures funded in FY 2001.)

Significant accomplishments for configuration in 2001 are summarized next.

Bonneville Project

- **Report on Future Juvenile/Adult Survival Improvements** — Completed a draft report and recommendation on overall project configuration and operations. Report is currently under ISRP review. The report and independent review will facilitate regional and federal decisions on the best course of action to achieve juvenile and adult survival improvements.
- **Second Powerhouse Corner Collector** — Completed outfall site selection and initiated the Detailed Design Report and Plans and Specifications for construction to begin in 2002. The corner collector, scheduled to be completed in FY 2004, is expected to improve juvenile survival by about 1 percent.
- **Spillway** — Initiated construction of flow deflectors on the five non-deflectored bays to be operational for the 2002 migration season. This action will reduce dissolved gases and benefit juvenile fish passage.
- **Adult PIT Tag Detection** — Completed installation and testing of an adult PIT detection system in the north shore ladder at Bonneville. This technology, to be installed in the remaining ladders at Bonneville and other projects beginning in 2002, will improve results of system survival studies and assessment of critical research uncertainties.

The Dalles Project

- **Surface Bypass** — Evaluations of "j-block" turbine occlusions for improving juvenile fish guidance was delayed by drought conditions and equipment difficulties. Testing will continue in 2002.
- **Spillway Testing** — Initiated an evaluation of the mechanistic causes of reduced juvenile survival during spill. The study will continue in 2002 to determine methods for improving survival rates in the spillway.

John Day Project

- **Removable Spillway Weir (RSW)** — Construction of prototype RSW planned for 2002 testing was deferred as a result of regional discussion to first address concerns about juvenile tailrace egress under RSW spill conditions. It is noted that RPA 72 called for beginning testing in 2002. This may also affect John Day configuration decisions called for by January 2003 in RPA 98.

McNary Project

- **Spillway** — Initiated construction of flow deflectors on the non-deflectored end bays to reduce dissolved gases and improve juvenile passage. The new deflectors will be operational for the 2002 migration season.
- **Temperature Control** — Initiated investigations of alternatives to address high forebay temperatures.
- **Juvenile Facility Improvements** — Completed evaluations and design for full flow PIT tag reading for installation in 2002. Also modified or replaced some fish release pipes.

Ice Harbor Project

- **Adult Ladder** — Initiated construction to provide one pump redundancy at the north shore fish ladder auxiliary water supply system and a complete upgrade of south shore electrical systems. These improvements will reduce potential risk of delays in adult passage.

Lower Monumental Project

- **Extended Length Screens** — Initiated evaluations of replacing existing screens with extended length screens to improve fish guidance and overall project survival. Evaluations are scheduled to continue in 2002.

Lower Granite Project

- **Surface Bypass (RSW)** — Completed construction, transport, installation, and initial hydraulic and fish survival tests of the RSW. Full-scale biological tests will be initiated in spring 2002.

Water Quality

In addition to the configuration measures identified above that address fish passage and efforts to reduce dissolved gas production at mainstem dams, the Action Agencies addressed water quality monitoring and participated in interagency coordination. COE worked with a NMFS regional forum Water Quality Team work group to address the annual monitoring program discussed in RPA 131 and to address systematic review of the fixed monitoring stations as discussed in RPA 132 of the NMFS BiOp. The work group developed monitoring station screening criteria addressing the representativeness and consistency of each station, the real-time basis utility of each station for decision-making, and the project release effect on water quality at each station.

To evaluate the criteria, the subcommittee performed preliminary assessments at six Lower Columbia River sites: The Dalles forebay and tailwater, Bonneville forebay, Warrendale and Skamania (both Bonneville tailwaters), and Camas/Washougal. The subcommittee concluded that the Camas/Washougal site should continue as a fixed monitoring location. Another station near Corbett will be evaluated in 2002. Additionally, a proposal to discontinue the Skamania site for 2002 will be discussed with Oregon and Washington water quality agencies. COE will also be performing studies in 2002 to determine whether The Dalles forebay station should be moved. The Water Quality Committee endorsed the recommendations of the subcommittee.

COE initiated discussions with the states of Idaho, Montana, Oregon, and Washington in 2001 about long-term variances for fish spill that would exceed total dissolved gas standards. Additional discussions will occur in 2002.

In related activities, as part of a comprehensive water-quality planning effort, COE was actively involved in discussions with the states of Washington and Oregon about their development of total dissolved gas total maximum daily loads (TMDL), and participated in agency meetings and public workshops during 2001. COE participated in public workshops during 2001 held by the U.S. Environmental Protection Agency (EPA) concerning the water temperature standards guidance and development of water temperature TMDLs for the Columbia/Snake rivers. These discussions will continue in 2002 with the states and EPA.

Strategy 2

Manage Water to Enhance Fish Survival

Progress is reported for each of the following water management substrategies: reservoir operations and system flow management, spill operations for project passage, juvenile transport actions, and other water management enhancement actions. A discussion of

relevant physical performance standards is included. Additional details on water management actions taken in 2001 can be found in the Hydro Actions Table in Appendix C.

Reservoir Operations and System Flow Management to Enhance Fish Survival

The reservoir operations substrategy generally focuses on individual FCRPS project operations that can benefit fish at or near each project or reservoir and therefore increase system survival by improving mainstem passage conditions. The system flow management substrategy targets coordinated system flow operations for mainstem flow management and redd protection. Physical performance standards within these substrategies are reported below and include spring and summer flows for anadromous fish, flows for chum in the fall and winter, and project minimum outflows for resident fish.

Spring and Summer Flows

The NMFS BiOp establishes flow objectives that seek to improve in-stream flow to aid juvenile fish migration and enhance water quality. The BiOps' flow analysis anticipated that under low-water conditions flow objectives would not be met.

Figures 3.9 and 3.10 show actual 2001 monthly average flows at Lower Granite and McNary dams, respectively, compared to Hydrological Simulation Model (HYDSIM) results for BiOp operations given 2001 runoff and BiOp flow objectives. In the modeled BiOp operations case, the chum operation is abandoned at the end of January and the system stores to meet April 10 refill requirements. Fifty-year average flows are included in the graph as a reference point. (HYDSIM uses 50 years of hydrological data to help make river management decisions, such as how to achieve reservoir elevations for flood control and refill, and to help predict river energy capabilities.)

As the graphs indicate, if priority had been placed on April 10 refill rather than the chum/power operation, it would have resulted in slightly increased flows at McNary in the spring and summer and at Lower Granite in the summer. The extreme low water conditions and, to a lesser degree, chum/power operations contributed to low reservoir elevations heading into the spring migration period. Furthermore, in-season management decisions on balancing use of available water for spring and summer periods reduced reservoir refill somewhat by the end of June (and subsequent summer flows), demonstrating the inherent conflicts in water management strategies under the NMFS BiOp (i.e., meeting chum flow needs while simultaneously storing for spring and summer flows). In any event, due to the drought and low runoff conditions, any alternative operation would not have been enough to meet BiOp flow objectives.

Figure 3.9 — 2001 Lower Granite Outflow (kcfs)

This figure and 3.10 (following page) compare actual flows at Lower Granite Dam and McNary Dam to simulated flows assuming the system resumed BiOp recommended operations after January 2001.

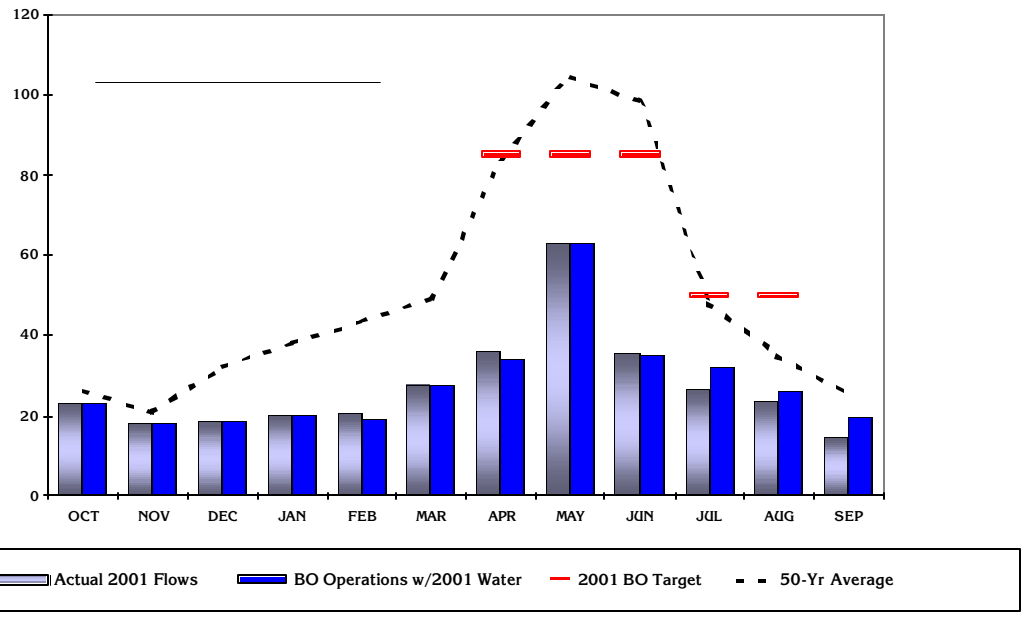
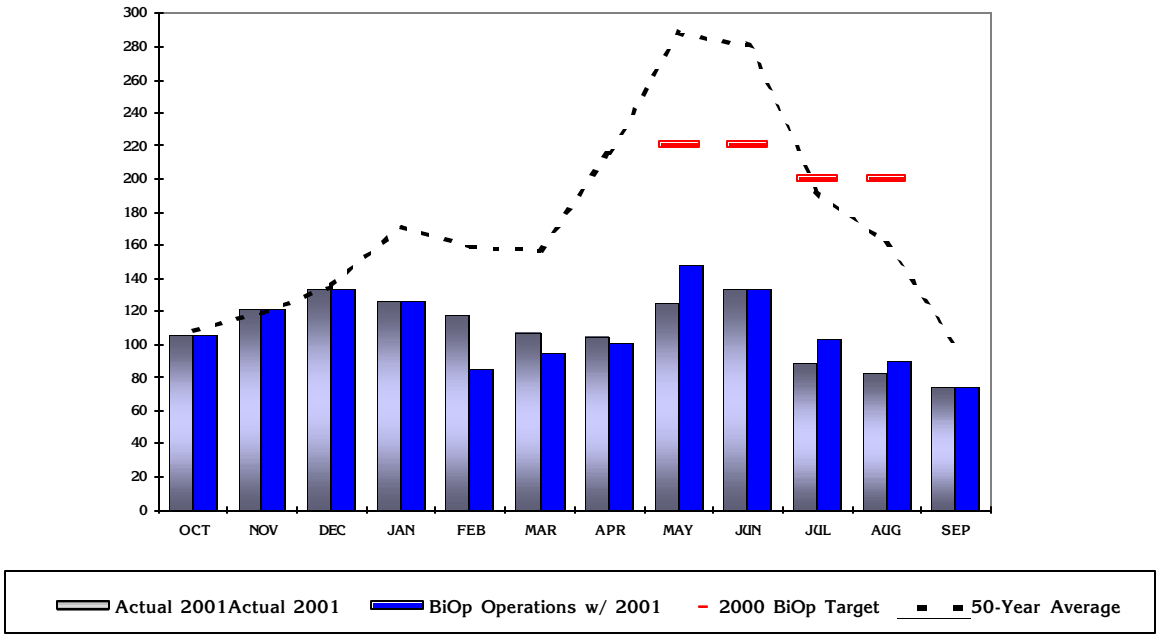


Figure 3.10 — 2001 McNary Outflow



Chum Flows

Flows to support chum spawning and emergence were provided from Oct. 30, 2000, through March 16, 2001. These flows were continued through the winter in part to allow power production needed to maintain power system reliability. When the flows ended March 16, it was expected that redds would be dewatered and perish; however, even though the average discharge at Bonneville was reduced after March 16, power peaking provided enough water to keep redds viable. Subsequent field observations revealed that fish continued to emerge from these redds for another 30 days.

Minimum Flows for Resident Fish

Minimum flows were met at Hungry Horse as recommended in the USFWS BiOp for bull trout on all but 15 days from Dec. 20, 2000, through September 2001. The flows from Hungry Horse maintained minimum flows downstream at Columbia Falls for all but 2 days of the operating year. All Hungry Horse outflow changes for the year were made within the established daily and hourly rates except for changes made for winter power emergencies, for summer transmission stability reasons, and on 4 separate days during the operating year. In all, there were only 19 incidents when minimum flows could not be met.

As recommended in the USFWS BiOp, minimum flows of 6 kcfs below Libby Dam were met throughout 2001. Ramping rates called for in the BiOp also were adhered to in 2001.

