Protecting Salmon and Steelhead

Endangered Species Act
Federal Columbia River Power System
2009 Progress Report Summary

December 2010

In May 2008, National Oceanic and Atmospheric Administration (NOAA) Fisheries issued a Biological Opinion (BiOp) on the operation of the dams that make up the Federal Columbia River Power System (FCRPS). The FCRPS projects are operated for multiple purposes including flood control, fish and wildlife, power generation, navigation, irrigation, and recreation. The FCRPS BiOp considered a Biological Assessment and a suite of actions proposed by the Bonneville Power Administration, Bureau of Reclamation, and U.S. Army Corps of Engineers, together referred to as the Action Agencies, to protect salmon and steelhead across their life cycle. It also provided NOAA Fisheries with scientific analysis under the Endangered Species Act (ESA) and an extensive list of Reasonable and Prudent Alternative (RPA) actions to avoid jeopardy to the fish.

Based on the BiOp, the Action Agencies committed to implementing actions to improve the survival of salmon and steelhead listed under the ESA, including the use of spill and surface passage structures at dams, management of water releases from storage reservoirs, expanded control of predators that prey

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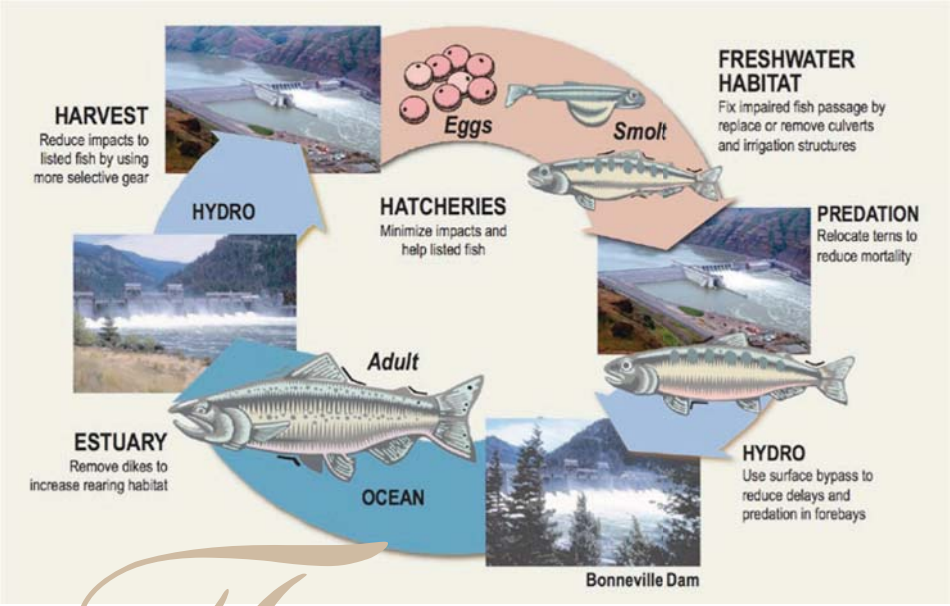

All-H Problems: All-H Solutions

Samples from the 2009 FCRPS BiOp

Throughout the Columbia River Basin, tribal, state, local, and federal parties are working in partnership to protect and restore stocks of salmon and steelhead. Thirteen stocks of these fish are listed as threatened or endangered under the Endangered Species Act (ESA). Many parties in the region are working together to protect and enhance important habitats, improve hatchery and harvest practices, and enhance river conditions for migrating fish. This report summarizes the actions implemented by the Action Agencies in 2009 to protect ESA-listed salmon and steelhead affected by the operation of the Federal Columbia River Power System (FCRPS).[1] It describes the status of Reasonable and Prudent Alternative (RPA) actions being implemented across the fish life cycle for that calendar year. The actions described in this annual report are focused on achieving biological performance standards, achieving programmatic performance targets, and addressing factors that limit certain life stages for specific evolutionarily significant units (ESUs) or

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[1] *The FCRPS includes 14 major dams and power plants on the Columbia and Snake rivers. These dams and power plants are operated as a coordinated system (including with Canada) to meet multiple purposes as authorized by Congress.*

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on young salmon, improvement of tributary and estuary habitat, and implementation of hatchery reforms. The Action Agencies also entered into the Columbia Basin Fish Accords with two states and five tribes to promote regional partnerships and "on-the-ground" implementation. The Action Agencies are responsible for providing annual progress reports detailing the implementation and progress of the RPA.

In 2009, the Obama Administration leadership engaged in a process considering the available science and the views of the court and the parties, and conducted independent scientific review. The Administration determined that the science underlying the 2008 BiOp was sound. However, there were uncertainties in some of the predictions regarding the future condition of the listed species. In light of these uncertainties, the Administration directed taking a more precautionary approach in implementing the RPA by developing the Adaptive Management Implementation Plan (AMIP, at *http://www.salmonrecovery.gov/BiologicalOpinions/FCRPS/2008Biop.aspx)*. The AMIP includes accelerated actions, additional research related to fish status and climate change, and precautionary use of biological triggers and contingency plans in case there is an unexpected, significant fish decline. The AMIP provisions were initiated in 2009.

To review the 2008 FCRPS BiOp in its entirety, go to *https://pcts.nmfs.noaa.gov/pls/pcts-pub/pcts_upload.summary_list_biop?p_id=27149.*

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This report is produced by the "Action Agencies"—the U.S. Army Corps of Engineers Northwestern Division, Bureau of Reclamation Pacific Northwest Region, and Bonneville Power Administration.

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distinct population segments (DPSs) of salmon and steelhead. Adaptive management is the process the agencies use to make adjustments to actions based on new scientific information and to meet biological performance objectives effectively and efficiently.

The full FCRPS 2009 Annual Progress Report, which includes the RPA Summary Table: Actions and Accomplishments, Detailed Description of RPA Action Implementation, and Project Tables for RPA Action Implementation, is available online at *http://www.salmonrecovery.gov*. Previous FCRPS progress reports and information on other salmon and steelhead protection efforts are available on websites listed at the end of this document.

Figure 1. Map of the Columbia River Basin showing action areas, dams, and listed species.

2009 Fish Status and Environmental Conditions

Adult Fish Returns and Trends

One way the Pacific Northwest tracks how well salmon and steelhead are doing is by comparing the number of fish that return each year to spawn. Many dams have fish counting stations where annual index tallies are made of the various species as they swim up the fish ladders. In 2009, more than 1.7 million adult and jack salmon and steelhead were counted as they passed Bonneville Dam. (Jack salmon are young males that mature and return to spawning grounds earlier than others in their age class.) This number exceeds historical averages (i.e., for 2000 and earlier) and is above the 10-year average (Figure 2). Specific adult return and trend information for the species addressed in the BiOp are presented beginning on page 24 of this section.

As shown in Table 1, counts in 2009 of adult steelhead, summer Chinook, coho, and sockeye passing Bonneville Dam exceeded the 10-year average. Spring Chinook and fall Chinook counts were slightly below the 10-year average. In a typical year, about 80 percent of all returning adult salmon are of hatchery origin, though the actual percentage varies by species.

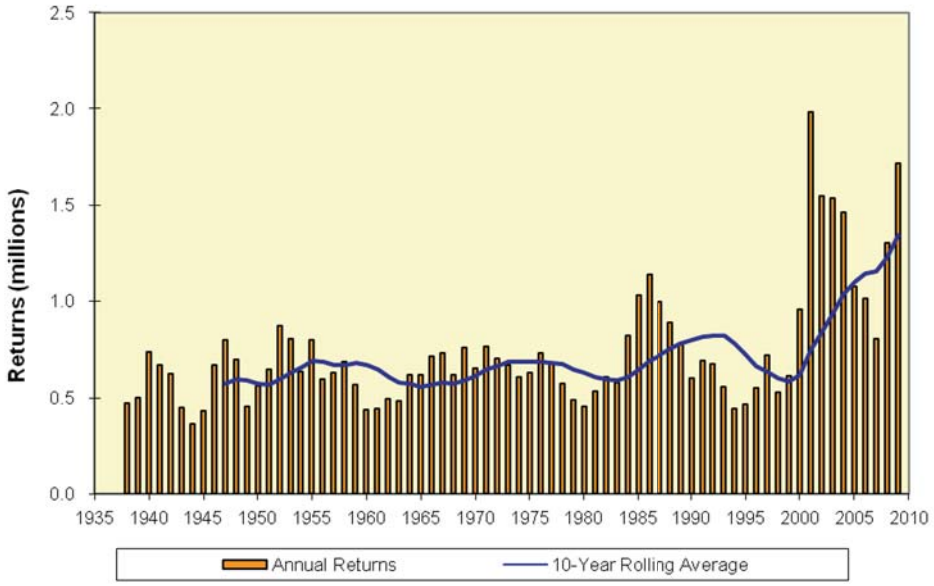


Figure 2. Adult and Jack Salmon/Steelhead Returns at Bonneville Dam, 1938 to 2009 (includes hatchery and natural origin fish).

Table 1. Adult Salmon and Steelhead Returns at Bonneville Dam – 2009 and 10-year Average.

Species	2009	10-year average
Chinook – Total [1/]	699,121	706,153
Spring Chinook [2/]	181,174	185,488
Summer Chinook	119,352	96,002
Fall Chinook	398,595	424,662
Steelhead	604,970	400,485
Sockeye	177,823	94,637
Coho [3/]	234,669	138,812
Chum and Pinks	203	205
TOTALS of all species for period	1,716,786	1,340,732

Period of 10-year average 2000-2009. Data are for daytime counts – 0400 to 2000 PST. All data from U.S. Army Corps of Engineers Fish Passage Report 2009, Table 18b, except as noted below:

[1/] Chinook data are from monthly values in Fish Passage Report 2009, Table 19, except values for 2000-2002 which are from monthly values in Fish Passage Report 2002, Table 18. Values include jacks.

[2/] Assumed Chinook run dates are: Spring = Jan 1–May 31; Summer = June 1–July 31; Fall = Aug 1–Dec 31.

[3/] Includes jacks.