Flows for Non-Listed Fish

The Action Agencies provided some limited releases of water from storage reservoirs for non-listed stocks in recognition of the value placed on these stocks, including their commercial and cultural importance to tribes and others in the region. These releases had minimal impact on future operations for fish and power system reliability.

Spring Creek Hatchery Releases

The Action Agencies agreed to a request to provide limited and targeted spill at Bonneville Dam to benefit Spring Creek Hatchery chinook releases prior to the onset of the fish passage season. Spill was provided for 12 hours on the nights of March 10, 11, and 12, at a rate of 47 kcfs. This volume of spill resulted in 9 MW-months of foregone energy at a cost of $2.1 million. That is roughly the equivalent of releasing about 0.1 foot of storage from Grand Coulee Reservoir in a day. The traditional request is for 10 days at 120 kcfs of spill. Further investigation is needed to determine the effects of various levels of spill on Spring Creek Hatchery returns.

Vernita Bar Operations

The flows provided for chum spawning and emergence simultaneously provided benefits for fall chinook rearing in the Hanford Reach. When chum flows were terminated on March 16, requests were made to maintain Vernita Bar protection flows. Though the BiOp prioritizes refill for spring flows, the Action Agencies (in coordination with NMFS and USFWS) appreciate the importance of this salmon population to the region. Consequently, 561,000 acre feet (KAF) of spill was provided to protect Hanford Reach fall chinook between March 16 and April 6, when established emergence criteria were met and flows were reduced to enhance system refill.

Spill Operations for Project Passage

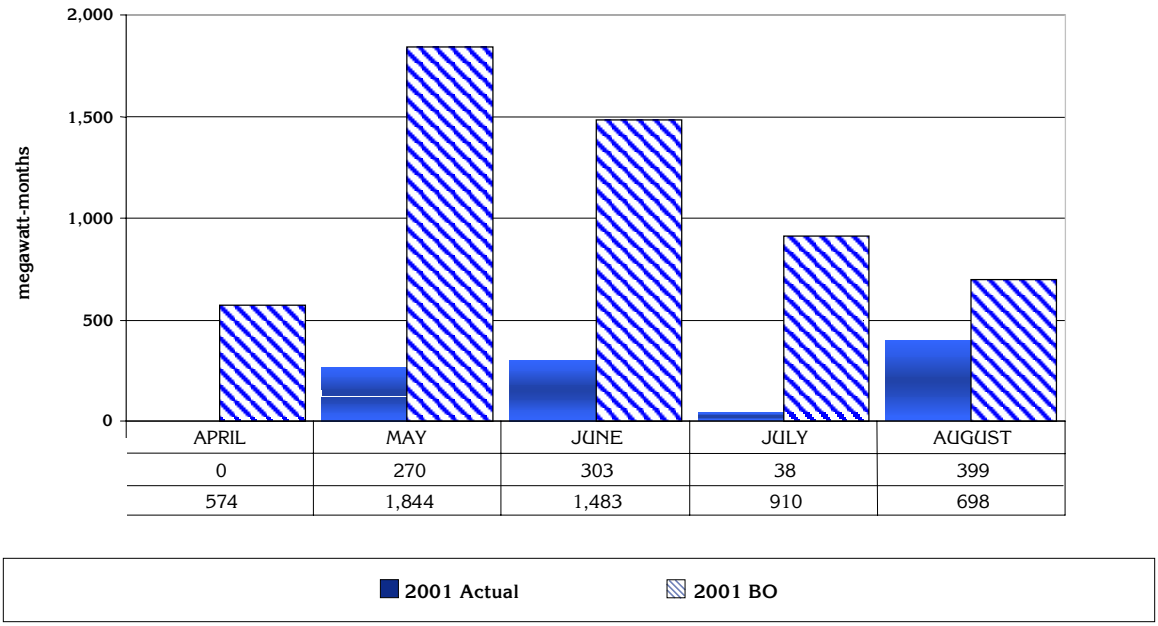
During the spring and most of the summer of 2001, juvenile spill could not be provided without conflicting with the power emergency criteria established through regional coordination (see *Appendix B*). The reduced regional power supply resulting from the drought and volatile power market led to projections that the region would not be able to meet near-term load nor have adequate resources going into 2002 to meet winter power needs. In light of these reliability concerns, the total volume of fish spill provided in 2001 was roughly 18 percent of the volume recommended in the NMFS 2000 BiOp. (See Figure 3.11.) However, as we further discuss below, this limited spill was targeted to achieve much of the biological benefits provided by spill under the BiOp, taking into account that most fish were transported rather than migrating in-river past the dams.

The Action Agencies began a targeted spill operation on May 16, 2001, at Bonneville and The Dalles dams. After much deliberation with the NMFS Regional Forum and the Regional Executive Roundtable, a regional task force composed of state, tribe, and federal agency representatives gave priority to those dams due to their low passage survival ratings. Additional spill began at John Day and McNary dams on May 25. Spill continued at these four projects through June 15. Because migration timing was generally delayed compared to historical passage timing, a significant portion of the run benefited from the targeted spill operation in the spring.

Power reliability issues continued to influence operations decisions throughout the summer. Analysis by NMFS and the Council of the impact of reduced spill on system survival for listed summer migrants indicated only limited effects (poor in-river conditions had already significantly affected in-river survival). (See Figures 3.4 and 3.5.) These analyses, coupled with ever-declining volume runoff forecasts, persuaded the Action Agencies to delay implementing spill operations for summer migrants.

Figure 3.11 — 2001 Juvenile Spill Comparison

This figure compares actual spill April through August 2001 to spill recommended in the BiOp Under 2001 Water Conditions.



On July 17, 2001, targeted spill at Bonneville and The Dalles dams was implemented. Subsequently, improvements in the reliability outlook due to greater-than-expected runoff and additional BPA power purchases (which improved system storage) enabled the Action Agencies to further increase spill at these two projects.

Juvenile Fish Transport Actions to Enhance Fish Survival

In 2001, between 90 and 95 percent of the Snake River yearling chinook and Snake River steelhead arriving at the head of Lower Granite Pool were collected and transported to below Bonneville Dam. As called for in the NMFS BiOp, smolt transportation was maximized at Snake River projects during the spring because in-river fish passage conditions were poor and there was little operational flexibility to improve them. Partial spring transport was also implemented at McNary as a risk management strategy to assist Mid- and Upper Columbia fish migrating under "summer-like" drought conditions. Full summer transportation programs were also implemented at Lower Granite, Little Goose, Lower Monumental, and McNary dams as the NMFS BiOp calls for under all flow conditions.

Other Water Management Enhancement Actions

Total Dissolved Gas (TDG)

In 2001, TDG standards were met on all but a few days. Oregon and Washington variance standards (115 percent in the forebays and 120 percent in the tailwaters) were slightly exceeded for 6 days in the McNary forebay and 2 days at the Camas/Washougal monitoring station during the spring and summer season. The exceedances were mostly individual days, rather than blocks of days, and due to low-flow conditions and the limited voluntary fish spill. Idaho water quality standards were exceeded for 17 individual hours during the entire 2001 water year.

Water Temperature

Temperatures in the Lower Columbia exceeded 20°C (Oregon's and Washington's standard) for most of July and August. Although low flow and drought conditions may have had some effect, temperatures tend to exceed 20°C in July and August in most years. Peak temperatures (see Figures 3.12 and 3.13) were as high as 24°C on two occasions, once in June and once in July. Tailwater temperatures in the Snake were generally cooler than the Lower Columbia tailwater measurements, at times exceeding 20°C at Lower Granite (Figure 3.15), however, temperatures at Ice Harbor were similar to those in the Lower Columbia (Figure 3.14). Dworshak operations helped cool temperatures in the lower Snake River (Figure 3.16).

Strategy 3

Operate and Maintain Fish Passage Facilities to Enhance Fish Survival

In 2001, COE carried out routine daily operation and minor maintenance of adult and juvenile fish facilities at the eight mainstem dams, performed major routine and annual maintenance on the facilities, and operated the juvenile fish transportation program, which included summer barging of Snake River fish through Oct. 31 and additional transportation at McNary Dam (see Section 3.1.3.3). These efforts were directed at maintaining and operating passage facilities within established criteria and providing enhanced transportation for best survival in the low water year. A key initiative was development and implementation of 5-year operation and maintenance plans consistent with the NMFS BiOp.

Major non-routine O&M accomplishments in 2001 include:

Bonneville Dam

- Rehabilitated portions of fish ladder systems and refurbished a portion of the submersible traveling screens (STS) that guide juvenile fish out of turbine intakes.

The Dalles Dam

- Procured new spillway fishway entrance bulkheads to facilitate future maintenance of the fishway.

Lower Monumental Dam

- Rehabilitated the floating mooring bitts for the fish barge dock and installed permanent piping and power for portable pumps to improve dewatering of the adult collection channel.

Major large capital accomplishments in 2001 include:

The Dalles Dam

- Replaced adult fishway diffuser gratings to improve fishway operations.

Figure 3.12 — Temperature at Bonneville

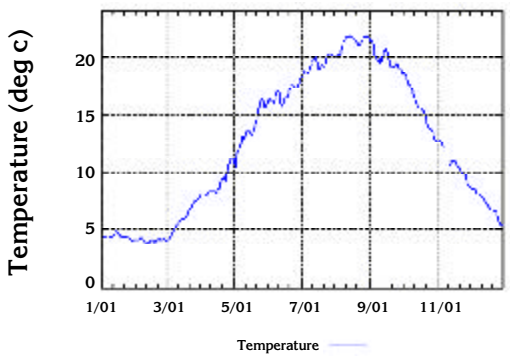


Figure 3.13 — Temperature at McNary

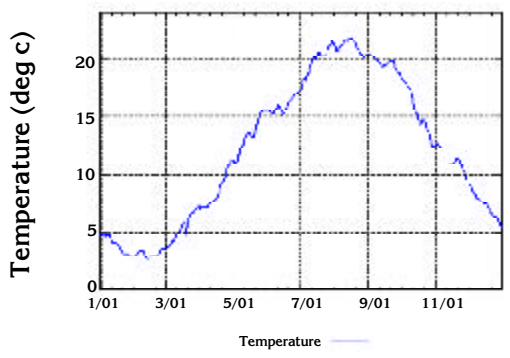


Figure 3.14 — Temperature at Ice Harbor

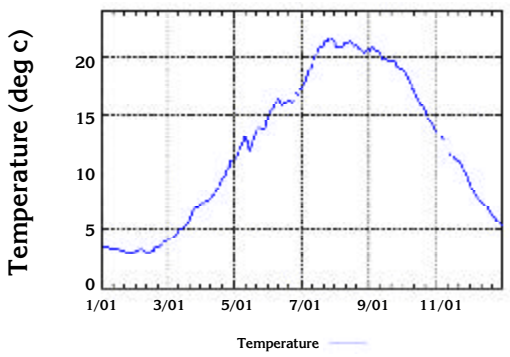


Figure 3.15 — Temperature at Lower Granite

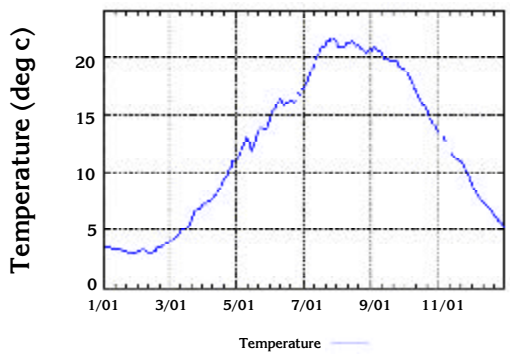
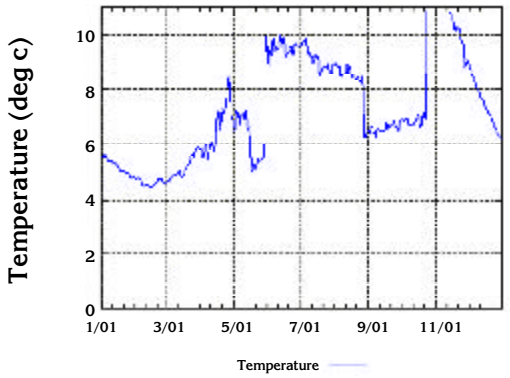


Figure 3.16 — Temperature at Dworshak



John Day Dam

- Initiated plans and specifications for rehabilitating the adult fish pumps to improve long-term operations of the fishways.