Adult Fish Survival

Survival rates of ESA-listed adult Chinook and steelhead through defined reaches within the FCRPS dipped below adult passage performance standards in 2009 for five of the six stocks that are monitored. (As shown in Figure 3, performance is measured as a 5-year rolling average.) Annually, the Action Agencies use the methodology in the 2008 FCRPS BiOp with annual updates for harvest estimates. Three of the five stocks that fell short of the BiOp performance standard were within 5 percent. However, two stocks — the Snake River spring/summer Chinook salmon ESU and the Snake River steelhead DPS— were significantly outside of the adult performance standard (Figure 3). Because the Snake River stocks are used as surrogates for Snake River sockeye and mid-Columbia steelhead survival, both of these stocks were also below the standard. This discrepancy is likely related to four factors: modifications to operations and structures at the dams to increase juvenile survival that in some instances may also delay adult passage; effects of sea lion predation-related injuries on spring Chinook; additional unquantifiable mortality levels caused by fisheries; and unaccounted levels of straying. Each of these four factors is being addressed through BiOp Research, Monitoring & Evaluation actions. Determining optimal spill levels for all life-cycle stages, modifying operations or structures with known adult passage problems, and managing sea lion predation should help improve adult survival rates in the future. Additionally, the Action Agencies are investigating adding Passive Integrated Transponder (PIT) tag detection capabilities to The

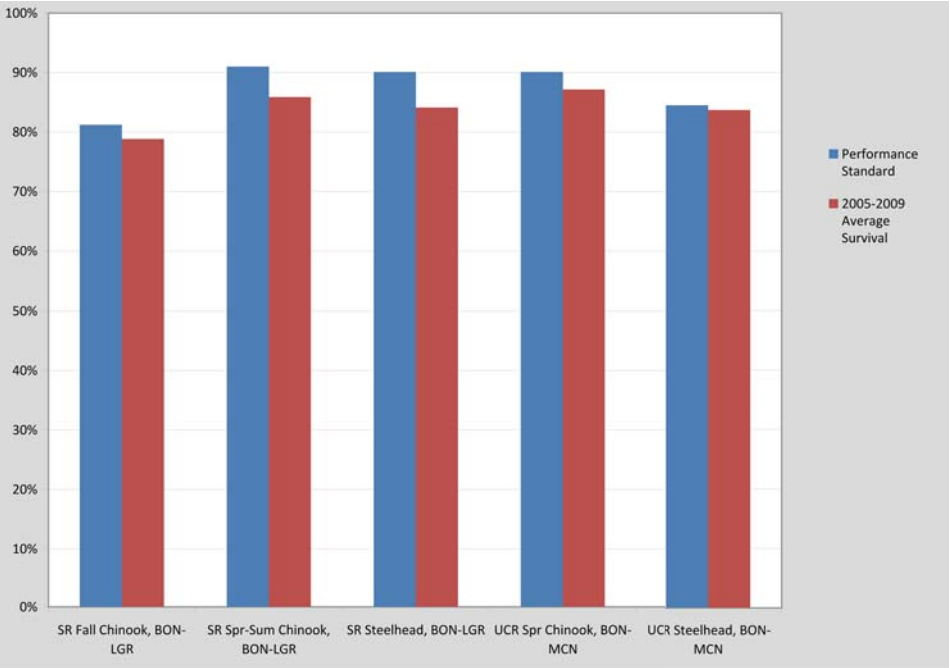
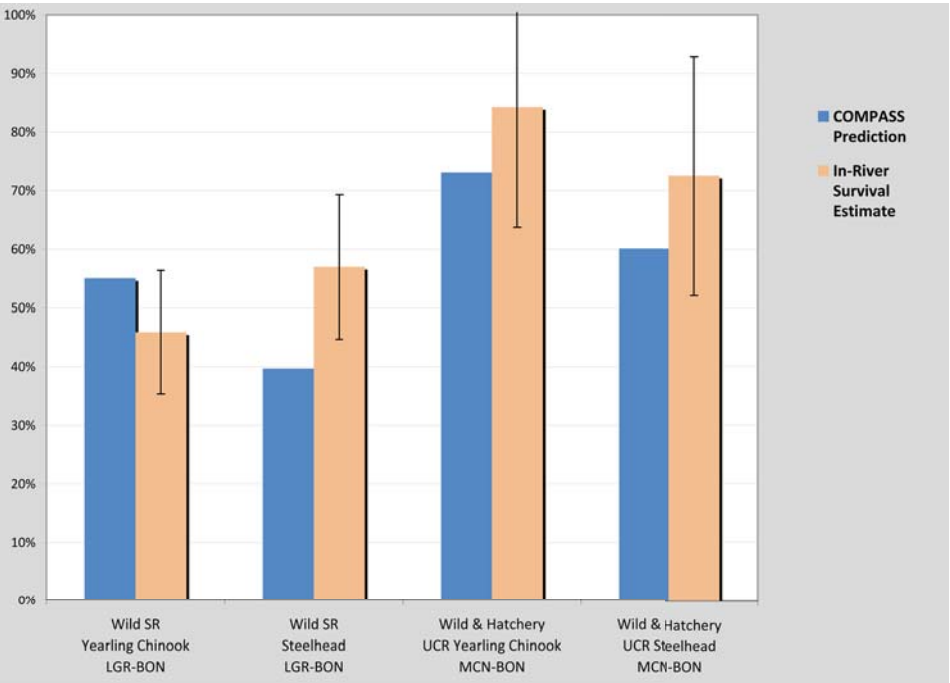


Figure 3. 2008 FCRPS BiOp Adult Survival Standard and Summary of Five-Year Rolling Average Adult Survival of Adults that Migrated In-River as Juveniles, Based on PIT Tag Conversion Rates of Snake River (SR) and Upper Columbia River (UCR) ESUs. (BON = Bonneville, MCN = McNary, LGR = Lower Granite)

Figure 4. COMPASS Model Predictions and PIT Tag Estimated In-River Survival for Juvenile Snake River (SR) Wild Spring/Summer Chinook and Steelhead and for Upper Columbia River (UCR) Wild/Hatchery Spring Chinook and Steelhead. Error whiskers indicate 95% confidence intervals. (BON = Bonneville, MCN = McNary, LGR = Lower Granite)



Dalles and John Day dams and adding PIT tag interrogation capability in fisheries above Bonneville Dam to better understand and quantify unexplained losses within those reaches.

Juvenile Fish Survival

Hatchery and wild juvenile salmon and steelhead that migrate to the ocean through the Snake and Columbia rivers can either be transported by barge or truck to below Bonneville Dam or left "in river" to migrate past the dams. Total system survival is a combination of transportation and in-river survival. The percentage of fish that travel in river compared to the percentage transported has ranged from 45 to 90 percent, depending on a number of factors, such as projected river flow volumes, how much spill is provided, and how well fish are attracted to juvenile fish bypass systems. In 2009 less than 50% of the Snake River steelhead and Chinook were transported. Approximately 98 percent of the transported juveniles survive to the point of release below Bonneville Dam. System survival to the Bonneville tailrace (survival of in-river and transported groups combined) was likely about 67% and 72% for wild and hatchery yearling Chinook salmon respectively, and 76% and 81% for wild and hatchery steelhead respectively. Because significant proportions of juvenile Upper Columbia spring Chinook and steelhead are not transported, in-river survival rates are equivalent to system survival rates for these species. Because additional "delayed mortality" may occur after the fish are released, research is being carried out under the BiOp to better understand any delayed effects of transport.

The BiOp established an in-river survival performance metric for Snake River and Upper Columbia River Chinook and steelhead; this metric is intended to provide important information for both the annual adaptive management process and the comprehensive evaluations in 2013 and 2016. The Action Agencies empirically measured in-river survival for 2009 (Lower Granite to Bonneville and McNary to Bonneville) and compared that with the survival estimates derived by running COMPASS modeling (with prospective survival estimates for the actions implemented at the start of the 2009 migration season using 2009 river conditions, fish migration patterns, and dam and transport operations). Figure 4 shows the results of these comparisons. Results indicate that the benefits from the RPA actions implemented to date are likely accruing as expected.

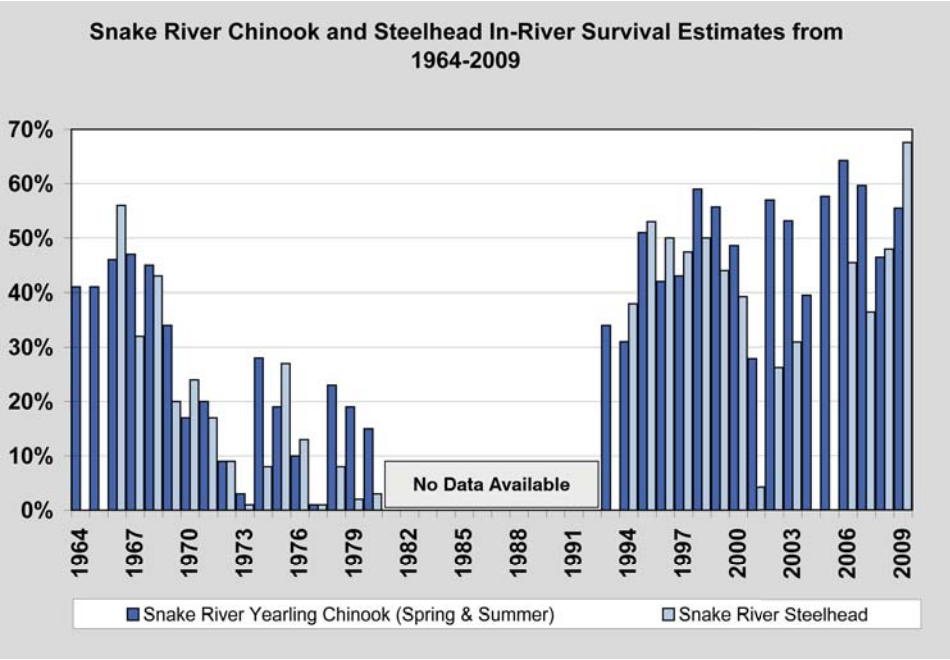


Figure 5. In-River Survival Estimates (Hatchery and Wild Combined) for Snake River Chinook and Steelhead. Steelhead estimates for 2004 and 2005 are unavailable due to lower PIT tag detection efficiency at Bonneville Dam. Survival estimates are not available for 1981 through 1992.

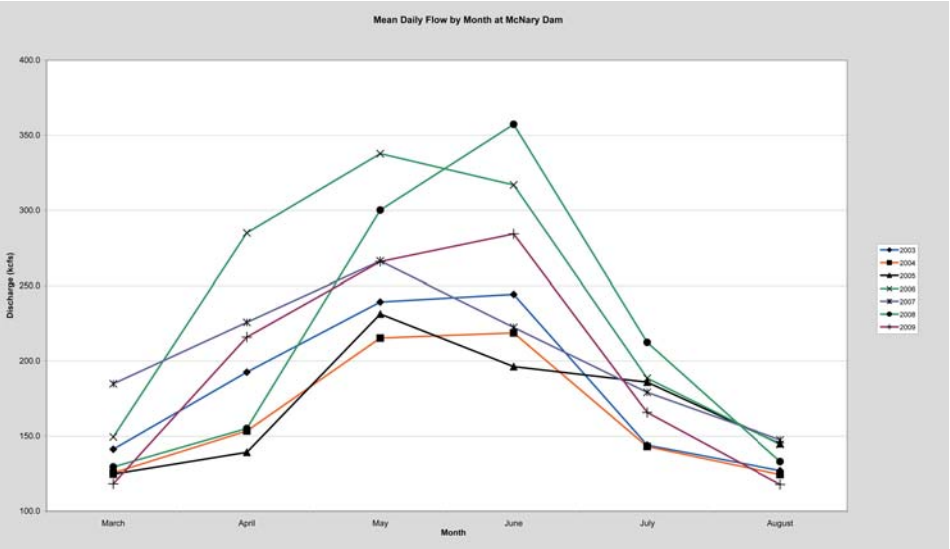


Figure 6. Mean Daily Flow by Month at McNary Dam, 2003-2009.

In-river survival estimates for wild Snake River steelhead, and combined hatchery and wild Upper Columbia River steelhead and spring Chinook were higher than mean estimates developed using the COMPASS model. Wild Snake River Chinook in-river survival estimates were lower than mean COMPASS estimates. These results suggest that steelhead are generally deriving more benefits from recently installed surface flow weirs compared to Chinook. Improvements planned to deter predation near dams (avian wires and egress improvements) are expected to result in additional benefits to all species.

Figure 5 shows the combined in-river survival estimates for hatchery and wild Snake River yearling Chinook salmon and steelhead through the entire hydropower system (Snake River trap to Bonneville Dam tailrace). Chinook survival was slightly above the average for the last 10 years; while steelhead survival the highest estimated in the last 12 years.