Lower Monumental Dam

- Rehabilitated all STSs to maintain juvenile fish guidance away from turbine intakes and modified valve operators for the juvenile fish dewatering structure to eliminate confined space problems.
- Initiated construction of additional access platforms to valves and piping in the juvenile fish facility. This work began in 2001 and will be completed in FY 2002.
- Prepared plans and specifications for rehabilitating fish pumps and awarded a contract for fabrication of new gears and factory reconditioning of gearboxes. (Will award a separate contract in FY 2002 for onsite rehabilitation of fish pumps.)

Ice Harbor Dam

- Rehabilitated all STSs to maintain juvenile fish guidance away from turbine intakes.
- Prepared plans and specifications for replacing and rehabilitating fish pump hydraulic systems to maintain long-term operations of the fishways.
- Prepared plans and specifications for replacing adult fishway entrance gates and hoists. Contracted for entrance weir gate construction (delivery in January 2002). Hoists will be on a future contract.

Variances and Modifications

Variances and modifications in hydrosystem measures compared to the 2000 NMFS BiOp are discussed in Section 4.0.

B. Habitat

Progress Addressing Habitat RPA Actions in 2001

The Action Agencies launched an aggressive new set of programs in 2001 to address tributary, mainstem and estuary habitat improvements. We adopted a structured approach to habitat improvement, relying on science-based strategies, criteria for priority projects, and independent science reviews. We also coordinated our efforts with similar regional processes including the Council's Fish and Wildlife Program and the Lower Columbia River Estuary Program (LCREP). Many of these projects were implemented with the help of state, tribal, and local partners, such as the Oregon Water Trust, Yakama Indian Nation, Nez Perce Tribe, Oregon Department of Environmental Quality, Washington State Department of Ecology, Idaho Office of Species Conservation, and others. Our work will accelerate in 2002 and beyond.

In the tributaries, programs addressed water quality, water quantity, fish passage, and irrigation screening in 16 subbasins of the Columbia and Snake rivers. The schedule is to enter all subbasins within 5 years, completing work in each within 10 years of entry. These 16 subbasins are Reclamation's priority locations for activities under RPA 149 (see Table 3B).

Table 3B — Reclamation's 16 Priority Subbasins for Tributary Habitat Improvements

EVOLUTIONARILY SIGNIFICANT UNIT (ESU)	PRIORITY SUBBASINS
Upper Columbia River spring chinook and steelhead	Methow, Entiat, Wenatchee
Snake River spring, summer, and fall chinook and steelhead	Lemhi, Upper Salmon, Middle Fork Clearwater, Little Salmon
Mid-Columbia River chinook and steelhead	North Fork John Day, Upper John Day, Middle Fork John Day
Lower Columbia River chinook, steelhead, and chum	Lewis, Upper Cowlitz, Willamette-Clackamas
Upper Willamette chinook and steelhead	Clackamas, North Santiam, McKenzie

Priority subbasins for other RPA actions will soon be identified based on interim de-listing criteria forthcoming from NMFS. In the meantime, the Action Agencies are prioritizing other restoration activities based on strategic criteria set forth in the 5-Year Plan, rather than geographic location.

Reclamation Initiatives (Tributary Habitat)

Reclamation initiated its tributary program in the Lemhi, John Day, and Methow subbasins by sending advance teams to meet with local representatives of federal, state, local, and tribal organizations, and citizens to scope workload (RPA 149). A Warm Springs Tribe employee is serving as Reclamation's subbasin liaison in the Upper and Middle Fork John Day subbasins. An existing Reclamation employee was reassigned to serve in the Lemhi. A Methow subbasin liaison was hired in January 2002. Liaison personnel will be stationed in each of the 16 subbasins to coordinate projects with landowners, watershed groups, tribes, and agencies. Liaisons are working with landowners to initiate projects and are coordinating efforts with other entities in the subbasins. Reclamation is designing fish passage and protective projects; assuring compliance with environmental, cultural resource, and state laws; and helping to identify funding sources for implementation. The projects are being prioritized based on subbasin locations, landowner interest and participation, and funding. Once Council subbasin plans are complete, project selection will be coordinated with those plans, consistent with the strategies in the BiOp.

In this latter regard, Reclamation supported the Council's provincial review process by providing data for the Salmon and Clearwater status reports. Other 2001 internal accomplishments at Reclamation included:

- Appointing ESA habitat coordinators in Portland, Yakima, and Boise (RPAs 1–6).
- Issuing contracts to develop subbasin programmatic NEPA evaluations which also will be used as the basis for programmatic ESA consultations with NMFS and USFWS.
- Modifying the 2002 appropriations budget request to Congress to create a new program for ESA compliance related to offsite mitigation.

In addition, Reclamation pursued these on-the-ground projects in 2001:

- Modifying several fish passage barriers in the Lemhi subbasin in partnership with state and local entities.
- Leasing water from the Idaho water bank in the Lemhi subbasin to assure fish migration flows in the lower Lemhi River and to avoid the potential of dry stream channels under prevailing drought conditions.
- Addressing fish screens and barriers in the Middle Fork and Upper John Day subbasins.

BPA Initiatives (Tributary Habitat)

In addition to the many projects selected through the Council process to meet ESA objectives, BPA solicited additional projects through three new initiatives. The solicitations issued in 2001 sought projects to mitigate the affects of the power emergency, projects with immediate benefits to listed fish species, and projects that encourage innovation. Most of the projects selected for implementation under these initiatives related to tributary habitat improvements. Although much of the groundwork for these projects will not be implemented until 2002, the requisite pre-field work was completed in 2001.

The Action Plan Initiative

As a voluntary response to the power emergency situation, BPA solicited proposals through an Action Plan Initiative aimed at identifying shorter-term projects that could be implemented in 2001 and provide immediate benefits to affected fish. Benefits from these projects are anticipated to continue in the long term. This solicitation was over and above the mitigation and recovery actions BPA had planned to implement under ESA and the Northwest Power Planning Act. Under this initiative, 20 tributary habitat projects were selected for implementation under the following substrategies: water quantity, passage and diversion improvements, and watershed health.

The High Priority Project Initiative

BPA sought to jumpstart BiOp implementation by initiating work on 14 "high priority" projects providing immediate benefits to anadromous fish habitat. This initiative was a one-time funding commitment for projects that would provide immediate, on-the-ground benefits. Although this initiative solicited proposals outside of the Council's Provincial Review process, the projects had to meet specific criteria adopted by the Council in its recent program amendments. The criteria included addressing imminent risks to survival of ESA-listed species, completion of all planning, permitting and landowner agreements, suitability for FCRPS mitigation under the Northwest Power Act, ISRP review, and other biological criteria.

The "high priority" projects selected for implementation relate to water quantity, passage and diversion improvements, and watershed health substrategies by protecting spawning and rearing habitat in Bear Valley; providing for habitat restoration and acquisitions at Ames Creek, Wagner Ranch, and Forrest Ranch in the John Day Subbasin; and reconnecting blocked habitat (restoring access to Hawley Creek and reconnecting Little Morgan Creek to the mainstem Pahsimeroi River).

The Innovative Project Initiative

Consistent with recommendation of the Independent Scientific Review Panel (ISRP), BPA also moved to address research needs identified in the BiOps by funding nine new "innovative" projects (six RM&E projects, two habitat projects, and one resident fish project). An innovative project is one that relies primarily on a method or technology not previously used in fish and wildlife projects in the Pacific Northwest or, if used in other projects, not previously used in an application of this kind. The two habitat projects approved under this initiative addressed the water quantity, watershed health, and subbasin planning and assessment strategies. The projects focused on improving the use of high technology to identify and characterize aquatic habitats and to ascertain habitat diversity in alluvial rivers.

In 2001, BPA also:

- Developed draft habitat acquisition criteria as required by NMFS Action 150, an effort that benefited from significant input from Council staff. Expected to be finalized in early 2002, the criteria will then be considered interim for an initial period of 12 to 18 months, during which time they will be subject to modification based on public input, peer review, and our experience in applying them.
- Began work under RPA 151 to develop a regional structure for flow improvements, i.e., water brokerage. Under this structure, projects will be initiated to increase tributary flows through water acquisitions and improvements at diversions. The water brokerage will test the effectiveness of various transactional strategies for increasing tributary flows. Proposals to develop other innovative strategies for water acquisition, and to address the need for an in-stream flow protocol, were sought in the Columbia Plateau, Columbia Gorge, and Intermountain provincial reviews held during 2001.
- Achieved several riparian zone improvements (RPA 153) under the Natural Resource Conservation Service's Conservation Reserve and Enhancement Program (CREP) and other actions (at least 90 miles of stream protected). We also awarded additional contracts to help achieve the goal of protecting 100 miles of riparian buffers in 2002. In fact, Wasco County, Oregon, alone expects to protect approximately 50 miles.

Joint Agency Initiatives (Mainstem Habitat)

Joint agency mainstem projects in 2001 addressed two RPAs:

- The Action Agencies, led by the Corp of Engineers, took steps to begin studying the feasibility (both biological benefits and ecological risks) of habitat modification to improve spawning conditions for chum salmon in the Ives Island area (RPA 156). In 2001, baseline information was collected on habitat type, use, and river bed temperatures in the Ives Island area. Once the feasibility study is completed, it will be presented to NMFS and shared with other interested agencies and tribes.
- BPA funded a Washington Department of Fish and Wildlife effort to rehabilitate and stock Duncan Creek with chum (RPA 157 focuses on improvements and restoration of mainstem and tributary chum habitat). Four springs were cleaned out and 30 pairs of chum were transplanted to the location. Those pairs successfully spawned and an additional 30 pairs of progeny were raised in the Washougal Hatchery. These will be released into Duncan Creek and the mainstem (Ives island) area.

COE Initiatives (Estuary Habitat)

In 2001, the groundwork was laid for initiating an ecosystem approach to salmonid recovery within the Columbia River estuary. COE and BPA funded several research projects in the estuary identified by the NMFS Northwest Fisheries Science Center. COE, BPA, and the LCREP also completed the estuary habitat inventory process called for in RPA 158. Furthermore, proposals that address all six habitat RPA actions for the estuary were prepared and submitted under the Council's Rolling Provincial Review by local, state, and federal agency partners. These include proposals for a program to oversee habitat restoration and improvement projects, a monitoring and evaluation program for the estuary, and research in the estuarine and near shore environments. Considering that COE and BPA support for estuary restoration has historically been modest, this comprehensive effort signals our commitment to achieve habitat improvements in this important ecosystem.

Habitat Coordination Initiatives

Also notable for 2001 was the establishment of a Federal Habitat Team (FHT). As part of the Basinwide Salmon Recovery Strategy (All-H Paper) the Federal Caucus agencies agreed to dedicate staff to this team. The Natural Resources Conservation Service (NRCS), though not a Federal Caucus member, is also represented on this team. The FHT's mandate is to coordinate federal efforts to implement the habitat elements of the All-H Paper. Among other tasks, the FHT and Council staff are working to finalize the planning structures for the Council's Subbasin Planning Program and the NMFS and USFWS Technical Recovery Team efforts. This effort directly supports RPA 154, which calls for coordination of federal recovery efforts across non-federal and federal lands.

Habitat Project Accomplishments

This section summarizes the accomplishments of the many projects begun or completed in 2001 to benefit anadromous fish habitat. To emphasize the importance of these achievements in meeting our ESA objectives under the BiOp, they are reported following the same format as in the 1-Year Plan. Specifically, they are organized by strategy, substrategy, province, and subbasin.

Action Agency recovery efforts in 2001 were implemented following our strategies to protect and enhance tributary habitat (Section 3.2.3), improve mainstem habitat experimentally (Section 3.2.4), and protect and enhance estuary habitat (Section 3.2.5). Accomplishments in support of these strategies are briefly described in each section, listed by substrategy. Substrategies promoted improvement in water quantity, water quality, passage and diversion improvements, watershed health, and subbasin planning and assessment. (Appendix C provides a complete listing by strategy and substrategy of the projects and measures funded in FY 2001.)

Strategy 1

Protect and Enhance Tributary Habitat

In 2001, the majority of habitat projects were in the tributaries, with the greatest concentration in the Columbia Plateau province. The Mountain Snake and Blue Mountain provinces also had large numbers of projects.

Substrategy: Water Quantity

Columbia Plateau

- **Yakima Subbasin** — Two projects protected Mid-Columbia steelhead and bull trout. One improved stream flow and passage for Simcoe Creek steelhead; the other increased Naches River in-stream flows by purchasing Wapatox water rights.
- **Deschutes Subbasin** — Two projects were implemented to enhance stream flow. In one, the Deschutes Water Exchange conserved 22 cubic feet water per second for in-stream flows. The other enhanced flow in Trout Creek to protect Mid-Columbia steelhead.
- **Umatilla Subbasin** — The Action Agencies coordinated a flow enhancement effort to benefit fish during critical migration periods.
- **John Day Subbasin** — Two flow enhancement projects were implemented to protect Mid-Columbia steelhead. One supplemented flow in Buck Hollow Creek; the other was the John Day Basin Streamflow Enhancement Project.
- **Walla Walla Subbasin** — Funds were provided to acquire flow in the Touchet River to protect Mid-Columbia steelhead and bull trout.

Blue Mountain

- **Grande Ronde Subbasin** — Action Agency funding enabled seven mainstem flow gauges in the Lostine and Wallowa rivers and Bear Creek to continue operating, part of the Wallowa County/Nez Perce Tribe Salmon Habitat Recovery Plan. Another project helped acquire Lostine River water rights to protect Snake River spring/summer chinook, steelhead, and bull trout.

Mountain Snake

- **Salmon Subbasin** — To protect spring/summer chinook, steelhead, and bull trout, a project was undertaken to transfer Lemhi water users. Action Agency funding was provided to lease water from the Idaho Water Bank to secure flows in the lower Lemhi River during the summer of 2001.

Substrategy: Water Quality

Columbia Plateau

- **Columbia Lower Middle Subbasin** — The Action Agencies supported an assessment of riparian conditions through spectrometric imaging of riparian vegetation. This work provided the basis for submitting TMDLs for the Tualatin River Subbasin and Umatilla River Subbasin to the EPA.
- **Yakima Subbasin** — Two water quality improvement projects were completed with Action Agency assistance: (1) 27 water quality monitoring sites were established at various creeks, diversions,

and tail end spills to measure temperature, dissolved oxygen, suspended sediments, bacteria, pH, specific conductivity, flow, and loading — part of the Yakima Tributary Access and Habitat Program; and (2) trees were planted in riparian areas of the Teanaway Basin and Upper Yakima Basin to reduce water temperatures.

- **Walla Walla Subbasin** — A Walla Walla Basin Watershed Council project to restore river flows was supported, resulting in water quality monitoring and TMDL development.

Substrategy: Passage and Diversion Improvements

Columbia Plateau

- **Yakima Subbasin** — Three passage and diversion projects were implemented. The Action Agencies supported the construction of Yakima Phase II screens at LaFortune/Powell and Wilson Creek/ Bull Ditch diversions. The Action Agencies also supported the Yakima Tributary Access and Habitat Program, which completed shop fabrication, delivery, and field installation for screens, fish bypass systems, and other work for 34 of 66 prioritized BPA Phase II water diversions.
- **John Day Subbasin** — Construction was completed on four permanent diversions, four pumping stations, four infiltration galleries, and one return-flow cooling project. Projects were part of the John Day Watershed Restoration Program of the Confederated Tribes of the Warm Springs Reservation of Oregon.
- **Walla Walla Subbasin** — The Action Agencies supported three projects of the Confederated Tribes of the Umatilla Indian Reservation. In the Walla Walla River, we provided technical support for operating passage and trapping facilities and transport equipment to ensure adequate passage conditions for juveniles and adults. We also partially funded construction of new intake screens for the City of Walla Walla's water supply on Mill Creek, designed the consolidation of Milton Ditch, removed the Marie Dorian Dam, and replaced an existing fish ladder and trap at the Nursery Street Bridge to improve passage for steelhead and bull trout.
- **Umatilla Subbasin** — To increase survival of juvenile and adult migrants, the Action Agencies assisted the Confederated Tribes of the Umatilla Indian Reservation with operations and monitoring of passage facilities, including screen sites, juvenile bypasses, traps, and adult ladders.

Blue Mountain

- **Grande Ronde Subbasin** — As part of the Wallowa County/Nez Perce Tribe Salmon Habitat Recovery Plan, the Action Agencies helped contract for a survey and preliminary design to replace three culverts (fish passage barriers) on Grouse Creek.

Columbia Cascade

- **Methow Subbasin** — To protect Upper Columbia River fish, the Action Agencies funded two projects to: (1) improve passage and restore habitat in Hancock Springs, and (2) install fish screens.

Mountain Snake

- **Salmon Subbasin** — To protect spring/summer chinook, steelhead and bull trout, a project was undertaken to restore passage in the Lower Lemhi/ Salmon Rivers.

Substrategy: Watershed Health

Multi-subbasin

BPA is funding two watershed health projects under the Innovative Project Initiative: (1) a study to identify and characterize habitat diversity in alluvial rivers, and (2) development of water body and aquatic habitat characterization techniques using high-resolution satellite imagery and aerial imagery.

Columbia Plateau (Riparian Improvement Projects)

- **Yakima Subbasin** — The Action Agencies assisted with three projects to improve watershed health: (1) restoration of the riparian corridor at Tapteal Bend on the Lower Yakima River through upland plantings by volunteers, (2) completion of wetland restoration on 1,200 acres and acquisition of an additional 3,000 acres for riparian and wetland restoration, and (3) an assessment of the impact of flow regulation on riparian cottonwood ecosystems.
- **Tucannon Subbasin** — The Action Agencies worked with the Umatilla National Forest to restore cut and fill slopes on Tucannon River roads; and began in-stream restoration at Cow Camp by adding large wood and rock structures to stabilize cutbanks, create pool habitat, and complete riparian plantings.
- **Umatilla Subbasin** — The Action Agencies assisted implementation of the Morrow County Buffer Initiative by the Morrow Soil and Water Conservation District (SWCD). The initiative produced 15 contracts for buffers on 360 acres

(approximately 20 miles). The Action Agencies also helped the U.S. Natural Resources Conservation Service (NRCS) and Morrow SWCD improve watershed health on 177 acres (14 contracts) under the Continuous Conservation Reserve Program and CREP.

- **John Day Subbasin** — Several watershed projects were carried forward with various partners. They included:
  - Establishment of the Columbia Plateau Natural Resources Collaborative, which completed small watershed projects in Buck Hollow, Dry Fork (Heppner), Juniper Canyon (Prineville), and Upper Stage Gulch (Pendleton). The Action Agencies also assisted with improvements on Trout and Willow creeks. Overall performance by NRCS and the conservation partnership to date: 129,470 acres of conservation management systems, 250 acres of buffers, and 69,500 acres of wildlife land improvement.
  - Riparian buffer planning and implementation by the Wheeler Soil and Water Conservation District (4 miles of buffers) and the Gilliam Soil & Water Conservation District (5.5 miles of CREP riparian buffers on 83 acres along designated steelhead habitat streams).
  - Continued work with the Oregon Department of Fish and Wildlife (ODFW) on various riparian habitat improvements.
- **Deschutes Subbasin** — The Action Agencies completed planning and studies for 2002 actions to improve steelhead habitat in a 3-mile reach of Trout Creek by restoring salmonid habitat quality, reducing unnatural bank erosion, and restoring natural channel function and aquatic and riparian biological processes.
- **Umatilla Subbasin** — The Action Agencies helped implement the Umatilla County Conservation Buffer Project, which included: (1) coordinating with the CREP to protect 22,622 acres under 128 contracts; and (2) co-sponsoring the Butter Creek Range and Riparian Enhancement Project, which has so far resulted in improvements to 100,000-plus acres. Improvements include riparian fence, grazing management, off-stream water, stream bank stabilization, animal feeding enhancements, and floodplain reconnection.

Columbia Plateau (Acquisitions and Other Projects)

- **John Day Subbasin** — The Action Agencies supported two projects: (1) acquisition of the Oxbow Ranch remaining 540 acres by the Confederated Tribes of the Warm Springs Reservation, to protect, enhance, and maintain a total of 1,022 acres of riverine, meadow, and forest habitat on the Middle Fork John Day River; and (2) partnering with the ODFW to restore salmonid habitat quality, reduce unnatural bank erosion, and restore natural channel function and associated aquatic and riparian biological processes in 1.2 miles of East Birch Creek.
- **Walla Walla Subbasin** — The Action Agencies supported planning and research for building setback levees to add 10 acres of floodplain along the Walla Walla River near Milton-Freewater, improving conditions for steelhead and bull trout.
- **Deschutes Subbasin** — The Action Agencies aided the Mosier Watershed Assessment and helped coordinate formation of The Dalles Watershed Council in Wasco County, Oregon.
- **Yakima Subbasin** — The Action Agencies funded a Pacific Northwest National Laboratory project to develop a nutrient/food-web management tool for watershed river systems. The laboratory configured and verified a watershed model for the Yakima River Basin.

Blue Mountain

- **Asotin Subbasin** — The Asotin County Riparian Buffer and Couse and Tenmile Creeks Protection Project were funded, resulting in construction of three sediment basins and planting of 29,300 native trees and shrubs on Asotin Creek.
- **Grande Ronde Subbasin** — Approximately 3,000 hardwoods were planted along the Lower Grande Ronde River for a riparian restoration project conducted in partnership with the Vale District and Baker field offices of the Bureau of Land Management. Six riparian flats, encompassing 20 acres, were also planted to reestablish conifers. The Action Agencies also joined the ODFW in supporting the Grande Ronde Basin fish habitat enhancement project restoring 0.5 mile of incised stream to natural channel conditions with improved floodplain connectivity.

Mountain Columbia

- **Coeur d'Alene Subbasin** — The Action Agencies helped the Coeur d'Alene Tribe project to protect, enhance, and maintain wetland and riparian habitat in the Lake Creek drainage as partial mitigation for the impacts attributed to the construction and operation of the Albeni Falls hydroelectric facility.

Mountain Snake

- **Salmon Subbasin** — The Action Agencies assisted the Nez Perce Tribe Department of Fisheries and Resources Management with the restoration and protection of Slate Creek Watershed. Eleven data-loggers were strategically dispersed throughout the subbasin to collect temperature data. Monitoring was conducted to prevent livestock overuse and assist riparian vegetation recovery. A culvert blocking upstream fish passage on Little Van Buren Creek was removed and a culvert was replaced on Royal Creek, to allow up and downstream fish passage.
- **Clearwater Subbasin** — The Action Agencies helped the Nez Perce Tribe rehabilitate the Newsome Creek Watershed on the South Fork Clearwater River. Approximately 170 miles of roads were surveyed, with 5.8 miles slated for decommissioning.

Substrategy: Subbasin Planning and Assessment

Columbia Plateau

- **John Day Subbasin** — In Sherman County, Oregon, the Action Agencies provided technical assistance to help improve upland conservation practices and monitoring on private farms and rangeland. Watershed councils were assisted in Pine Hollow, Grass Valley, Fulton and Gordon canyons, and Mack's Canyon.
- **Columbia Lower Middle Subbasin** — The Action Agencies helped the Oregon Watershed Enhancement Board conduct watershed assessments for priority watersheds on private lands, such as Fifteen-Mile and Tygh creeks.
- **Yakima Subbasin** — The Action Agencies aided the Yakima/Klickitat Fisheries Project. The Yakama Nation coordinated development and submittal of the Columbia Plateau Subbasin Summary for the Yakima Subbasin.

Blue Mountain

- **Grande Ronde Subbasin** — Two subbasin planning/assessment projects were supported: (1) the Action Agencies helped the Northwest Habitat Institute and the Washington Department of Fish and Wildlife establish a baseline for key ecological functions of fish and wildlife for subbasin planning, and (2) the Nez Perce Tribe received assistance securing a watershed restoration planner.
- **Asotin Subbasin** — The Action Agencies helped the Asotin County Conservation District complete its Asotin Creek Subbasin Summary.

Mountain Snake

- **Clearwater Subbasin** — To facilitate three subbasin planning/assessment projects, the Action Agencies: (1) worked with the Lewis Soil Conservation District to improve steelhead trout habitat in Lawyer Creek, (2) helped the NRCS complete a Little Canyon Creek Watershed Assessment, and (3) supported a project by the Clearwater Focus Program of the Idaho Soil Conservation Commission to coordinated subbasin summary review and distribution. The Action Agencies also supported development of the Clearwater Subbasin Focus Watershed Program by the Nez Perce Tribal Fisheries/Watershed Program, including completion of the final draft Clearwater Subbasin Summary.
- **Salmon Subbasin** — The Action Agencies aided restoration work on the Yankee Fork Salmon River by the Custer Soil and Water Conservation District and the Idaho Governor's Office of Species Conservation. This included U.S. Geological Survey analysis of heavy metal impacts within the Yankee Fork watershed.

Strategy 2

Improve Mainstem Habitat Experimentally

In 2001, mainstem habitat improvement was addressed through research projects and the restoration of tributary and mainstem habitat for Columbia River chum salmon.

Substrategy: Water Quality

In 2001, the Action Agencies worked to lower total dissolved gas at Bonneville, The Dalles, Little Goose, Lower Granite, Lower Monumental, and McNary dams; and conducted a temperature control project at McNary.

Substrategy: Watershed Health

Columbia Plateau

- **Columbia Middle Lower Subbasin** — A study investigated the feasibility of restoring a riprap levee near Pasco, Washington, with shallow water, small substrate, and riparian vegetation. The Action Agencies also initiated a study on improving aquatic and terrestrial habitat on a 2-mile stretch of the Columbia River north shore near Pasco.