In 2009, yearling Chinook salmon and steelhead migration rates through the hydropower system were faster (i.e., in-river travel times shorter) than average, especially for steelhead. These faster rates of travel were likely because of higher water velocities, relatively high spill proportions, and the use of surface passage structures at most projects.

Water Year and Streamflow Summary

The Columbia River Basin experienced average water conditions in 2009. Snake River flow volume was near average throughout April 2009, but it increased to above average for most of May because of late-season thaw of larger-than-average snowpack (Figure 6). In addition, the large influx of cold meltwater made April and May water temperatures the coldest in the Snake River in recent years.

Ocean and Climate Conditions

Columbia River Basin salmon and steelhead abundance is strongly correlated with periods of relatively warm or cold off-coast ocean conditions. In general, warmer conditions are less favorable for salmon and colder conditions are more favorable. Pronounced warm and cold cycles have occurred over most of the past century, lasting approximately 20 to 30 years each (Figure 7). This climate pattern is known as the Pacific Decadal Oscillation (PDO).

A cool PDO regime in place from about 1947 to 1976 was characterized by abundant salmon returns to the Columbia River Basin. The PDO shifted to a warm phase in about 1977, which coincided with a significant decline in Columbia River Basin salmon runs. Although it is not clear yet whether another longer-term shift has taken place or what effects might be associated with climate change, ocean conditions have been variable since about 1999, with relatively brief cool and warm periods.[2]

The National Oceanic and Atmospheric Administration (NOAA) Fisheries Northwest Fisheries Science Center (NWFSC) oversees the Ocean Ecosystem Indicators Project to track specific

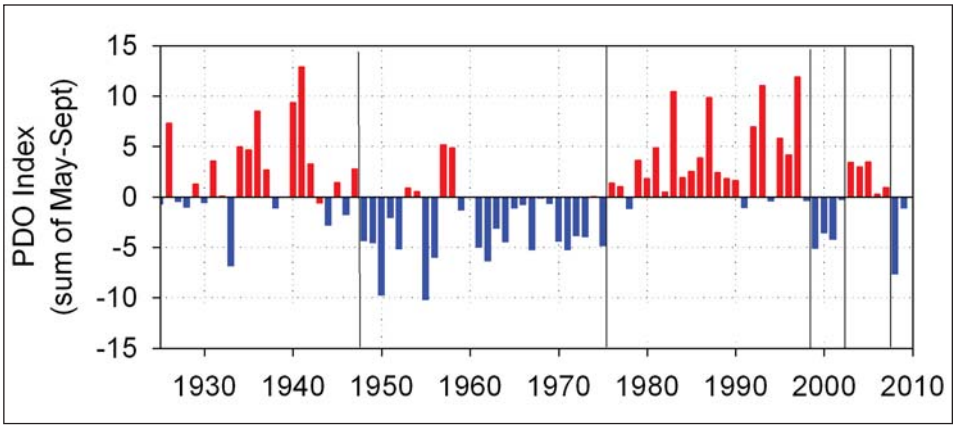


Figure 7. Pacific Decadal Oscillation from 1925 to 2009, Showing Its 20- to 30-Year Cycle.

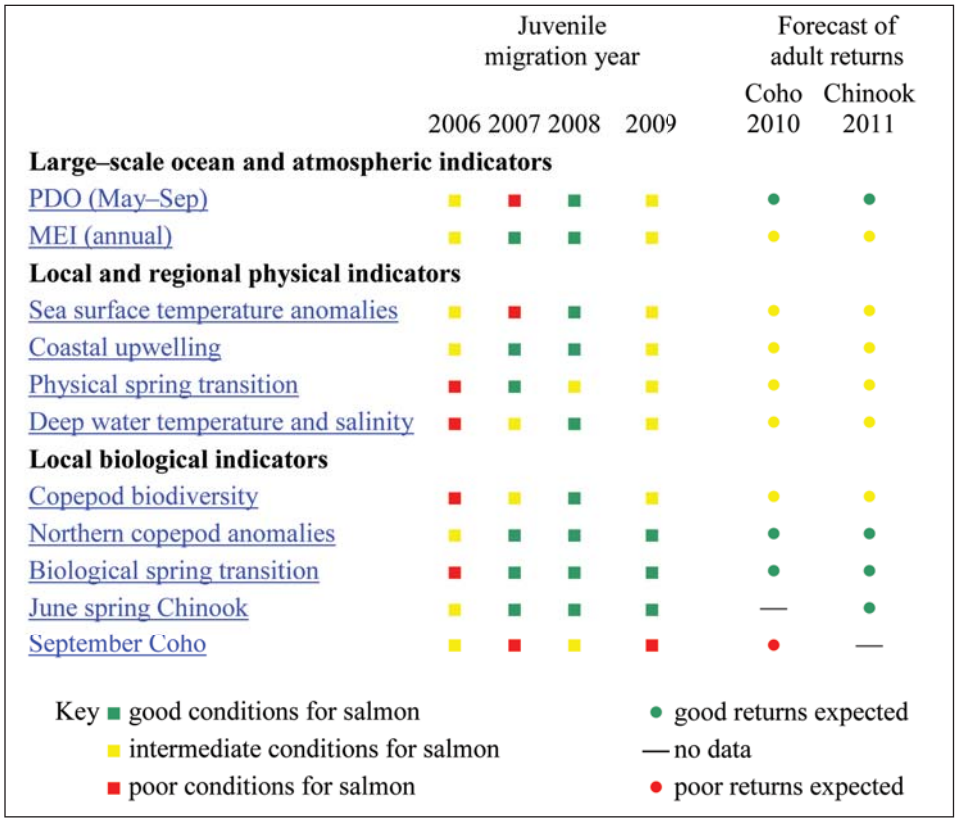


Figure 8. Ocean Ecosystem Indicators of the Northern California Current. Colored squares indicate positive (green), neutral (yellow), or negative (red) conditions for salmon entering the ocean each year. In the two columns to the far right, colored dots indicate the forecast of adult returns based on ocean conditions in 2009

climatic and biological indicators believed to influence the growth and survival of juvenile salmon once they reach the ocean. The NWFSC forecasts coho and Chinook salmon returns based on a survey of a range of ecosystem indicators. Ocean indicators during juvenile migration year 2008 were the best overall since 1999-2000. However, during the second half of 2009 the trend of cool ocean conditions shifted to a warmer regime, likely leading to higher mortality of juvenile salmonids. The NWFSC continued to forecast high Chinook returns in 2010, but it expects those returns to decline in 2011 (Figure 8).[3]

New Climate Change Information

The 2008 BiOp summarized a number of studies, including the Independent Scientific Advisory Board's (ISAB) review of the literature relevant to climate change impacts on Columbia River Basin salmon and steelhead (Climate Change Impacts on Columbia River Basin Fish and Wildlife, Independent Scientific Advisory Board, 2007). Under the RPA, the Action Agencies continued funding and collaborative support to the Washington Department of Ecology in 2009 to contract with the University of Washington Climate Impact Group to develop climate change streamflow scenarios. The Action Agencies are developing additional data sets, such as climate change water supply forecasts and flood control elevations, which will be used in conjunction with the streamflow scenarios developed by the University of Washington to adequately model climate change impacts to the hydrosystem.

As of December 2009, there was no significant new scientific information, studies or observations that fell outside of the range of climate conditions considered in the 2008 BiOp.

[2] *For more information, see the Pacific Northwest Climate Impacts Group website at http://cses.washington.edu/cig/.*

[3] *See the Northwest Fisheries Science Center's Ocean Ecosystems Indicators website at: http://www.nwfsc.noaa.gov/research/divisions/fed/oeip/a-ecinhome.cfm.*

Implementation Overview

The Action Agencies have established implementation strategies and actions using the "All-H" approach—hydropower, habitat, hatchery, and harvest, plus predator management—to work toward salmon and steelhead recovery in the Columbia River Basin. Work performed is summarized below. Detailed descriptions can be found in the RPA action implementation portion of this Annual Progress Report.

Hydropower

Under the hydropower strategy, the Action Agencies implemented juvenile and adult dam passage modifications, operational improvements for spill and transport of juvenile fish, water management operations, and operational and maintenance activities aimed at improving juvenile passage survival and adult returns. These actions are focused on achieving higher juvenile dam survival performance standards, as well as overall system survival and in-river survival.

Improvements for Fish at the Dams

Most salmon and steelhead in the Columbia River Basin encounter one or more hydroelectric dams as they migrate to and from the ocean. Fish passage systems provide various routes of passage to help salmon and steelhead get past the dams. Over the past several decades, juvenile fish survival past the dams has improved dramatically.

Juvenile fish pass dams by many routes: through the turbines, through juvenile bypass systems, through spillways, or by collection and transport in barges or trucks. Turbine passage is often considered to be the least desirable juvenile route of passage. As a result, juvenile bypass systems, spill, and other surface passage routes are used to divert the vast majority of migrating fish past the turbines. Depending on location, time of year, and species, about 76 to 99 percent of the juvenile fish use these non-turbine routes. Juvenile dam survival estimates of 86 to 99 percent have been demonstrated at Snake and Columbia River dams, with survival rates at most of the dams in the upper 90 percent range. The BiOp includes dam survival performance standards (through all passage routes) of 96 percent for spring migrating fish and 93 percent for summer migrating fish. These standards may have been met at some dams and for varied seasons, but significant improvements are also under way. In 2009, the agencies continued to make improvements to fish passage. Key accomplishments are noted below.

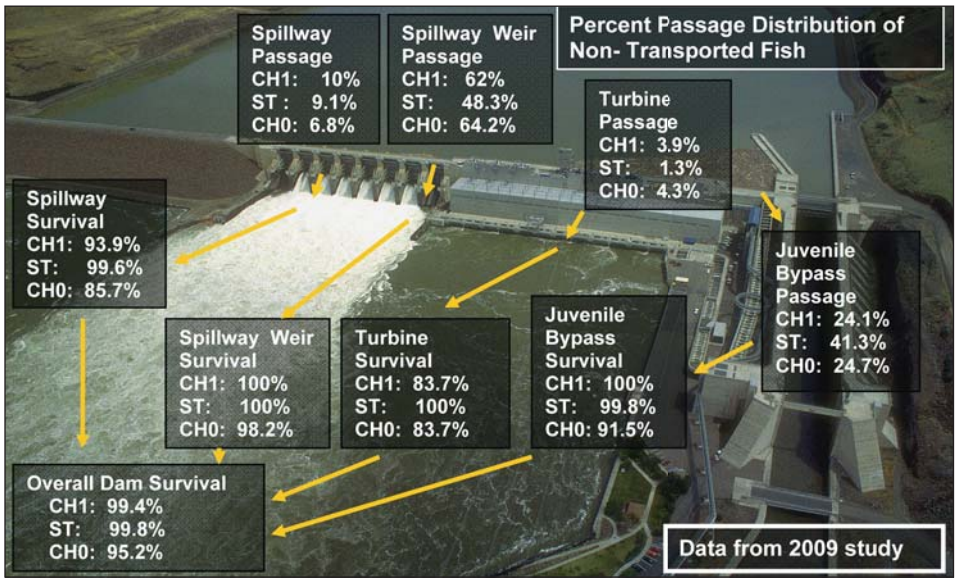


Figure 9. Little Goose Dam — 2009 Route-Specific Passage and Survival Estimates for Yearling and Subyearling Chinook and Juvenile Steelhead. CH0 = subyearling Chinook. CH1 = yearling Chinook. ST = steelhead. BiOp performance standards are 96% survival for yearling Chinook and steelhead, and 93% for sub-yearling Chinook. Overall dam survival estimates for Little Goose Dam in the 2009 study were 99.4% for yearling Chinook, 99.8% for steelhead, and 95.2% for subyearling Chinook.