- **Columbia Lower Subbasin** — The Action Agencies began two projects to: (1) enhance spawning habitat in an area historically used by chum salmon in Duncan Creek, and (2) re-establish 14.3 miles of historical salmonid habitat and provide an isolated bull trout population access to the mainstem Columbia. Improvement of spawning conditions in 2001 included work to accommodate chum spawning below Bonneville Dam.

Substrategy: Subbasin Planning and Assessment

Columbia Plateau

- **Columbia Lower Subbasin** — The Action Agencies funded studies of chum salmon limiting factors and the relationship between Columbia River and tributary chum salmon populations. Research in 2001 included investigations of chinook and chum spawning populations below each of the four lowermost mainstem Columbia River dams and the size of each population, if present.

Strategy 3

Protect and Enhance Estuary Habitat

RPAs 158–163 call for habitat protection, enhancement, and RM&E in the Columbia River estuary. There were five major estuary efforts in 2001: inventory, research, restoration, demonstration projects, and a June 2001 Estuary Workshop.

Substrategy: Watershed Health

Columbia River Estuary

- **Columbia Estuary Subbasin** — LCREP and the Action Agencies began the estuary habitat inventory process called for in RPA 158. The Action Agencies also funded several research projects in the estuary identified by the NMFS Science Center and others on salmonid use of the estuary, relevant estuary characteristics, salmon survival through the estuary, and effects of the hydropower system on estuary characteristics. These efforts are part of a multi-year research program to increase knowledge of the estuary and its relationship to salmon and steelhead survival.

  The Action Agencies also started work with LCREP and others to identify near-term estuary habitat enhancement/protection projects that will provide clear benefits for listed fish as a comprehensive restoration plan is developed. What we learn from these projects will aid research and future actions for all estuary RPAs. The projects will likely include wetland acquisition, wetland restoration, dike removal, and the identification of existing habitat needing greater connectivity.

- **Columbia Lower Subbasin** — In 2001, COE began a "general investigation" study of the Columbia River from river mile 0 to 145. The results of this study will underpin future feasibility studies and estuary improvement projects requiring cost-share partners. This study will also inform actions under the new COE authority, Section 536 of the Water Resource Development Act of 2000, authorizing cost-shared projects to protect, monitor, and restore fish and wildlife in the Lower Columbia and Tillamook estuaries. This 10-year program is being coordinated with NMFS, LCREP, and local interests.

Substrategy: Subbasin Planning and Assessment

Columbia River Estuary

- **Columbia Estuary Subbasin** — In June 2001, COE, LCREP, and American Rivers jointly sponsored an Estuary Workshop on protection, enhancement, research, and related activities. Workshop participants developed criteria and set priorities for restoration. The proceedings of this workshop were submitted to NMFS, and will serve as the basis for developing implementation and research plans for the estuary. The findings have also been informative to Action Agency efforts under RPA 150 to develop general criteria for identifying habitat priorities.

  The workshop also addressed the need to synchronize efforts with the Council's subbasin planning efforts for the Columbia River Estuary. The Action Agencies assisted in obtaining Council approval for LCREP participation in the subbasin planning process for the Columbia River estuary, to take advantage of LCREP's expertise.

Variances and Modifications

Variances and modifications in habitat measures compared to the 2000 NMFS BiOp are discussed in Section 4.0.

C. Hatcheries

Artificial Propagation

In 2001, the Action Agencies supported a unified regional approach using artificial production to help meet fish recovery objectives and support treaty obligations. The first year's implementation of the artificial propagation measures in the NMFS BiOp focused on planning and coordination activities. To that end, the Action Agencies:

- Began funding the four-step planning process of the Safety-Net Artificial Propagation Program (RPA 175).
- Began the planning process to develop new or updated Hatchery and Genetic Management Plans (HGMPs) to guide hatchery reform and aid recovery of listed stocks (RPA 169).
- Initiated the regional planning and coordination required for development of a comprehensive marking plan (RPA 174).
- Continued to operate FCRPS mitigation hatcheries in 2001 that contribute to tribal and other harvest of salmon and steelhead.

Implementation of these actions has been, and will continue to be, a major regionwide undertaking, requiring substantial coordination with state and federal fishery managers, tribes, the Council, and other entities. Consequently, it will require more time to complete the actions than originally contemplated by NMFS in its BiOp.

Strategy 1

Implement Safety-Net Program

BPA initiated the Safety-Net Artificial Propagation Program (SNAPP) in 2001 by working with NMFS and the USFWS to scope out and determine how best to implement the program over the next few years. The scoping effort resulted in BPA funding a SNAPP coordinator to facilitate the program's four-step planning process. The SNAPP coordinator convened an oversight group composed of the relevant parties (states, tribes, NMFS, USFWS, and BPA) to help implement the program. That group determined the initial list of 10 safety-net populations identified in RPA 175 that should receive additional scrutiny and developed a new list of 38 populations that will proceed to the first step of planning process — extinction risk analysis — to identify candidate populations for intervention.

BPA also continued to support ongoing safety-net artificial propagation programs designed to prevent extinction of critically depressed populations of ESA-listed Snake River salmon. Major safety-net programs funded under the Columbia River Basin Fish and Wildlife Program include:

- A captive brood stock program for Lostine River, Catherine Creek, and Upper Grande Ronde River spring/summer chinook salmon populations in Oregon. Fish are reared at NMFS' Manchester, Washington, Laboratory; the captive broodstock facility at Bonneville Hatchery; and Lookingglass Hatchery.
- A captive rearing program for Lemhi River, East Fork Salmon River, and West Fork Yankee Fork Salmon River spring/summer salmon chinook in Idaho. Fish are reared at the Eagle Hatchery and Manchester Laboratory.
- A captive brood stock program for Tucannon River spring/summer chinook salmon in Washington at Tucannon Hatchery and Lyons Ferry Hatchery.
- A captive brood stock program for Snake River (Redfish Lake, Idaho) sockeye salmon. Fish are reared at Eagle Hatchery, Burley Creek Hatchery (NMFS), Sawtooth Hatchery, and Bonneville Hatchery.

Additional ongoing and planned Columbia River Basin Fish and Wildlife Program safety-net programs are listed in the BPA Hatchery Projects table in Appendix C.

Strategy 2

Implement Hatchery Reform

In 2001, the Action Agencies initiated the development or updating of HGMPs to identify opportunities to reduce potentially harmful hatchery practices and/or aid recovery through hatchery reforms. This HGMP planning process will allow us to determine whether a hatchery or facility can contribute to recovery of listed species through the modification of existing practices or facilities. Proposals for HGMP development at Lower Snake River Conservation Plan (LSRCP) hatcheries in Idaho, Washington, and Oregon were submitted to the Council's 2001 Provincial Review process for BPA funding. Development of HGMPs for the Leavenworth National Fish Hatchery complex (Leavenworth, Entiat, and Winthrop hatcheries) began in 2001. The development of HGMPs for all remaining federally-funded anadromous fish hatcheries within the FCRPS will be initiated in 2002.

C. Hatcheries

Artificial Propagation

In 2001, the Action Agencies supported a unified regional approach using artificial production to help meet fish recovery objectives and support treaty obligations. The first year's implementation of the artificial propagation measures in the NMFS BiOp focused on planning and coordination activities. To that end, the Action Agencies:

- Began funding the four-step planning process of the Safety-Net Artificial Propagation Program (RPA 175).
- Began the planning process to develop new or updated Hatchery and Genetic Management Plans (HGMPs) to guide hatchery reform and aid recovery of listed stocks (RPA 169).
- Initiated the regional planning and coordination required for development of a comprehensive marking plan (RPA 174).
- Continued to operate FCRPS mitigation hatcheries in 2001 that contribute to tribal and other harvest of salmon and steelhead.

Implementation of these actions has been, and will continue to be, a major regionwide undertaking, requiring substantial coordination with state and federal fishery managers, tribes, the Council, and other entities. Consequently, it will require more time to complete the actions than originally contemplated by NMFS in its BiOp.

Strategy 1

Implement Safety-Net Program

BPA initiated the Safety-Net Artificial Propagation Program (SNAPP) in 2001 by working with NMFS and the USFWS to scope out and determine how best to implement the program over the next few years. The scoping effort resulted in BPA funding a SNAPP coordinator to facilitate the program's four-step planning process. The SNAPP coordinator convened an oversight group composed of the relevant parties

Map 2 — Action Agency Funded Anadromous Fish Production Facilities and Anadromous/Resident Fish Conservation Hatcheries

- Eleven LSRCP hatcheries (Dworshak [chinook program], Lookingglass, Lyons Ferry Complex [Lyons Ferry and Tucannon], Clearwater, Magic Valley, McCall, Sawtooth, Irrigon, Wallowa, and Hagerman hatcheries).
- Eight COE hatcheries (Dworshak [steelhead program], Bonneville, Spring Creek, Leaburg, McKenzie, Marion Forks, South Santiam, and Willamette hatcheries).
- Three Reclamation hatcheries (Leavenworth, Entiat, and Winthrop hatcheries).

BPA also continued to fund experimental and production hatchery facilities under the Council's Columbia River Basin Fish and Wildlife Program. Major facilities in operation in 2001 included the Umatilla Hatchery and the Cle Elum Supplementation and Research Facility (Yakima Hatchery). Construction of the Nez Perce Tribal Hatchery facilities continued in 2001.

Variances and Modifications

Variances and modifications in hatchery measures compared to the 2000 NMFS BiOp are discussed in Section 4.0.

D. Harvest

The Action Agencies initiated harvest reform measures in 2001 to begin addressing the five RPA actions contained in the BiOps and identified in the 1-Year Plan. The goal of the Action Agencies' harvest strategy is to benefit listed species through implementation of harvest actions while enabling continued harvest by tribal and non-tribal entities.

Consistent with the four implementation strategies listed in this section, the Action Agencies initiated two new projects, including the tangle-tooth net program, and continued two existing projects, such as the gill net exchange program. Compared to other categories in the BiOps, there are relatively few harvest RPAs (5) and harvest projects (14). Most projects are related to either selective fisheries or RM&E, and nearly all are systemwide or multi-basin in geography.

Last year, BPA purchased more than $300,000 worth of new, larger mesh nets for tribal fishers to allow more ESA-listed steelhead through the Zone 6 fishery. It has not yet been reported how many of the nets were used last year. During the previous season, about one-third of the more than 600 nets in the tribal fishery were of the larger mesh variety.

Strategy 1

Develop Fishing Techniques to Enable Fisheries to Target Non-listed Fish While Reducing Harvest-related Mortality on ESA-listed Species

In 2001, BPA funded gear efficacy testing studies of tangle-tooth net and trawl gear to determine their potential for reducing mortality of ESA-listed salmonids in the non-treaty spring and fall fisheries downstream of Bonneville Dam. This effort will compare the impacts of capture and release from tooth-net versus trawl gear on immediate and short-term mortality of spring chinook. The nets were effective at catching salmon, but data are not yet available on survival of released fish.

BPA also continued to study the effectiveness of the Tribal Gillnet Exchange Program in Zone 6. Here the larger 9-inch-mesh gill nets were provided to facilitate escape of larger listed steelhead. The Action Agencies will report on this and other planned tests (on fish wheels, traps, and weed-line modifications on set-nets) next year. Through coordination with NMFS and the salmon managers, BPA will develop a prioritized list of gear types and associated mortalities for consideration in future years (RPA 164).

Strategy 2

Improve Harvest Management Assessments, Decisions, and Evaluations

The Action Agencies funded a feasibility study above Bonneville Dam in 2001 to determine the existence and impact of lost fishing nets. Lost nets may play a role in adult salmon losses in the mainstem. Project personnel are currently adapting and calibrating side-scan sonar technology to identify net materials to enable field implementation in early 2002.

Strategy 3

Support Sustainable Fisheries for the Meaningful Exercise of Tribal Fishing Rights and Non-tribal Fishing Opportunities Consistent with the Recovery Effort

In 2001, the Action Agencies continued the Columbia River Terminal Fisheries Project for chinook and coho in Youngs Bay and other sites in the lower river below Bonneville Dam. The goal of the project is to determine the feasibility of creating and expanding terminal, known stock fisheries in the Columbia River

Basin to allow harvest of strong anadromous salmonid stocks while providing greater protection to depressed fish stocks. In addition, the Action Agencies began scoping the potential for developing similar sites in tribal management Zone 6, including Little White Salmon and Klickitat rivers, and in Eagle Creek above Bonneville Dam.

E. Resident Fish

There were approximately 15 ongoing projects in 2001 that supported the USFWS BiOp for Kootenai River white sturgeon and bull trout. Some projects that are reported under the hydrosystem category also benefited white sturgeon and bull trout. Additional new projects and objectives that target BiOp requirements were solicited by COE and BPA and have been recommended for funding beginning in FY 2002. Water management and project operations conformed to BiOp requirements and schedules, except when precluded by the exceptionally low runoff (e.g., Libby spill test).

Strategy 1

Promote the Reproduction and Recruitment of Kootenai River White Sturgeon

Our strategy for Kootenai River white sturgeon is to improve the population's ability to produce juveniles and to help ensure that those progeny grow and ultimately mature. Two substrategies address this. The first is to identify the factors limiting natural production and survival of juvenile sturgeon to age one and, to the extent possible, manage the Kootenai River to overcome those limitations. One of those studies, the Libby spill test, did not occur as scheduled in 2001 due to the low water conditions. However, other studies continued or were initiated in 2001, including:

- Initiation of an EIS process for implementing VarQ at Libby. The "variable discharge" formula (VarQ) is intended to improve the annual refill potential of Hungry Horse Reservoir and Lake Koocanusa, better positioning them to provide higher flows for threatened fish species in late spring and summer.
- Evaluation of flood levels along the banks of the Kootenai River below Libby Dam.
- Commencement of studies of sturgeon spawning substrates and nutrient enrichment (via mesocosms) at and downstream of Bonners Ferry, Idaho.

The second substrategy is to continue producing families of juveniles through the Kootenai River white sturgeon conservation hatchery program. This program, begun in 1991, will continue until viable adults are no longer available for brood stock.

Strategy 2

Determine the Impacts of the FCRPS on Bull Trout and Corrective Actions

This bull trout strategy encompasses three substrategies. The first — a focus in 2001 — is to determine the extent to which bull trout use and are affected by FCRPS dams and reservoirs. For example, in 2001 we:

- Studied the effects of water withdrawal from Dworshak Reservoir on bull trout distribution in the North Fork Clearwater Drainage.
- Developed lists of FCRPS dams that will be priorities for studying bull trout passage and entrainment.
- Continued to study the production of kokanee (bull trout forage species) in Lake Pend Oreille, including winter operation at 2,053-foot elevation, as part of an experiment to provide kokanee access to clean shore gravels for spawning.
- Conducted several other studies that benefit bull trout beyond BiOp requirements.

Results of these studies will help determine whether and how much mitigation would be appropriate and the performance standards that might be applied to mitigation efforts.

The second bull trout substrategy is to operate and modify FCRPS dams to protect, provide, and reconnect bull trout habitats. We implemented protective measures in 2001 in areas where the link between the FCRPS and the welfare of bull trout is already relatively clear, including ramping rate and minimum flow constraints at Hungry Horse and Libby dams. Despite the drought, minimum flow levels were provided to aid bull trout in the Kootenai and Flathead rivers on all but 15 days.

Development of performance standards — the third bull trout substrategy — is scheduled to begin in 2002.

Variances and Modifications

Variances and modifications in resident fish measures compared to the 2000 NMFS BiOp are discussed in Section 4.0.

F. Research, Monitoring, and Evaluation (RM&E)

The BiOps call for a RM&E program to support annual progress reporting and multi-year check-in evaluations, and in the long-term to demonstrate that mitigation efforts are effective. RM&E projects provide information for these check-in assessments and also provide information for the annual planning, prioritization, and adaptive management of mitigation actions called for in the BiOp. The current structure for managing project planning and implementation identifies three primary strategies or categories for RM&E:

- **Status Monitoring** — Projects that help assess the condition or trend of Evolutionarily Significant Unit (ESU) populations and key environmental attributes relative to performance targets.
- **Effectiveness Monitoring** — Projects that help assess the expected benefits of different categories of hydro and offsite mitigation actions called for in the BiOp.
- **Critical Uncertainties Research** — Projects that help resolve or reduce key uncertainties in assessments of the survival and recovery requirements of the ESUs.

In 2001, projects related to RM&E RPAs in the BiOps involved monitoring the effectiveness of recovery actions, status monitoring, and critical uncertainties. Six of the nine projects selected for implementation under the 2001 Innovative Project Initiative (see Section 3.2.1.2) were RM&E projects: two involving subbasin planning and assessment and four involving watershed health.

Also during 2001, the Action Agencies and NMFS developed a proposed structure for a comprehensive RM&E program that will help assess the effect of mitigation actions. An Action Agency and NMFS RM&E Oversight Workgroup was formed and took initial steps to develop a program plan that satisfies monitoring needs expressed in the BiOp and is compatible with needs of the Council's Fish and Wildlife Program and subbasin planning. This work will help identify appropriate funding levels and coordination relative to already established state and federal monitoring programs.

Although BiOp implementation plans were not finalized until late in 2001, a majority of 2001 RM&E projects were already set in motion. The severe water shortage provided opportunities to evaluate conditions not normally seen, but also caused many planned programs to be modified.

Appendix A provides a complete listing of CRFM studies funded in FY 2001.

Strategy 1

Status Monitoring

Projects grouped under this strategy address RPA requirements to provide or support status information on adult and juvenile fish abundance, distribution, and survival, or environmental conditions that have been identified as key measures of fish performance. In 2001. Status-monitoring projects included:

- Monitoring adult and juvenile migration at Columbia and Snake River dams. These projects included ongoing programs such as the PIT tagging and monitoring program and the hatchery marking program.
- Determining the effectiveness of the first in-ladder adult PIT tag detection system at Bonneville Dam's Washington-shore ladder. McNary was evaluated for feasibility of installation.
- Monitoring Snake River fall chinook emergence and migration timing.
- Developing a small-stream prototype PIT tag detection system as part of the Innovative Projects solicitation.
- Additional water temperature monitoring in the McNary Dam forebay and the Lower Granite reservoir to provide information on baseline environmental conditions to which salmon are exposed during migration. This information will be used to develop a three-dimensional model.
- Project planning for a status monitoring program for the John Day basin.
- Project planning to evaluate the relationships between estuary, plume, and near-shore ocean conditions and juvenile salmon growth and survival.
- Development of a draft report that identifies data collection protocols and approaches to monitor tributary habitat indicators, performance standards, and measurement methods. The approach may be suitable to broad scale status monitoring of certain habitat indicators.
- Developing data and analyses to address juvenile and adult use of the estuary, plume, and near-shore ocean, including associated physical and biological conditions and predation.

Strategy 2

Effectiveness Research

Projects under this strategy address RPA requirements to provide or support information on the physical and biological responses of hydrosystem and offsite mitigation actions. Studies performed or initiated in 2001 evaluated:

- The effects of limited spill, low flow conditions, and higher summer temperatures on passage and survival of adults through the hydrosystem. Estimates of unaccounted loss were also evaluated during a year with high adult returns. This was the second year for evaluating passage routes and success for kelts moving through the hydrosystem.
- Use of forebay guidance mixers to reduce temperatures in localized areas where fish hold in the McNary forebay.
- Spillway conditions at The Dalles Dam, to isolate what causes higher than normal spillway mortality conditions.
- The potential for increased mortality of fish passing though one or more bypass systems.
- The effect of simulated Wells Inserts on the fish guidance efficiency of extended bar screens at Lower Granite Dam.
- The influence of the estuary on juvenile survival. Initial work included setup of index sites for evaluation of juvenile abundance and timing in the estuary and development of a new sonic tag that will allow us to attribute mortality of known source fish as they pass through the estuary and through the salt water intrusion zones.
- Effectiveness of the Northern Pikeminnow Management Program.
- Predation on juvenile salmonids using the PIT tag recovery from avian islands in the estuary, to identify "hot spots" of avian predation in the migration corridor.
- Summer and fall chinook spawning, incubation, growth, out-migration timing, and survival, to determine recovery and restoration potential through supplementation in the Clearwater, Grande Ronde, Salmon, and Imnaha rivers.
- The effects of supplementation and hatchery management practices on wild fish production and genetics.
- The effectiveness of reconditioning wild steelhead kelts.
- The impact of steelhead and chinook adult outplantings on wild populations.
- The effectiveness of captive brood stock alternatives.
- Different "separator concepts" to improve separation of juvenile chinook from steelhead for transport. Separation of species may reduce levels of stress for wild chinook during transport and lead to lower delayed mortality. Studies of an existing prototype separator at Ice Harbor and a new operational separator at McNary will help design a new juvenile fish bypass facility planned at Lower Granite Dam.

Another project involved developing scopes of work and proposal requests for tributary projects addressing the effectiveness of diversion dam removals, water augmentation, and diversion screens.

Strategy 3

Critical Uncertainties

Projects implemented under this strategy focus on RPA requirements to address large, systematic research needs and identify improvements in analytical methods required for more robust and confident assessments of population extinction risks, probabilities of recovery, and needed survival improvements for each ESU. A key first step was taken in 2001 by identifying critical uncertainties in the BiOp assessments of population survival requirements. These uncertainties are summarized in the following box, as well as in the draft 5-Year Plan.

Projects initiated in 2001 focused on three critical uncertainties: (1) differential delayed mortality of transported fish relative to in-river migrants, (2) in-river juvenile passage survival, and (3) adult passage survival. These projects were the subject of targeted research under the COE Anadromous Fish Evaluation Program. Research on juvenile passage survival includes the uncertainty of different dam passage route histories relative to health and delayed mortality. As part of additional research efforts on delayed mortality, the Action Agencies initiated studies for implementation in 2002 to evaluate the feasibility of using acoustic tags to estimate survival below Bonneville Dam and through the estuary. Studies already begun in 2001 focused on evaluating:

- Use of cool water corridors and refugia during the upstream migration of steelhead and fall chinook. A component of this evaluation was to determine the potential benefits of cool water releases from Dworshak on adults salmon migration.

- Comparative differences in the homing and straying of adult fish with known juvenile passage histories and sites of origin.
- Differences in physiological responses (including cumulative stress) between hatchery and wild chinook and steelhead that are transported and those passing multiple dams.
- Differences in migration behavior of post-release transported fish versus in-river migrants, and how that may affect chances of survival (travel time, predation rates, and migration routes) in the estuary and near-shore ocean environment. Steelhead and fall chinook were radio-tracked from Bonneville Dam or the transport release location through the upper estuary to the saltwater interface. Information from this study will help improve transportation programs; identify problem areas in the estuary; and provide travel times, holding, and survival rates.

Some initial project development was also performed in 2001 to address the critical uncertainties of: (1) the reproductive success of naturally spawning hatchery fish relative to wild spawners, and (2) delayed mortality of in-river migrants. Alternative research approaches have been identified for both of these uncertainties and will be used for developing requests for proposals and projects in 2002.

Critical Uncertainties from BiOp Population Assessments that Require Targeted Research

1. **Hatchery Spawner Effectiveness**
   Determination of the true population status of hatchery fish spawning in the wild, and survival improvements needed, depends on reducing the uncertainty of their reproductive success in the wild.
2. **Differential Delayed Mortality of Transported Fish (D Value)**
   The D value is the estimated ratio of the post-Bonneville survival of transported fish relative to in-river migrating fish. The wide range of values estimated for D, and the potential spatial and temporal variability that are not fully understood, necessitate obtaining better information on D.
3. **Extra (Delayed) Mortality of In-river and Transported Fish**
   Extra mortality (EM) was first conceived in the Snake River Plan for Analyzing and Testing Hypotheses (PATH) process to explain the additional mortality reflected in the historic time series of spawner-recruitment data that could not be explained by other variables in life-cycle models. Resolving the uncertainty about sources of EM is critical before a decision can be made to remove dams, to have any confidence that this action would have a significant benefit.
4. **Effects of Reservoir Operation on White Sturgeon and Bull Trout**
   Reservoir operations' effects on the production of bull trout and white sturgeon is largely unknown. Information is needed to identify the trade-offs between resident fish and anadromous fish mitigation options.

G. Coordination

Implementation Planning and Coordination with States and Tribes

In 2001, the Action Agencies placed a high priority on developing the first 5- and 1-year implementation plans as required by both the NMFS and USFWS BiOps. By Feb. 7, we completed an outline of the 2002-2006 Implementation Plan and discussed it in detail with NMFS, USFWS, the NMFS Regional Forum Implementation Team (IT) and other regional players. To share the initial approach with key regional players and potential partners, the outline was also mailed to states and tribes and posted on the www.salmonrecovery.gov website. Informal discussions with NMFS, USFWS, Council, tribes, cultural resources program managers, state representatives, and others continued throughout the spring. In May, the Action Agencies shared a revised structure and approach, as well as an initial draft of the performance standards chapter, with the IT and others.