Spill and Surface Passage

Fish passage through the spillway is widely recognized as one important way to get juvenile fish to pass the dams quickly. Water is "spilled" through spillway openings rather than being routed through turbines to generate power or for other purposes. The Action Agencies' hydro operations include spring and summer spill to help juvenile salmon and steelhead pass the lower Columbia and Snake River dams. In 2009, consistent with the court-ordered 2009 Spring and Summer Fish Operations Plans, spill levels from 2008 were repeated with only those modifications necessary to accommodate new structures and/or to conduct essential research.

Surface passage structures are used in addition to conventional spillways to provide more natural river passage conditions, improve juvenile fish survival, reduce juvenile fish passage delay, improve water quality, and make more efficient use of spill. Most juvenile salmon tend to travel in the upper 10 to 20 feet of the water column as they migrate downstream to the ocean. When approaching the dams, juvenile fish need to dive to depths of 50 to 60 feet to access passage routes such as a spillbay opening or a guidance screen that will guide them into a juvenile bypass channel. Surface passage structures such as spillway weirs and the Bonneville corner collector provide downstream migrating fish with more surface-oriented routes of dam passage, thereby reducing passage delay and improving survival.

In 2009, a spillway weir was installed and tested at Little Goose Dam. This project was a key milestone in the Action Agencies' commitment to install surface passage and achieve performance standards at all Snake River and Columbia River dams. Surface passage has now been installed at all Snake and Columbia River dams, and the Action Agencies are continuing to evaluate surface passage technology at several of the dams. The Little Goose spillway weir was an effective passage route for juvenile fish and appeared to help exceed performance standards. Dam passage survival estimates were 99.4 percent for yearling Chinook, 99.8 percent for steelhead, and 95.2 percent for subyearling Chinook (Figure 9). Results for other projects which were evaluated in 2009 are presented in Section 3.

Juvenile Bypass Systems

Juvenile fish screened bypass systems are in place at seven of the eight lower Columbia and Snake River dams. These bypass systems guide fish away from turbines by means of submerged screens installed in the turbine intakes. As fish travel with flow into the turbine intakes, the guidance screens guide the fish up through channels in the dam, routing them away from turbines. The fish are then either passed back to the river below the dam (bypassed) or loaded into barges or trucks for transport downstream past the remaining dams.

In 2009, modifications to the juvenile bypass system at Bonneville Powerhouse II continued to be evaluated following completion in 2008. The Little Goose bypass outfall relocation was initiated in 2008 and completed in 2009.

Fish Transportation and Barging

Juvenile fish transportation is an ongoing program that collects fish from juvenile bypass facilities at Lower Granite, Little Goose, Lower Monumental, and McNary dams and transports them by either barge or truck to release sites below Bonneville Dam.

The timing and conditions for fish transportation are determined based on annual research comparing adult returns to the spawning grounds of transported fish versus fish that migrated in-river. In general, fish survive better migrating in-river in early April, but they survive better when transported during lower-flow conditions in mid to late May. Also, steelhead generally exhibit higher survival, compared to Chinook salmon, when transported during the spring migration.

In 2009, transportation began on May 1 at Lower Granite Dam, May 6 at Little Goose Dam, and May 8 at Lower Monumental Dam. Transportation of juvenile fish at McNary Dam began on July 16. Approximately 16.7 million juvenile salmon and steelhead were collected at transport locations in 2009, with about 8.7 million fish being transported to below Bonneville Dam. Based on PIT tag data, NOAA Fisheries estimated that 40 percent of wild Snake River yearling Chinook and 38 percent of hatchery Snake River yearling Chinook were transported in 2009, while 46 percent of wild Snake River steelhead and 43 percent of hatchery Snake River steelhead were transported that year (Figure 10). Of the fish transported, over 99 percent were transported by barge, and just under 1 percent were trucked.

Water Management and Flow Operations

In addition to fish passage at the dams, operators manage storage reservoirs to enhance fish survival. River flows are augmented with water released from upstream storage dams to help juvenile migration and adult spawning, and to cool water temperatures.

Water managers recognize that available storage—water that actually can be managed—is limited relative to total annual runoff in the Columbia River Basin. Specific operating plans are used at individual reservoirs to provide salmon flows, protect resident fish, manage flood risks, and serve other authorized purposes.

In the fall 2008, the Action Agencies updated the annual Water Management Plan to incorporate any changes to the operating plans from the previous year. Both the storage projects and the run-of-river mainstem lower Columbia River and Snake River projects were operated under the plan to aid juvenile fish passage. (Storage projects are the Libby, Hungry Horse, Albeni Falls, Grand Coulee, and Dworshak projects, while run-of-river projects are Bonneville, The

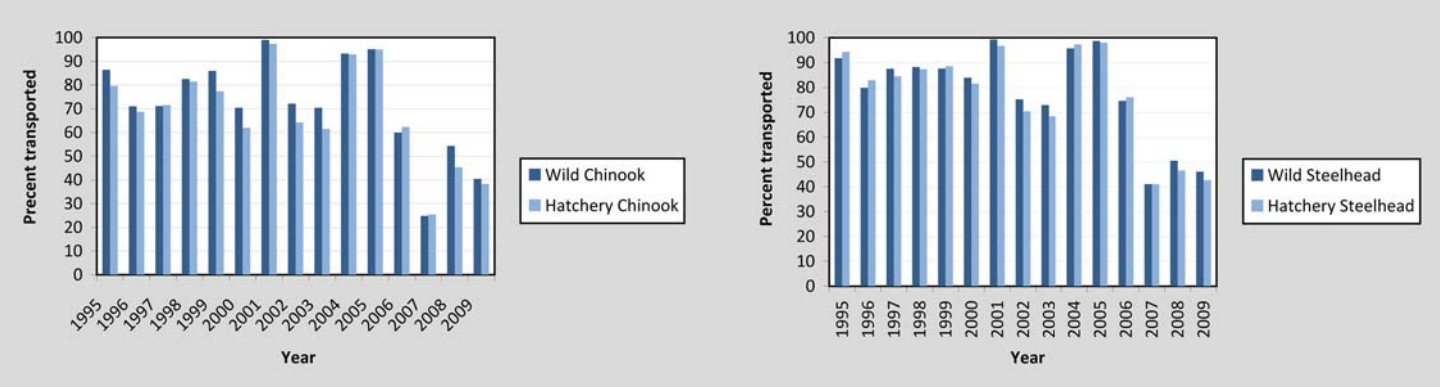


Figure 10. Estimated Percent of Yearling Chinook Salmon and Steelhead Transported to Below Bonneville Dam by Year (1995-2009)[4].

[4] *Faulkner, J. R., S. G. Smith, W. D. Muir, D. M. Marsh, J. G. Williams. 2010. Survival Estimates for the Passage of Spring-Migrating Juvenile Salmonids through Snake and Columbia River Dams and Reservoirs, 2009. Report by National Marine Fisheries Service to the U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife, Seattle, Washington, Contract 40735, Project No. 199302900, 117 p.*

Dalles, John Day, McNary, Ice Harbor, Lower Monumental, Little Goose, and Lower Granite dams.)

The Action Agencies coordinated with Canada and entered into an agreement on operation of treaty storage for non-power uses for the period December 15, 2008, through July 31, 2009. Under this agreement, 1 million acre-feet (MAF) of flow augmentation water was stored in Mica Reservoir during January 2009. All flow augmentation storage under this agreement was released by July 31, 2009. The Action Agencies stored 444 thousand acre-feet (kaf) into non-treaty storage, primarily in January and early February 2009, bringing the U.S. account to 88 percent of full on September 30, 2009.

In 2009, the Bureau of Reclamation (Reclamation) provided 487 kaf of flow augmentation water from the upper Snake River above Brownlee Reservoir in accordance with the NOAA Fisheries 2008 Upper Snake River Irrigation Projects BiOp. For more information see the December 1, 2009, Annual Progress Report for Reclamation's 2009 Salmon Flow Augmentation Program.

Water Quality

Fish passage spill operations may result in the generation of total dissolved gas (TDG) supersaturation in the Columbia and lower Snake rivers at levels above 110 percent, the current state and federal water quality standards. The states of Washington and Oregon have exceptions to these standards as long as the elevated TDG levels provide for improved fish passage through the spillway without causing more harm to fish populations than would occur through other passage routes. The U.S. Army Corps of Engineers (Corps) monitors TDG levels in the river and adjusts spill patterns and spill rates to stay within acceptable levels. There are instances when TDG levels are greater than state TDG standards resulting from either voluntary spill for fish passage or involuntary spill. In 2009, there were 116 gauge-day instances associated with voluntary spill for fish. There were 192 gauge-day instances resulting from (1) high river flows that forced involuntary spill, (2) Bonneville Power Administration (BPA) load requirements lower than actual powerhouse capacity, or (3) outage of hydro power equipment.[5]

To help manage water temperatures in the lower Snake River in the summer, cold water is released from Dworshak Dam on the Clearwater River from early July through mid-September. The tailwater temperatures at Lower Granite Dam through the augmentation season only exceeded 68 °F for a few hours (15 hours) at the end of July and early August. For a more thorough discussion of how the system was operated in 2009, see the annual "Annual TDG and Temperature Report" links at *http://www.nwd-wc.usace.army.mil/tmt/wqnew/*.

Kelt Management

BPA and the Corps completed the 2009 Kelt Management Plan and released it for comment in December. The 2009 version of the Kelt Management Plan was a synthesis of previous research on kelt migration studies through the hydrosystem as well as kelt reconditioning efforts. The 2009 Kelt Management Plan also discussed research efforts that began in 2009 as well as kelt-specific operations outside of the normal spill season at Bonneville Dam and The Dalles Dam. To facilitate increased efforts in the kelt research program, BPA and the Corps also designed and began construction on an expanded temporary kelt handling facility at Lower Granite Dam.

BPA funded the Columbia River Inter-Tribal Fish Commission (CRITFC) to prepare a Master Plan for kelts, which will provide the detail on the reconditioning topic in the broader Kelt Management Plan. The Master Plan will focus on kelt collection and reconditioning at various locations. CRITFC has subcontracted portions of this project to the University of Idaho. The Kelt Master Plan, which will apply to reconditioning Snake River kelts, is part of a three-step technical review process required by the Northwest Power and Conservation Council (NPCC) for artificial propagation projects, particularly those that affect natural populations and involve construction of capital facilities.

Evaluations of the potential benefit of providing surface passage early in the spring for outmigrating steelhead kelts continued with a second year of estimating passage through the ice and trash sluiceway at The Dalles Dam. The corner collector at Bonneville Dam was also opened early based on kelt counts in the juvenile bypass system. This ongoing research will help inform decisions regarding the long-term operations of surface passage routes for kelt outmigration.