The first draft 5-Year Plan, Endangered Species Act Implementation Plan for the Federal Columbia River Power System (2002–2006), was published as a draft in July 2001 and circulated to states and tribes for review and comment. It provides a conceptual foundation and management framework the Action Agencies can use to coordinate RPA recovery actions and measures. Advance copies were e-mailed to states and tribes on July 20, followed by a hardcopy mailing on July 27 and a public posting on the salmon recovery website on July 31. (A formal state and tribal comment period was extended from Sept. 7 to Sept. 28.) Regional federal executives then met with their state and tribal counterparts on August 1 to discuss the 5-Year Plan. From that meeting a state, tribal, and federal "steering committee" was formed. The steering committee was tasked to identify policy level issues and prepare agendas for future regional executive meetings, which occurred on Oct. 19 and Dec. 6.

The draft 5-Year Plan was formally submitted to NMFS and USFWS in August. Because regional discussions continue to focus on it, the plan remains in draft form. The Action Agencies intend to incorporate appropriate changes into the next 5-year implementation plan for 2003–2007. We anticipate releasing drafts of the 2003–2007 plan and 2003 1-year plan in summer 2002. Final versions of these two documents are scheduled for delivery to NMFS and USFWS in September 2002.

The 1-Year Plan, Endangered Species Act 2002 Implementation Plan for the Federal Columbia River Power System, was released in November 2001. Advance electronic copies of the document were e-mailed to states and tribes on November 6; hardcopies were mailed the next week. Final copies were posted on the salmon recovery website for public viewing on November 15. The Action Agencies officially submitted the 1-Year Plan and supplemental material to NMFS and USFWS on Nov. 13.

NMFS will consider the 1- and 5-Year Plans and this 2001 Progress Report to prepare its annual findings on Action Agency BiOp implementation. The findings letter is scheduled to be issued 45 days after receipt of the above three documents.

Coordination with NMFS Regional Forum

In addition to discussing the draft 1- and 5-Year Plans with IT, and the 2002 Water Management Plan with the Technical Management Team, the Action Agencies coordinated with the NMFS Regional Forum teams throughout the power emergencies in the winter, spring, and summer of 2001, including:

- Sharing draft principles and analyses directly with IT.
- Executive meetings with states and tribes.
- Formal comment periods seeking comments and input from states, tribes, and other regional stakeholders.

Coordination for Offsite Measures

Extensive coordination with state, tribal, and local entities occurred for offsite measures through the Council's Provincial Reviews and solicitation processes. The Action Agencies also use the Federal Caucus and the Federal Habitat Team to coordinate with their federal partners. LCREP provides for coordination of estuary activities.

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4.0 Variances and Modifications from the 2000 Biological Opinions

During 2001, the Action Agencies sometimes found it necessary to make adjustments to implementation of certain RPA actions. Those variances and modifications are noted in this section.

In 2002, the Action Agencies plan to continue overall implementation of BiOp measures and to address these changes to ensure actions stay on track to meet BiOp expectations.

A. Hydrosystem Variances and Modifications

John Day Spill Evaluations (NMFS RPA Action 71)

Due to drought conditions and the power emergency, COE was not able to implement the 24-hour spill evaluation in 2001.

John Day Spillway (NMFS RPA Action 72)

COE delayed development of the removable spillway weir (RSW) at John Day in 2001, at the request of a Fish Facility Design and Review Work Group (FFDRWG) subgroup working on physical hydraulic models at the Waterway Experimental Station (WES). That group made its recommendation based on recently identified concerns relating to tailrace juvenile egress survival.

The current plan is to begin tests in 2002 to evaluate juvenile egress at spill levels lower than that currently prescribed. Two seasons of evaluations are anticipated to be required prior to RSW prototype installation and testing. The direction of the RSW/skeleton bay program will continue to be discussed over the course of 2002 and as data from the egress tests becomes available.

Lower Monumental (NMFS RPA Action 99)

Because evaluation of a RSW at Lower Granite was deferred from 2001 to 2002, an analysis comparing the relative passage survival benefits of replacing existing screens with a RSW surface-bypass system at Lower Monumental will not be completed by January 2003 as asked. At least 2 years of evaluation of the RSW at Granite are necessary before we can be confident that the information is of value to the analysis at Lower Monumental. This requirement will defer completion of the Lower Monumental passage analysis until January 2004.

VarQ at Libby (USFWS 8.1.b and d; NMFS RPA Action 22)

Although scoping and hydrologic studies got underway in FY 2001–2002, the timeline for preparing a planned environmental impact statement (EIS) and underlying environmental impact analysis were not consistent with implementation of VarQ for the 2002 fish migration season as called for in the BiOps. However, COE and the other Action Agencies, in coordination with NMFS and USFWS, are considering interim implementation of VarQ beginning in 2003. Plans include: (1) completing a spill test at Libby in June 2002 to study spill/dissolved gas relationships, (2) completing hydrologic studies for a new VarQ operation and coordinating with Canada on this new operation in 2002, (3) reviewing recently collected information on contaminant levels in sediments at Grand Coulee Dam, and (4) completing NEPA documentation sufficient to make an interim decision. A decision on whether to proceed with an interim VarQ operation will be made in December 2002.

B. Habitat Variances and Modifications

Reclamation High Priority Subbasins (NMFS RPA Action 149)

Reclamation's approach to accomplish stream flow, screening, and barrier projects in high-priority subbasins follows the intent of the RPA, and consequently will rely on the planning processes for subbasin assessment and plans established under the Council's rolling Provincial Review. As noted in the Progress Report, Reclamation will initiate programs in at least three subbasins per year for 5 years, until a total of 16 subbasins identified in the Basinwide Recovery Strategy are being addressed. However, since subbasin assessments and plans will not be completed under the Council's process during the first few years of this effort, Reclamation will rely on other indicators to establish priorities for project selection in the subbasins. Indicators include the following: barriers that are currently accessible but block additional access to upstream spawning and rearing areas, unscreened diversions in areas that are currently accessible to fish, and stream flow areas so dewatered that they provide barriers to passage. Once the Council's subbasin plans are available, Reclamation will adopt those plans for development of project selection criteria.

Long-Term Habitat Protection (NMFS RPA Actions 150 and 153)

These RPA actions call for BPA and NMFS to develop criteria and priorities for identifying habitat projects by June 1, 2001. However, since issuance of the BiOp and through ongoing discussion between NMFS and BPA, the agencies decided development of priority criteria for global application to the overall habitat program would better serve recovery efforts. BPA and NMFS have developed a set of draft priority criteria that will be further refined by COE and Reclamation. The agencies plan to finalize these criteria by June 1, 2002, apply them for an interim period of 12 to 18 months, and then modify them based on public input, peer review, and our experience in applying them. This modification to the schedule will not reduce the effectiveness of the RPA.

Water Strategy (NMFS RPA Action 151)

As required by this action, BPA has begun establishing a water brokerage to initiate a trial round of water solicitations. However, a methodology to ascertain in-stream flows that meet ESA requirements has yet to be developed. Because BPA expects to develop an acceptable methodology as monitoring and evaluation occurs for the various water acquisition projects, the modified schedule will not significantly reduce the effectiveness of the RPA.

C. Hatchery Variances and Modifications

HGMP Development (NMFS RPA Action 169)

Implementation of this action is a major regionwide undertaking, requiring substantial coordination with state and federal fishery managers, tribes, the Council, and other entities. Consequently, it will require more time to complete the actions than originally contemplated by NMFS in its BiOp.

Fish Marking (NMFS RPA Action 174)

For logistical and other reasons, completion of the comprehensive marking strategy will not occur by the end of 2001, requiring a change in the schedule specified in the RPA. Because the Action Agencies expect the plan to be completed early in 2002 to guide necessary marking programs beginning in

mid- to late 2002, this delay will not have substantial impact on the success of the RPA over the long term.

Safety Net Hatchery Program (NMFS RPA Action 175)

Implementation efforts so far suggest two modifications of this RPA are necessary. First, the list of initial populations that should be subjected to the safety net analyses may change. Second, the four-step planning process for the initial list of populations cannot be completed by the end of 2001 as specified in the RPA.

The Action Agencies believe the revised list of initial SNAPP populations will result in a materially better implementation of the SNAPP program than that envisioned in the RPA. The short delay in completing the planning phase for the initial populations (required to revisit the initial list) should not negatively affect the program, particularly since 2001 turned out to be a favorable return year for Snake River adult salmon and steelhead.

D. Resident Fish Variances and Modifications

VarQ at Libby (USFWS 8.1.b and d)

See explanation under Hydrosystem Variances and Modifications.

Libby Spill Test (USFWS 8.2.a.1, 3 and 7)

The spill test at Libby could not be conducted in 2001 due to lack of water and has been rescheduled for 2002. Therefore, schedules for the following dependent actions have slipped:

- **8.2.a.1** — The spill test was planned for FY 2001, but very low water conditions prevented Lake Koocanusa from reaching spill elevations, making it impossible to conduct a spill test. The spill test is planned for June 2002 as part of the VarQ EIS, assuming that there is adequate water and completion of appropriate NEPA analysis for the spill test itself.
- **8.2.a.3** — This action cannot be executed in FY 2002. Regular use of the spillway depends on conducting the spill test in spring 2002 to determine the total dissolved gases (TDG) percent as a function of varying spill, and on the integrity of the spillway itself. Assuming that the spill test results in TDG values not considered harmful to aquatic biota, the spillway may then need to undergo extensive surface repair and reinforcement. The earliest this work can be completed is FY 2004.
- **8.2.a.7** — This action requests that COE determine the feasibility of using the Libby spillway to provide an additional flow of 5,000 cfs by Dec. 30, 2001. Because the spill test has now been deferred for two consecutive years, however, this determination cannot be made until the spring of 2002. Then, as noted above, the spillway would need extensive repairs, which would be completed sometime in 2004.

Temperature Modeling (USFWS 10.7)

We have verbal confirmation from the USFWS that the inclusion of Libby and Hungry Horse in this BiOp action was an error. However, as it is in the BiOp, it remains a requirement. Through the 2002 1-Year Plan, the Action Agencies request the USFWS to formally acknowledge in writing (i.e., in a findings letter) that the reference to Libby and Hungry Horse is in error, and formally delete the reference in the BiOp to Libby and Hungry Horse dams under Snake River temperature control.

Bull Trout Studies (USFWS 11.A.2.1.c)

The Action Agencies intend to pursue this action, but will seek clarification both on the scope of the studies for which bull trout observations will be reported and on the reporting process. For example, the action does not specify its geographic scope, although it is in the terms and conditions for the Lower Columbia River.

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5.0 Conclusions and Adaptive Management

On the whole, implementation of ESA fish measures throughout the FCRPS is on track and expected to meet 2003 benchmarks. Although some difficulties were experienced in 2001, we took hundreds of steps to further fish survival — both planning efforts and extensive "on-the-ground" projects in areas of hydrosystem operations, habitat, hatcheries, and harvest. Where work remains to be done, we have already identified adaptive management actions in the 2002 Implementation Plan.

Biological results of 2001 were decidedly mixed. We saw very high adult returns and record adult survival rates of about 99 percent per dam, among the highest on record. Estimated 2001 total system juvenile survival (combined in-river and transportation survival) was similar to or slightly higher than that predicted for Snake River spring migrants, somewhat lower for Columbia River chinook, and substantially lower for Columbia River steelhead. Survival rates of the small number of in-river migrants (fish not transported) were very low, but that was not unexpected given the year's near record low flows. How this will impact future adult returns is not yet known; however, the NMFS Science Center suggests that improved estuary conditions may bolster future adult returns from 2001 out-migrants.

The Action Agencies' mission in meeting their Endangered Species Act responsibilities is to take a long-term view of FCRPS operations and actions, while taking into account the interests of all stakeholders. As such, we advocate rigorous analysis of the still emerging results before considering major changes in system operations. We will continue to implement BiOp actions with diligence, and plan to continue overall implementation of BiOp actions. We will address variances to actions to ensure we stay on track to meet BiOp expectations.

Meanwhile, from our implementation experience in 2001, we have been able to draw some constructive conclusions:

A. Extreme Circumstances Require Resourcefulness and Difficult Tradeoffs

- **Dry-year Tools** — While reliance on spot market purchases to meet power and fish needs has been an effective dry-year strategy in the past, market price volatility demands that additional dry-year strategies be developed for when energy supplies are limited and costs are high. In 2001, we learned

we can reduce the occurrence of emergency operations and address effects on fish by making demand and supply side arrangements with customers to reduce load, buy water rights, encourage voluntary conservation, and initiate funding for wind projects, among other actions. Additionally, marketing strategies that take advantage of West Coast load diversity, such as one-for-two power exchanges with California, can meet reliability needs in a mutually beneficial manner. We will explore these dry year tools and other demand- and supply-side actions so our regional "toolbox" will be ready, should another drought year occur.