Predator Management

Four main predator species are a major cause of mortality of ESA-listed fish in the Columbia River system. Populations of Caspian terns and double-crested cormorants, which eat large numbers of migrating juvenile fish, have increased over the last two decades in the Columbia River Estuary. These two species are also present in the mid-Columbia region. Among fish, northern pikeminnow are voracious consumers of juvenile salmon and steelhead. California sea lions are known to consume substantial numbers of adult spring Chinook salmon and winter steelhead below Bonneville Dam. Predation by bass is also a concern.

Federal and state agencies are cooperating in efforts to reduce predation on listed species. Programs to redistribute Caspian terns currently nesting in the estuary, deter and block sea lions from Bonneville Dam fish ladders, and reduce the northern pikeminnow population through a sport-reward program have been successful in decreasing the loss of adult and juvenile salmon to predation. In 2009, the Action Agencies continued efforts to control specific predators and improve survival of juvenile fish.

Caspian Terns and Double-Crested Cormorants

Caspian terns and double-crested cormorants consumed an estimated 17.5 million, or about 15 percent of all, juvenile Chinook and steelhead

[5] *[number of TDG gauges] x [number of days in spill season, April 3 through August 31]*

Double-Crested Cormorant

estimated to reach the estuary during the 2009 outmigration. The federal agencies have been addressing growing populations of Caspian terns and double-crested cormorants nesting in the estuary as well as those in the mid Columbia River that prey on juvenile salmon.

Recent efforts to redistribute Caspian terns from Rice Island, in the Columbia River Estuary, to East Sand Island, nearer to the ocean, were successful in reducing predation rates. As intended, the relocation shifted the terns' diet away from juvenile salmon toward a more diverse diet of predominantly marine fish species. (At Rice Island, juvenile salmon made up 75 to 90 percent of the terns' diet.)

In 2009, the East Sand Island tern colony consumed approximately 6.4 million juvenile salmon (*http://www.birdresearchnw.org/CEDocuments/Downloads_GetFile.aspx?id=391157&fd=0*). In comparison, in 1999, the colony consumed about 15 million salmon when located at Rice Island. Approximately 12,087 pairs of Caspian terns nested on East Sand Island in 2009, about 10 percent more than in 2008 (Figure 11).

In 2009, the Corps continued carrying out the Caspian Tern Management Plan with the construction of a second new island at Summer Lake Wildlife Area (east of the Cascades in south central Oregon) for tern relocation before the nesting season. This allowed the managed nesting habitat area on East Sand Island to be reduced to 3.5 acres. Construction of new islands continued during the summer of 2009 with the creation of an additional one-half acre island at Summer Lake, as well as three new islands in the Klamath Basin at the Tule Lake and Lower Klamath National Wildlife Refuges. As of the end of 2009, no Caspian terns had nested on the island created in 2008 at Fern Ridge Reservoir, while nearly 700 breeding pairs were attracted to the Island constructed in 2008 at Crump Lake. At all of the islands constructed or enhanced through the tern management plan, social attraction, tern decoys, and tern colony sounds were used in spring 2009 to attract terns.

In 2009, East Sand Island had the largest double-crested cormorant colony in western North America. This consisted of about 12,087 breeding pairs that consumed an estimated 11.1 million juvenile salmonids, mostly sub-yearling Chinook salmon. By comparison, in 1989, the cormorant nesting population on East Sand Island totaled only about 100 pairs. As a result of the growing consumption by cormorants, in 2009 the federal agencies accelerated development of a Double-crested Cormorant Management Plan using techniques similar to the current Caspian Tern Management Plan.

Caspian terns and double-crested cormorants are also responsible for most avian predation losses along the mid Columbia River. On Crescent Island in the McNary Pool, 349 breeding pairs of Caspian terns (the lowest number since monitoring began in 1997) consumed an estimated 360,000 juvenile smolts. The largest Caspian tern colony on the Columbia Plateau in 2009 (486 nesting pairs) was on Goose Island in Potholes Reservoir. PIT tag recoveries at this site indicate that around 15.5 percent of Upper Columbia steelhead passing Rock Island Dam in 2009 was consumed by Caspian terns from Goose Island. In 2009, 310 nesting pairs of cormorants were found on Foundation Island, and 810 nesting pairs were observed at the north end of Potholes Reservoir. Both of these colonies have declined somewhat over the last four years. An estimated 200 to 400 cormorants overwintered on the lower Snake River with juvenile salmonids consisting of about 13 percent of their diet.

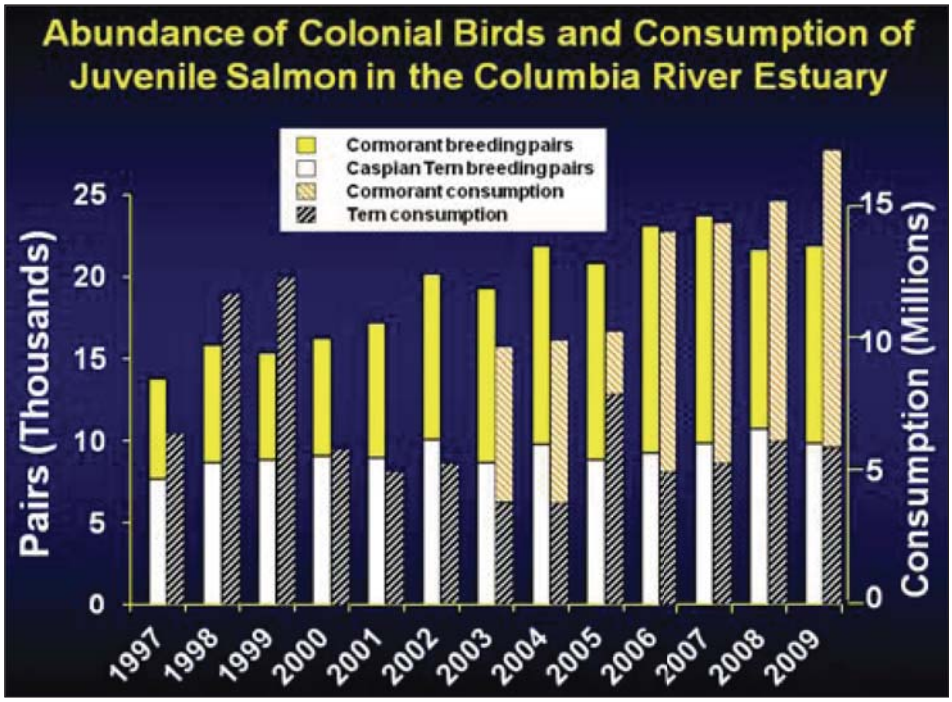
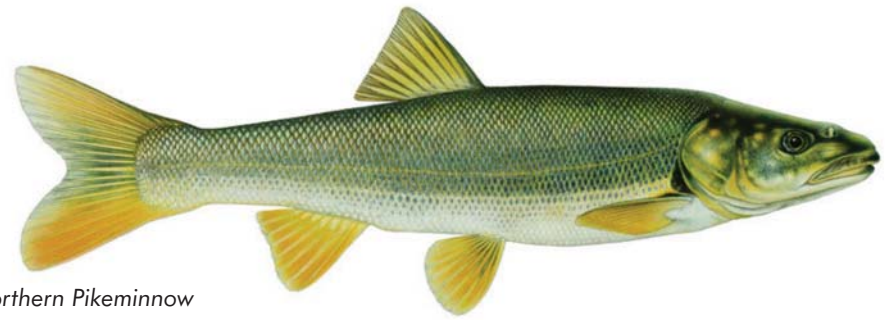


Figure 11. Abundance of Colonial Birds and Consumption of Juvenile Salmon in the Columbia River Estuary. Source: Columbia Basin Fish and Wildlife Authority, Status of Fish and Wildlife Resources in the Columbia River Basin - 2010. http://sotr.cbfwa.org/RES_Downloads.cfm?mnu=RES



Northern Pikeminnow

Northern Pikeminnow

Large northern pikeminnow are voracious consumers of juvenile salmon. Since 1990, BPA has funded the Northern Pikeminnow Management Program (NPMP) to reduce the numbers of larger pikeminnow and improve survival of juvenile salmon. The NPMP relies on private-sector fishing efforts to provide the majority of the catch of northern pikeminnow. In 2009, the BPA reward for the catch of this predator was sustained at a higher-tiered monetary level initiated in 2005. This reward structure helps sustain the higher catches and, in 2009, resulted in the highest harvest rate of pikeminnow since program inception.

In addition, program managers reinstated a dam-angling program component for the first time since 2001. This program provided two fishing crews that focused on the forebay and tailrace sections of the Bonneville and Dalles dams—areas not accessible to the general fishing public. Also in 2009, evaluation crews were able to tag 80 percent more pikeminnow than in 2008, to better evaluate the benefits of predator management. The NPMP has removed more than 3.3 million pikeminnow from the Columbia River since 1990. Evaluation indicates that, as a result, pikeminnow predation on juvenile salmon has declined 38 percent In that time, saving 4 to 6 million juvenile salmon annually that otherwise would have been eaten by this predator.

California Sea Lions at Bonneville Dam

In recent years, California sea lions, which are protected under the Marine Mammal Protection Act (MMPA), have been observed swimming more than 140 miles up the Columbia River to Bonneville Dam to prey in increasing numbers on adult spring Chinook salmon, winter steelhead, and white sturgeon. Generally arriving from mid to late February and leaving by the first week in June, these male sea lions are gaining weight in preparation for the summer mating season.

Corps biologists began gathering data on sea lion presence and predation at the dam in 2001, when six California sea lions were documented. In 2002—the first full season of monitoring—30 sea lions were counted. In 2004, 101 sea lions were counted, and in 2005 the number was estimated at 87 or more. From 2006 to 2008, the number increased from 72 to 84. Not all sea lions counted were at the dam at the same time; usually about 30 were present on any one day. The number of fish eaten by sea lions has increased every year from 2006 to 2009 (Table 2). In 2002, the expanded consumption estimate was 1,010 adult salmon and steelhead that would otherwise have passed Bonneville Dam from January 1 through May 31. In 2009, the expanded consumption estimate was 4,489 adult salmon and steelhead (Table 2, Figure 12). Stellar sea lion numbers and salmon consumption nearly doubled in 2009. For more information, see http://www.nwd-wc.usace.army.mil/tmt/documents/fish/2009/sea_lion_hazing2009.html.

The Corps has implemented a variety of sea lion deterrents, from physical barriers to non-lethal harassment. Sea lion exclusion devices were installed at Bonneville Dam to prevent sea lions from entering the fish ladders through the 12 primary fishway entrances. Corps biologists also coordinated with U.S. Department of Agriculture personnel and boat-based crews from the Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife (WDFW), and CRITFC on all sea lion harassment activities at Bonneville Dam. In addition, the Action Agencies supported CRITFC in conducting monitoring and non-lethal harassment efforts to deter marine mammal predation downstream of the dam.

In 2009, under the MMPA nuisance sea lion removal authority, the states removed 14 California sea lions (in addition to the 11 removed in 2008). Even with the removal of 25 targeted

Year	Bonneville Dam salmonid passage (Jan. 1-May 31)	Expanded salmonid consumption estimate		Adjusted salmonid consumption estimate	
		Estimated consumption	% of run (Jan. 1 to May 31)	Estimated consumption	% of run (Jan. 1 to May 31)
2002	284,733	1,010	0.4 %	-	-
2003	217,185	2,329	1.1 %	-	-
2004	186,804	3,533	1.9 %	-	-
2005	82,006	2,920	3.4 %	-	-
2006	105,063	3,023	2.8 %	3,401	3.1 %
2007	88,474	3,859	4.2 %	4,355	4.7 %
2008	147,543	4,466	2.9 %	4,927	3.2 %
2009	186,060	4,489	2.4 %	4,960	2.7 %

Table 2. Consumption of Salmonids by California Sea Lions, Steller Sea Lions, and Harbor Seals at Bonneville Dam, From Surface Observations Conducted Between 2002 and 2009. Total salmonid passage counts include all adult salmonids that passed Bonneville Dam from January 1 through May 31. "Expanded" estimates correct for the fact that observers are not present at all times. "Adjusted" estimates further correct to account for catch events where the prey species could not be identified.