- **Power Reliability Tradeoff** — We recognize that using water to generate power to meet power system emergencies can adversely affect use of water for other purposes. In such circumstances, operations that provide benefits to multiple project purposes become more desirable (i.e., winter chum protection). Additionally, marketing strategies that take advantage of West Coast load diversity, such as one-for-two power exchanges with California, can meet reliability needs in a mutually beneficial manner.
- **Flow Shaping and Tradeoffs** — Despite record low flows, we found we could achieve mutual benefits by meeting some minimum flows and shaping flows for chum spawning and Vernita Bar flow requirements, while meeting loads and maintaining reliability. However, combined with the severe drought condition, this contributed to depressed reservoir elevations heading into the spring migration period and lowered river flows during the spring reservoir refill period. The experiences of 2001 highlighted sometimes competing demands for winter, spring, and summer flows. Because flow decisions made early in the year are based on highly speculative forecasts, we need to continue to use adaptive management through the regional forum, TMT and IT, to modify operations and actions in real-time.
- **Offsets** — We determined that opportunities to provide passage help for migrating fish affected by low flow conditions or by an extended power emergency offer benefits that are realized at varying times. Increases in predator removal may have immediate benefits. Other measures, such as tributary habitat improvements, will take a longer period to realize benefits.
- **Extensive Coordination** — We found extensive and timely information sharing and coordination among federal agencies and with states, tribes, other utilities, and others were vital to help Action Agencies' decision-makers develop a regional response to the 2001 drought and power emergency conditions. Coordination included proposing principles of operation, sharing analytical methodologies and information, and soliciting public comments on these principles. At the same time, however, it was critical to make timely operating decisions in order to target spill to peak migration.

B. Hydrosystem Operational Flexibility is Important

- **Flow** — Other than some flow shaping, there was not much we could do to improve overall flows in 2001. This is consistent with expectations in the BiOps for flows in low water conditions. Fortunately, adult survival appeared unaffected by the drought conditions.
- **Targeted Spill** — Despite the circumstances of 2001, we were able to provide the very limited amount of available spill (due to power conditions) in a manner that benefited a substantial number of in-river migrants. Only a small proportion of fish were left to migrate in-river because most were transported per the NMFS' BiOp. Still, we determined the biological effect of limited spill can be maximized by conducting it at dams where it is most effective and targeting it to the peaks of fish passage and times of slowest migration.
- **Transportation Benefits** — We found the BiOp strategy to maximize juvenile fish transportation in years of low flow is further supported by 2001 projections of total system survival. In low flow conditions like that of 2001, transportation is a preferred passage strategy because in-river conditions are unfavorable and there is little operational flexibility to improve them.
- **Chum** — As mentioned under flow shaping in 4.1, we found we could take several steps at Bonneville Dam to benefit chum without impacting future operations. These included "reverse load factoring" (letting water levels rise at night and holding them down during the day) to keep spawning at lower elevations and managing flows to Bonneville tailwater elevation to conserve water in storage.

C. Habitat Improvements are Progressing

- **Tributaries** — While the drought reminded us about the importance of maintaining flow levels adequate for fish and habitat needs, we learned our ability to respond flexibly to opportunities to acquire water must take into account institutional as well as practical constraints. For example, our ability to consummate irrigation buy-outs was complicated by the difficulty of verifying whether the acquired water would in fact remain in the stream.
- **Mainstem** — Although results are still tentative, a study of mortality above Lower Granite Dam and Reservoir appears to confirm that mortality is relatively high in this reach. When results are finalized, the Action Agencies will consider potential mainstem actions to enhance survival. We also discovered that raising the reward for northern pikeminnow directly translates into increased catch and successful predator reduction.
- **Estuary** — We learned that our efforts to encourage Caspian terns to nest at East Sand Island nearer the mouth of the estuary rather than at Rice Island have been highly successful, resulting in substantially reduced predation on salmonids in the estuary.
- **Solicitations** — We are committed to integrating the administrative processes for considering proposals for both BiOp implementation projects and the Council's Fish and Wildlife Program. However, we find it inevitable that during the Provincial Review cycle, we may occasionally need to solicit projects outside of that process. Our experience in 2001 (with the three targeted solicitations for attracting on-the-ground projects with immediate benefits) indicates that even such focused efforts remain subject to the delay and constraints imposed by the administrative process for the regular project cycle.
- **Technical Recovery Teams** — We learned from our experience with the NMFS Technical Recovery Teams (TRT) that we must proceed simultaneously on two fronts. Specifically, even while conducting and completing Phase 1 activities, we must be initiating and completing Phase 2 activities.
- **Subbasin Planning** — Subbasin planning presents a similar challenge to that of the TRTs. We learned that even though the NMFS BiOp directs the Action Agencies to organize our efforts within the context of subbasin plans, until such plans exist we must nonetheless proceed with the work of recovery. This complicates our ability to establish priorities at the regional scale, for until subbasin plans are complete, there will be no common basis for identifying priorities across subbasins.
- **Next Steps** — We learned RPA actions require varying time frames and approaches to implement, and integrating these efforts is challenging. Some habitat RPA actions are discrete and can be readily addressed by a single project over a short timeframe, i.e., 3 to 5 years. Others are discrete, but will require research to be sustained over a longer timeframe of 10 to 15 years. Remaining RPA actions will require multiple projects and/or a comprehensive basinwide program. Our collective experience in achieving habitat improvements is substantial, and we were able to make progress in 2001.

Next steps include determining where to target habitat improvements, when to initiate them, and at what level to sustain or replicate them. Over the long term, subbasin planning will inform these decisions. In the near term we will focus on implementing key strategies, working in the 16 priority subbasins, and shifting to an ecosystem approach in the estuary and elsewhere.

D. Hatchery Improvements Require Extensive Coordination

- **Coordination** — We found initial implementation of BiOp hatchery actions in 2001 required substantial coordination with state and federal fishery managers, tribes, the Council, and other entities. Continued implementation will also require this high level of coordination. Consequently, we understand implementation of these actions will require more time to complete than originally contemplated by NMFS in its BiOp.

E. Harvest Improvement Projects Underway Appear Successful, but More Coordination is Required

- **Net Programs** — We learned from preliminary results that very small mesh tooth-tangle nets coupled with revival tanks provide adequate catch rates and minimal release mortality. Early evaluation of larger mesh gillnets in tribal fisheries also show significant survival benefits to steelhead under certain conditions.
- **Coordination** — As with actions supporting other RPAs, we understand taking additional harvest actions will require extensive coordination and prioritization with state, tribal, and federal fish managers, primarily through the Council's Mainstem/Systemwide Provincial Review process. It is too early to assess whether this process will yield the appropriate mix of projects to both fulfill the requirements of the BiOps and keep on schedule for the 2003 check-in.

F. Resident Fish Improvements Require More Study

- **Drought Impacts** — We found that poor precipitation and runoff conditions, like those in 2001, will limit when and how well some BiOp actions are implemented (e.g., the Libby spill test originally scheduled for 2001). We also recognize the difficult tradeoffs when managing water for the benefit of both anadromous and resident ESA-listed species.
- **Sturgeon** — We learned from ongoing research that prescribed spawning flows below Libby may be sufficient to induce some spawning of Kootenai River white sturgeon, but failure of the young sturgeon to survive to age 1-plus indicates factors beyond flow may also be limiting recruitment into the population. We will continue to study those factors and, when possible, make corrections. The potential that burbot may be listed under the ESA is also prompting us to look more broadly at ecosystem function in the Kootenai River Subbasin.
- **Bull Trout** — We have set priorities for dam passage and entrainment of bull trout, and will be implementing studies accordingly. In the Lower Columbia and Snake rivers, we are considering how research projects can be designed to measure bull trout use of the mainstem reservoirs and migrations between reservoirs and tributaries.

Sources of Data

BPA, USACE, and Reclamation. 2001. Endangered Species Act Implementation Plan for the Federal Columbia River Power System. Summer 2001.

BPA, USACE, and Reclamation. 2001. Endangered Species Act Implementation Plan for the Federal Columbia River Power System. Summer 2001.

BPA. 2001. Federal Columbia River Power System 2001 Implementation Plan. Draft Report October 2001.

Burner, C.J. 1951. Characteristics of spawning nests of Columbia River Salmon. Fishery Bulletin 61, Volume 52: 95–110.

Casillas, E. 2001. Personal communication with J. Anderson. University of Washington. Seattle, Washington. October 2001.

CBFWA. 2001. Fish Passage Center: 2001 Juvenile Salmon Migration, Preliminary Analysis. October, 2001. Portland, Oregon.

CBFWA. 2001. Fish Passage Center: Spring Migration 2001. Memo from Michelle DeHart. August 10, 2001. Portland, Oregon.

Clooney, T.D. UCR Steelhead and Spring Chinook Salmon Quantitative Analysis Report, Part 1: Run Reconstructions and Preliminary Assessment of Extinction Risk, technical review draft, Portland, Oregon: National Marine Fisheries Service, Hydro Program, December 20, 2000.

Columbia Basin Fish and Wildlife Authority. 2001. www.cbfwf.org/province.htm (information from project proposals in provincial reviews). October 2001.

FPC. 2001. Weekly Report. January 28, 2001.

FPC, 2001. Effect of spill at John Day Dam on yearling and steelhead survival estimates from McNary Dam tailrace to John Day Dam tailrace in 2001. Memorandum to Michele DeHart from Tom Berggren (Oct. 22 2001).

Fishwire Advisory. 2001. NW Fishletter. Fall Chinook Peak, but Prices Go Through Floor. No. 130, September 11, 2001.

Johnson O.W., W.S. Grant, R.G. Kope, K. Neely, F. W. Waknitz, and R. Waples. 1997. Status review of chum salmon from Washington, Oregon, and California. NOAA Tech. Memo. NMFS-NWFSC-32. 20pp.

Kostow, K. 1995. Biennial Report on the Status of Wild Fish in Oregon. Oregon Department of Fish and Wildlife, Portland, OR. 218 pp.

NMFS. 2001. 2000 FCRPS Biological Opinion. December 21, 2000.

NMFS. 1999. Draft biological opinion on the issuance of two section 10 permits for takes of threatened and endangered species associated with Upper Columbia River ESU spring chinook salmon hatchery supplementation programs. NOAA/NMFS, August 4, 1999.

NMFS. 2000. Biological opinion of the operation of the Federal Columbia River Power System. NW Fish Science Center. Seattle, Washington. December 2000.

NMFS. 2000. Passage of juvenile and adult salmonids past Columbia and Snake River Dams. A White Paper. NW Fisheries Science Center. Seattle, Washington. April 2000.

NMFS. 2000. Summary of research related to transportation of juvenile anadromous salmonids around Snake and Columbia River Dams. A White Paper. NW Fisheries Science Center. Seattle, Washington. April 2000.

NMFS. 2001. Preliminary survival estimates for passage of juvenile salmonids through Snake and Columbia River reservoirs and dams, 2001. Memo from M.H. Schiewe. NW Fish Science Center. Seattle, Washington. September 10, 2001.

NMFS Science Center. Annual presentation of survival results to the NWPPC, February 2002.

NPPC. 2001. Issue paper: Analysis of 2001 Federal Columbia River Power System Operations on Fish Survival. March 30, 2001. Portland, Oregon.

Olsen, D., J. Anderson, R. Zabel, J. Pizzimenti, and K. Malone. 1998. The Columbia River Flow Targets — Augmentation Program. A White Paper Review with Recommendations for Decision Makers. Prepared for Columbia Snake River Irrigators, Eastern Oregon Irrigators, Idaho Water users, Northwest Irrigation Utilities and Washington State Water Resources Associations. February 1998.

Peters, C.N., D.R. Marmorek, and I. Parnell. 1999. Plan for Analyzing and Testing Hypotheses (PATH): Decision Analysis Report for Snake River Fall chinook. Prepared for NPPC. Portland, Oregon.

Peters, J., and J. Pizzimenti. 1997. Evaluation of the Program for Enhanced Harvest and Habitat Law Enforcement and Public Awareness for Anadromous Salmonids and Resident Fish in the Columbia River Basin. Prepared for BPA. Portland, Oregon.

Pizzimenti, J., and S. Statz. 1997. Radio Tag Study of 1997 Migrating Fall Chinook above the Columbia River Dams. Prepared for BPA. Portland, Oregon.

The Columbia Basin Bulletin. 2001. Weekly Fish and Wildlife News. Upriver Fall Chinook Forecast Boosted Again. September 21, 2001. Bill Crampton, Editor.

University of Washington. 2001. DART Information System (temperature and dissolved gases). www.cqs.washington.edu/dart/river.html. October 2001.

USFWS. 2000. Biological Opinion of the Operation of the Federal Columbia River Power System.