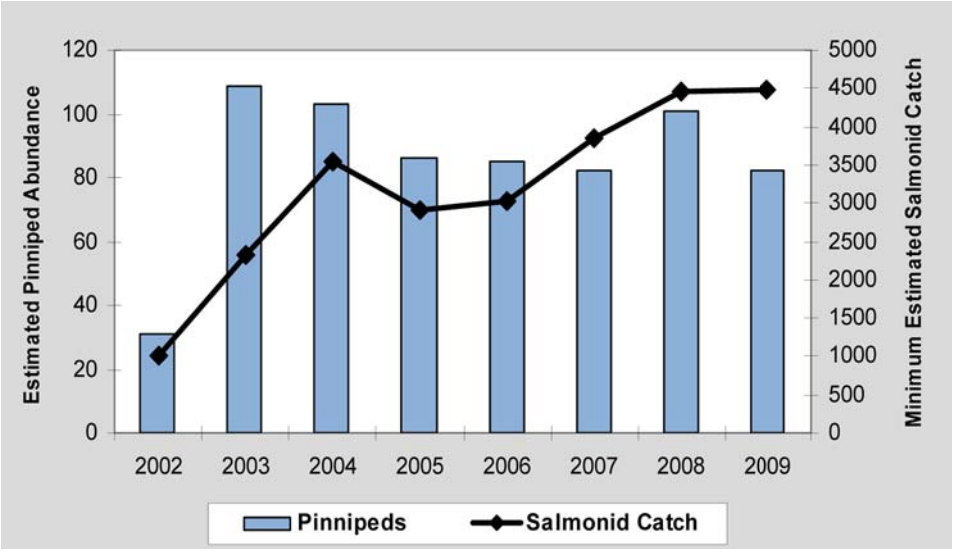


Figure 12. Estimated Minimum Number of Adult Salmonids Consumed by Pinnipeds and Estimated Total Number of Pinnipeds Seen at Bonneville Dam January 1–May 31, from 2002 to 2009. In 2005, regular observations did not start until March 18. Pinnipeds observed included California sea lions, Steller sea lions, and harbor seals. Source: 2009 Field Report: Evaluation of Pinniped Predation on Adult Salmonids and Other Fish in the Bonneville Dam Tailrace
http://www.nwd-wc.usace.army.mil/tmt/documents/fish/2009/2009_Pinniped_Report.pdf

California sea lions, the numbers of salmon being consumed remained high. Had those sea lions not been removed, however, up to 1000 additional salmon may have been consumed over the last two years.

Habitat Protection and Improvement Actions

Columbia River habitat, both estuary and tributary, is important to salmon in their complex life cycle. Each year, the Action Agencies spend tens of millions of dollars under the RPA and the Columbia Basin Fish Accords to implement actions that improve the quantity and quality of habitat used by salmon in the estuary and tributaries. In coordination and partnership with tribes and federal, state, and local parties, the Action Agencies are increasing the volume of water in streams, installing or retrofitting fish screens at water diversions to keep fish safely out of irrigation canals, reconnecting side channels and floodplains to add complex and diverse habitats, removing barriers to fish passage, and acquiring easements or other protective interests for riparian areas along tributaries.

Tributary Habitat

In 2009, the Action Agencies continued to expand an already significant tributary habitat program and took steps to target key factors known to limit the survival of specific salmon and steelhead populations. The expanded program uses up-to-date biological information to target habitat actions to fish populations with the greatest biological need, combined with the advice of local expert panels which identify and prioritize the most biologically appropriate actions for those populations. In addition to these ongoing population-focused efforts, the Action Agencies maintained or expanded their current overall level of effort for other anadromous fish populations.

Projects to protect, improve, or restore critical fish habitat employ different approaches targeted to the specific limiting factors found in the individual watersheds. The following sections summarize Action Agency accomplishments in 2005 to 2009 and provide specific examples of the work completed in 2009. For perspective, we also show cumulative accomplishments from 2005 through 2009. While this report emphasizes completed work, there are also many additional tributary habitat projects underway for completion by 2012.

Increasing Water Quantity and Quality through Water Transactions

Fish can perish from the combined effect of naturally low summer flows and water withdrawals for human uses. One of the most effective and immediate steps the Action Agencies may take to improve fish habitat is to lease or purchase water rights or install water efficiency improvements to increase the amount of water in streams. This in turn provides immediate improvements to salmon and steelhead survival by reducing thermal stress and providing higher quality habitat for spawning and juvenile rearing. Since 2005, the Action Agencies acquired instream water to conserve or protect close to 240,000 acre-feet and 1,200 cubic feet per

BPA has supported work by the Washington Water Trust and Colville tribe to increase flows in Salmon Creek and help enhance steelhead passage to 14 miles of stream. Before, above left. After, above right.


Photos. Snake River Chinook and steelhead in the Lemhi watershed benefitted from over 1,800 acre-feet of water and summer passage when irrigators collaborated on multiple water transactions.

second (cfs) of water in the Columbia River Basin (Figure 13).

The primary mechanism BPA uses to increase water quantity is through the Columbia Basin Water Transactions Program (CBWTP). One highlight from this program in 2009 was the agreement to provide up to 29.9 cfs (equivalent to 700 acre-feet) of instream flow to Salmon Creek in the Okanogan subbasin to improve passage for threatened Upper Columbia River steelhead. The purposes of this water acquisition project are to rewater 4.3 stream miles in Salmon Creek by increasing flows and to enhance other fish passage efforts by the Colville tribe under their Fish Accord, that provide steelhead access to 14 miles of habitat along the creek.

For 2009, water transaction highlights also included seven permanent conservation agreements and an annual diversion reduction agreement in the Lemhi watershed to increase flows and provide upstream and downstream passage at a critical passage point for Snake River steelhead and Snake River spring/summer Chinook populations. By working with multiple landowners, the Idaho Department of Water Resources developed agreements to secure over 1800 acre-feet of water annually and increase flows to 25-35 cfs during the summer to ensure fish passage.

This collaborative effort to combine multiple water transactions in the Lemhi has helped create a viable passage corridor for steelhead and Chinook, and it marks the initial set of BPA-supported water transactions through the CBWTP and the Fish Accord with Idaho. The cumulative effect of these water transactions is resulting in improved habitat conditions for salmon and steelhead in the basin.

Improving Habitat Complexity

Salmon evolved in streams with multiple channels that meandered and flooded seasonally. These processes created complex habitats that provided important rearing areas for juvenile salmon and steelhead, as well as cool-water refuges during the heat of summer. Human development has changed the nature of most of the Columbia River Basin's river systems, depriving salmon of some of these habitat attributes.

An important component of the Action Agencies' habitat program involves funding actions and providing technical assistance to improve channel complexity by reconnecting side channels and, where feasible, increasing floodplain function to improve instream habitat conditions. The Action Agencies have improved more than 100 miles of stream since 2005, with nearly 12 miles completed in 2009 (Figure 14)

One example of this type of work involved the placement of boulders and large wood within the West Fork Neal Creek, in Hood River County, Oregon. Seventy-five logs were placed at six sites in the wetted stream channel of West Fork Neal Creek and its floodplain. Fifty-five of these logs were harvested from adjacent Hood River County lands as whole trees with rootwad attached. The remainder of the logs were cut logs transported to the project area to be used in the uppermost treatment sites. Ten boulders were harvested on site and used as ballast for the cut logs. These boulders and large wood will help increase holding, spawning, and rearing habitat for ESA-listed winter steelhead, Coho salmon, and resident trout.

Improving and Protecting Riparian Areas to Improve Water Quality

Riparian habitat—the streamside environment—makes a major contribution to water quality and juvenile salmon survival. Although actions to improve and restore degraded riparian habitat can take years to yield results, they are nonetheless an essential element of a strategy to improve salmon habitat. Because these actions can help moderate stream temperatures, they are an important hedge against the longer-term effects of climate change, which are expected to cause stream temperatures to increase seasonally throughout the Columbia River Basin.

Riparian habitat can be protected through land purchases or conservation easements, which aim to reduce adverse land use impacts. In many instances, plantings or natural revegetation can reestablish a viable riparian zone by providing shade and other benefits for the stream. Since 2005, the Action Agencies have improved more than 5,000 acres and protected nearly 47,000 acres. In 2009, BPA funded projects to improve nearly 1,900 acres of riparian vegetation, protected through lease or purchase more than 9,300 acres of riparian habitat, installed fencing along 27 stream miles, and improve or relocate about 3.6 miles of roads in riparian areas. These projects are expected to provide habitat benefits that will help keep water cool and clean for ESA-listed populations (Figure 15).

For example, in 2009, BPA funds were used to re-contour the stream channel and plant seven miles of vegetation along the South Fork Salmon River in Idaho. The riparian planting work included clump planting, seeding, and straw and rock placement to reduce erosion.

As the riparian vegetation from these projects matures over time, it will help shade and cool the stream water and

provide opportunities for recruitment of the large woody debris needed for habitat complexity.

Reducing Fish Entrainment at Irrigation Diversions

The Action Agencies have been funding projects to replace, improve, and install fish screens at irrigation diversions to prevent fish from becoming trapped in or entrained into irrigation ditches. The fish screens, which are designed according to state and federal criteria, keep fish in the streams (i.e., out of irrigated fields) and thus provide immediate improvements to juvenile fish survival. Fish entrainment is also reduced by consolidating irrigation diversions and replacing instream diversions with groundwater wells, allowing water to be diverted for irrigation and reducing or eliminating entirely the need for an associated fish screen. In 2009, the Action Agencies addressed fish entrainment at five locations and installed more than 60 fish screens.

Improving Access to Spawning and Rearing Habitat

Human development has restricted access to significant portions of the historical range of Columbia River Basin salmon and steelhead in many Columbia River tributaries. Many of these blockages can be fixed with negligible economic impact, providing a big biological boost to fish. Since 2005, the Action Agencies have improved access to approximately 845 miles of instream habitat for anadromous fish (Figure 16).

In 2009, the Action Agencies funded projects that opened nearly 265 miles of fish habitat. One example of this type of work involved the removal of a culvert in Salt Creek, Idaho, on the South Fork Salmon River. The existing culvert was acting as a migration barrier to Chinook, steelhead, bull trout, and westslope cutthroat. Replacing the culvert with a bridge opened 3.6 miles of fish habitat.

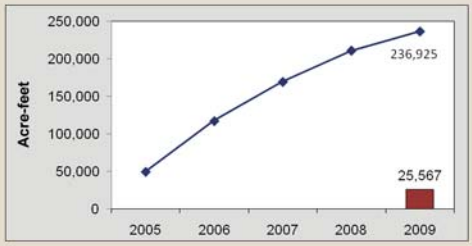


Figure 13. Water Protected, in Acre-Feet and Cubic Feet per Second of Flow, 2005-2009.

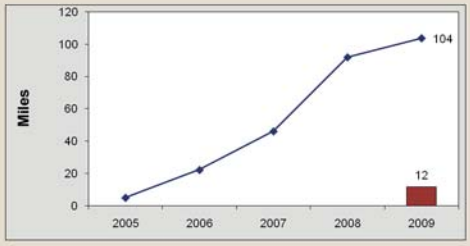


Figure 14. Miles of Stream with Complexity Improvements, 2005-2009

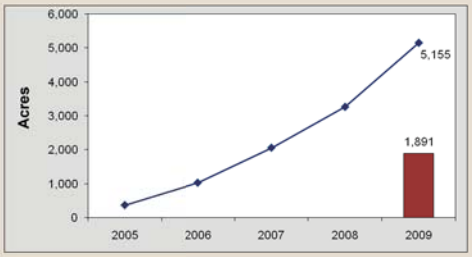


Figure 15. Acres of Habitat Improved, 2005-2009. Note: Improvement measures include creating, connecting, or realigning channels; conducting controlled burns; planting; practicing no-till farming; removing mine tailings and invasive plant species; enhancing floodplains; or restoring wetlands.

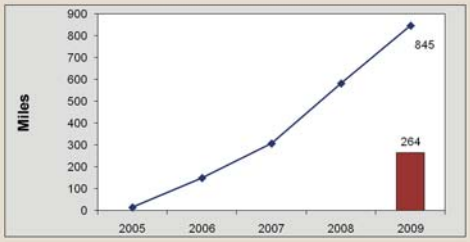
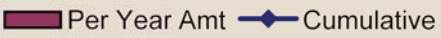


Figure 16. Miles of Habitat Made Accessible, 2005-2009



Estuary Habitat Actions

Fish from throughout the Columbia River Basin use the Columbia River Estuary for varying amounts of time during all months of the year. The estuary's diverse habitats provide food and refuge for juvenile salmon for rearing and migrating as they make their critical transition from fresh water to salt water. Adult salmon returning to the Columbia River also must pass through the estuary.

In 2009, the Action Agencies entered into a Memorandum of Agreement with the state of Washington and expanded funding to implement on-the-ground projects to address biological priorities and key factors that limit fish survival in the estuary. Project types included the protection and restoration of remaining high-quality, off-channel habitats, reduction of invasive plants, and protection and restoration of riparian and wetland areas. In 2009, the Action Agencies completed seven on-the-ground habitat projects in the estuary, with another nine projects in the planning and development phase.

One of the estuary habitat projects implemented by the Action Agencies in

Replacement of a culvert on Salt Creek with a bridge (above right) opened 3.6 miles of habitat.

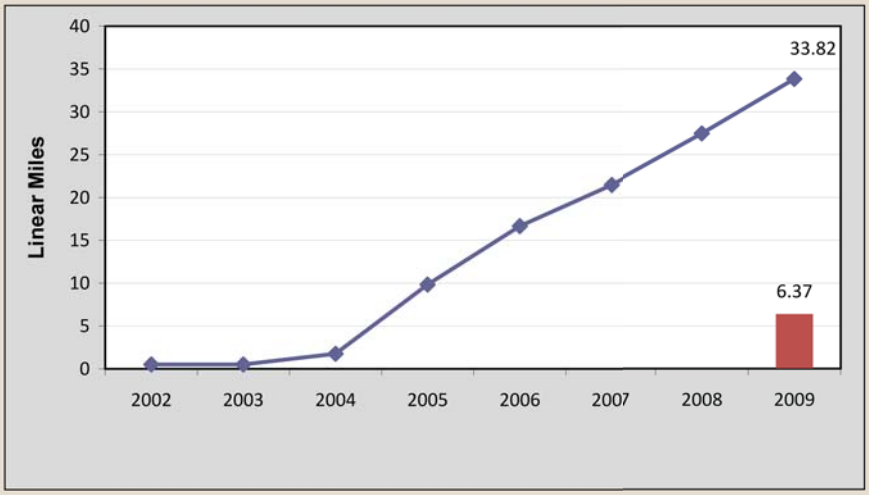


Figure 17. Estuary Riparian Areas Improved 2002-2009. Improvement measures include fencing, native riparian plantings, removal of invasives, and increasing complexity by adding large woody debris.

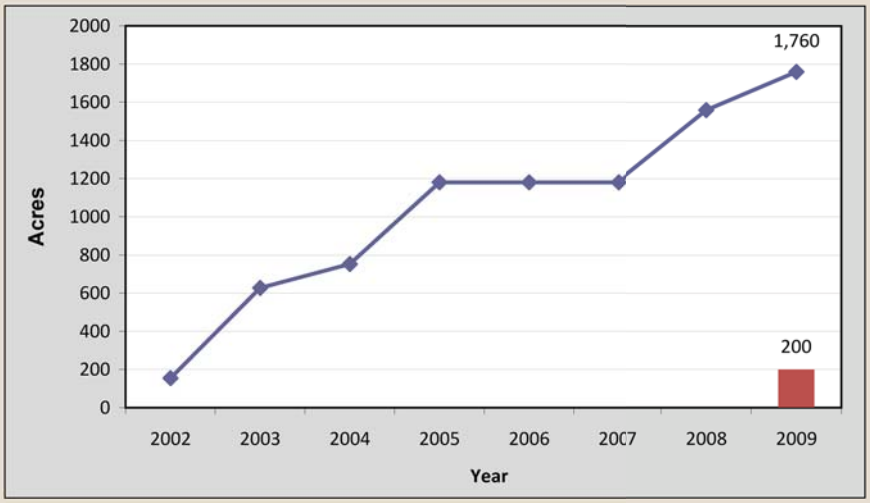


Figure 18. Estuary Habitat Acquired, 2002-2009. Habitat acquired includes land acquisitions for future restoration activities.

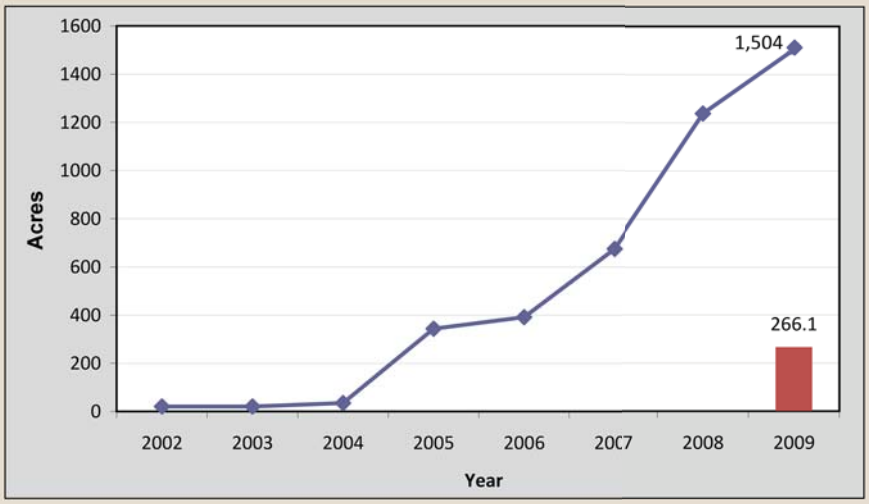


Figure 19. Estuary Floodplain Improved, 2002-2009. Improved access includes breaching or lowering dikes and levees, installation of fish passage structures, and enhancing floodplains for juvenile salmon benefit.

2009 was the Grays River Restoration Project. The objective of this project is to restore habitat-forming processes to enhance salmon and steelhead populations in the Grays River, a Columbia River tributary. The major components of this project included planning, design, installation, and monitoring of five engineered logjams (ELJ) that aid in rejuvenating historical channel and floodplain processes. Additional restoration measures included reforesting the riparian corridor to enhance future large woody debris recruitment and investigation of conservation activities within ecologically critical areas. Monitoring was integrated with restoration activities to evaluate restoration effectiveness and allow for adaptive management of future restoration treatments as well as other degraded watersheds in the lower Columbia River.

In 2009, LCREP carried out a NOAA Fisheries-funded pile structure removal pilot project, with monitoring provided by the Corps of Engineers, leading to a report on the feasibility of assessing the effects of removal projects. The Corps started the contracting process for a study to identify which pile dike structures were still needed to meet its navigation requirements. The Corps also determined that, because its pile structures were congressionally authorized, additional process may be

Table 3. Summary of Estuary Habitat Metrics, 2009.

Action	Metric
Improve and Restore Streams/Channels	6.34 linear miles
Plant/Maintain Native Vegetation	241 acres
Remove Invasive Plant Species	25 acres
Restore Riparian Wetland Areas	1 acre
Restored riparian forest habitat	210 acres
Restored backwater shallow water habitat	87 acres
Land Acquisition (Future restoration actions will be implemented on land acquisitions.)	200 acres

required before removal can occur. As a result, near-term emphasis turned to removal of pile fields. The Action Agencies, with LCREP and others, worked on planning for pile field removal pilot projects, and three pile fields were identified as possible pilot project candidates.

Table 3 summarizes the estuary habitat metrics accomplished in 2009 with Action Agency funding assistance. Figures 17, 18, and 19 show cumulative improvements since 2002.

Projects for future implementation are now being identified using emerging tools such as the Columbia River Estuary Ecosystem Classification System (CREEC). CREEC is being developed by scientists from the University of Washington and the United States Geological Survey, and is scheduled for completion in 2012. CREEC will help local experts, planners, and project managers strategically identify and select restoration and protection projects in the estuary that provide the highest benefits for the 13 listed ESUs in the Columbia River.

Hatchery Actions

The Action Agencies continue to fund an extensive existing hatchery program as offsite mitigation for the federal dams, including conservation hatcheries for listed fish, while preparing for scientifically based hatchery reforms throughout the Columbia River Basin. BPA funded the Hatchery Scientific Review Group (HSRG) process in 2009 to help the HSRG to complete its comprehensive review and analysis of all Columbia River Basin hatchery programs and prepare its final reports with recommendations for hatchery reform. The Action Agencies' strategy is to ensure that FCRPS mitigation hatchery programs are aiding conservation and not impeding recovery of salmon ESUs or steelhead DPSs by reforming hatchery operations to reduce the genetic and ecological effects on ESA-listed salmon and steelhead.

The Lower Snake River Compensation Program and WDFW staff continued planning for specific hatchery reform actions to transition the Tucannon River and Touchet River steelhead hatchery programs from Lyons Ferry Hatchery broodstock to local broodstock. The Winthrop National Fish Hatchery continued a pilot program to evaluate longer-term rearing of juvenile steelhead that would be required to transition to

Figure 20. Anadromous fish hatcheries funded by the Action Agencies, including anadromous/resident fish safety-net hatcheries.

a locally adapted steelhead broodstock in the Methow River — a key initiative aimed at addressing one of the factors limiting the productivity of this Upper Columbia River steelhead population.

The Action Agencies also continued to fund safety-net programs to reduce the extinction risk of at-risk populations of ESA-listed Snake River sockeye salmon and Snake River spring/summer Chinook. One of those programs, the Snake River Sockeye Salmon Captive Broodstock Program, preserves this critically imperiled species. The program has produced hundreds of thousands of progeny from remnants of the wild stock. The progeny are raised in carefully managed hatcheries and released into their natural habitats to spawn or migrate downstream. Since 1999, 1,838 adults from the program have returned to Redfish Lake. In 2009, 833 adults returned to the Stanley Basin, eclipsing the 2008 return of 650 adults. The 2009 return was the largest recorded annual return since 1956.

The BiOp calls for the Action Agencies to expand the program to produce between 500,000 and 1 million smolts annually. Throughout 2009, BPA worked with the state of Idaho and Idaho Department of Fish and Game (IDFG) to identify and begin the acquisition process for a hatchery property with adequate water quantity and quality to achieve the expanded production level.

The Action Agencies continued to fund hatchery conservation programs for Upper Columbia, Mid-Columbia, and Snake River steelhead to preserve and rebuild genetic resources and assist in promoting recovery of these DPSs. During 2009, BPA continued funding two projects – one to recondition Columbia and Snake River steelhead Kelts and increase spawner abundance of these threatened DPSs, and another project aimed at reintroducing Columbia River chum salmon in lower Columbia River tributaries below Bonneville Dam and increasing the abundance of this threatened ESU.

Harvest

The overall harvest objective for all ESUs is to improve adult life-stage survival. Harvest of ESA-listed fish species in the Columbia River Basin is managed primarily through state and federal agencies—other than the Action Agencies—and tribes. However, the Action Agencies have supported the identification and implementation of approaches or conservation measures to reduce the effects of harvest on ESA-listed species. In 2009, the Action Agencies continued funding the initial evaluation of several types of live-capture fishing gear that can be used to selectively harvest marked hatchery fish while allowing ESA-listed wild fish to escape unharmed. The main gear type tested in 2009 was the purse-seine in the upper Columbia River below the mouth of the Okanogan River.

Research, Monitoring, and Evaluation

The Action Agencies implement an extensive research, monitoring, and evaluation (RME) program that focuses on maximizing performance of management actions. The RME program is implemented through the NPCC's Fish and Wildlife Program, the Corps' Anadromous Fish Evaluation Program, and Reclamation's technical assistance activities, and it is coordinated with RME activities of other regional agencies. The Action Agencies work closely with the Pacific Northwest Aquatic Monitoring Partnership – a forum for coordinating state, federal, and tribal aquatic habitat and ESA-listed salmon and steelhead monitoring programs; the Columbia Basin Fish and Wildlife Authority; and the state and tribal constituents. The objective is to collaboratively advance a regionally coordinated approach to fish and habitat status monitoring, action effectiveness research, critical uncertainty research, and data management. The RM&E approaches and implementation planning receive oversight and direction through the review of the Action Agency, NPCC, and NOAA Fisheries' BiOp RM&E Workgroup. Additional recommendations on RM&E needs and priorities for fish population monitoring and for hatchery and habitat effectiveness monitoring have been provided by state and tribal fish management agencies through development of the Columbia River Basin Anadromous Salmonid Monitoring Strategy (ASMS).

In 2009, programmatic performance was tracked through project implementation and compliance monitoring, while biological and environmental performance was tracked and evaluated through status monitoring, action effectiveness research, and critical uncertainty research. Performance standards were monitored to ensure accountability and adherence to proposed actions.

The Action Agencies implemented RME projects within nine strategic areas:

- Fish population status monitoring
- Hydro RME
- Tributary habitat RME
- Estuary and ocean RME
- Harvest RME
- Hatchery RME
- Predation and invasive species management RME
- Coordination and data management
- Project implementation and compliance monitoring

Fish Population Status Monitoring

For fish population status monitoring, the Action Agencies continue to monitor the status of ESA-listed fish and enhance the existing status monitoring performed by regional fish management agencies. The ASMS provides a comprehensive strategy for high-precision adult spawner and juvenile productivity monitoring programs for one population per each Major Population Group for each listed ESU or DPS. Supplemental fish population status information is also obtained through multiple hatchery and habitat effectiveness research and monitoring.

Hydro RME

Hydro RME studies were conducted on the juvenile fish transportation program, turbine survival, water temperature, and juvenile and adult dam passage survival and passage efficiency. The

Action Agencies expanded coverage in detecting PIT-tagged fish and improved the ability to evaluate new and alternative fish passage operations and technologies. The Action Agencies tagged more than 2.3 million smolts in 2009.

Tributary Habitat RME

Tributary habitat conditions and limiting factors were evaluated through state of the art "Intensively Monitored Watersheds", which quantify the relationships between habitat conditions and fish productivity. The expansion of habitat status and trend monitoring to support the habitat evaluations for fish habitat condition and climate change for one population per major population group was integrated into the ASMS and will be reviewed by the Independent Scientific Review Panel (ISRP) before implementation in 2010.

Estuary and Ocean RME

Estuary and ocean studies were conducted to evaluate fish performance and life history diversity relative to various habitat areas and key environmental attributes. The bathymetry and topography of the estuary continued to be mapped. Work was also continued on development of the CREEC and on an index of habitat connectivity. The effects of individual habitat actions were assessed and a methodology for estimating the cumulative effects of habitat projects was further developed. Critical uncertainty research was conducted on the importance of different tidal, freshwater, estuary, plume, and nearshore ocean environments, as well as development of a hydrodynamic numerical model to evaluate contemporary and future habitat changes caused by climatic and anthropogenic effects, and to describe the temporal and spatial features of the Columbia River Estuary and plume that are important for salmon in relation to ocean conditions. Early ocean migration and survival studies continued to be implemented and refined.

Harvest RME

Harvest investigations linked to FCRPS interests included feasibility studies for Zone 6 harvest PIT tag recoveries to help refine upstream adult survival rates. Selective fishing methods and gear were evaluated. Support was continued for coded-wire tagging and recovery operations needed to assess the survival, straying, and harvest rates of specific hatchery fish stocks. Further work was advanced on genetic stock identification techniques.

Hatchery RME

Regional coordination of a hatchery action effectiveness program was initiated. The relative reproductive success (RRS) studies of hatchery-origin fish compared to natural-origin fish continued to be assessed for several ESA-listed salmon and steelhead populations. Hatchery studies also continue to assess the effects that hatchery programs and implemented reform actions have on native populations.

Predation and Invasive Species Management RME

Predation RME studies were conducted to evaluate and monitor the Northern Pikeminnow Management Program, avian predation rates on juvenile salmon in the lower Columbia River, and predation rates of California sea lions on adult salmon below Bonneville Dam. Completion of the stock assessment for double-crested cormorants occurred in 2009, and management plans for avian predation and other predation on juvenile salmonids were further advanced. Continued monitoring on the effectiveness of predation management actions were implemented as a component of most predator management projects.

Coordination and Data Management, Project Implementation and Compliance Monitoring

The Action Agencies continued to coordinate RME planning and implementation through the Corps' Anadromous Fish Enhancement Program and the project planning and review efforts of the NPCC's Fish and Wildlife Program. Through the Action Agencies' participation and leadership in regional coordination forums, they continued their support for standardization and coordination of tagging and monitoring efforts and data management. Regional coordination to support the ASMS resulted in a regional strategy for fish status VSP monitoring, habitat action effectiveness and hatchery action effectiveness. It also initiated the development of a data management strategy to support data exchange that will, in turn, support the BiOp and recovery of salmonids.

2009 Accomplishments

WHAT ARE OUR GOALS AND STRATEGIES?	WHAT ARE OUR KEY INITIATIVES?	WHAT ARE OUR KEY ACCOMPLISHMENTS?
HYDROSYSTEM		
Increase the survival rates of fish passing through mainstem dams: • Configure dam facilities to improve juvenile and adult fish passage survival • Manage water to improve juvenile and adult fish survival • Operate and maintain fish passage facilities to improve fish survival	• Operate and maintain adult fish ladders and other fish facilities • Guide juvenile fish away from turbines • Improve passage routes through the dams for juvenile fish to achieve 96 percent dam survival for spring Chinook and steelhead and 93 percent dam survival for subyearling fall Chinook • Manage available water to improve conditions for migrating fish • Transport juvenile fish in barges or trucks past dams in a spread-the-risk approach • Track migrating fish with PIT detection systems • Implement kelt management and reconditioning to improve steelhead productivity	• Water Management, Fish Passage, and Water Quality Plans completed and followed. • The Dalles Dam ▪ Completed first year of construction of extended-length spillwall to improve tailrace conditions. (Construction of spillwall was completed in 2009-2010 maintenance season.) • John Day Dam ▪ Completed second year of post-construction evaluation of two prototype spillway weirs; similar to 2008 results, turbine entrainment was reduced by 50% or more from the baseline. ▪ Continued to develop and improve avian deterrence systems in the tailrace to reduce the high level of juvenile fish predation by birds observed in 2008. • Ice Harbor Dam ▪ Completed the design of a turbine unit to improve juvenile survival and reduce fish passage injury, and solicited a contract for procurement. • Lower Monumental Dam ▪ Completed second year of post-construction evaluation of a spillway weir installed in 2008. Estimates of relative concrete survival for spring migrants exceeded the performance standard, while the estimate for summer migrants was slightly below (92.9%) • Little Goose Dam ▪ Installed and completed a first year post-construction evaluation of a spillway weir. Relative concrete survival estimates exceeded the performance standard for spring and summer migrants. ▪ Completed the installation of a full-flow PIT detector in the juvenile bypass system. ▪ Completed the relocation of the juvenile bypass system outfall. • Kelt Management ▪ Continued development of the Kelt Management Plan, including a synthesis of past migration and reconditioning research and discussion of future directions. ▪ Completed second year evaluation of the potential benefit of providing surface passage routes early in the spring for outmigrating steelhead kelts at The Dalles Dam ice and trash sluiceway. ▪ Opened the corner collector at Bonneville Dam one week early (i.e., April 3). Ongoing research will help inform decisions regarding the long-term operations of surface passage routes for kelt outmigration. ▪ Constructed expanded kelt holding facilities at Lower Granite Dam.

2009 Accomplishments

WHAT ARE OUR GOALS AND STRATEGIES?	WHAT ARE OUR KEY INITIATIVES?	WHAT ARE OUR KEY ACCOMPLISHMENTS?
PREDATOR MANAGEMENT		
Reduce the number of juvenile fish consumed by predators: • Redistribute avian predators • Reduce fish predation • Manage sea lion predation	• Provide alternative Caspian tern habitat in the Western Region to encourage redistribution (began in 2008, will complete around 2012) • Gradually reduce tern habitat in the Columbia River estuary, after alternative habitat is provided in other locations; reduce annual juvenile salmonid consumption by Caspian terns in the estuary to approximately 2.5 million fish • Provide incentives to reduce the number of large northern pikeminnow in the Columbia River • Address presence of sea lions below Bonneville Dam • Monitor predation by sea lions below Bonneville Dam • Initiate further baseline research and development of a future draft environmental impact statement to determine whether double-crested cormorant management is warranted	• Created two one-half acre islands at Summer Lake Wildlife Area for alternative habitat for Caspian tern nesting before the nesting season. • Reduced managed habitat for Caspian tern nesting on East Sand Island to 3.5 acres. • 700 Caspian tern breeding pairs nested on the Crump Lake island in 2009. • After the nesting season, four additional islands were constructed, one at Summer Lake and three in the Klamath Basin. • Continued development of a Cormorant Management Plan, including baseline research and potential management techniques to reduce increasing cormorant predation on juvenile salmon. • Installed a new avian wire array in the tailrace at John Day Dam to reduce the high level of juvenile fish predation by birds observed in 2008, but anchor failures limited effectiveness. Improved array was designed in 2009 for installation in spring 2010. • Continued hazing of sea lions below Bonneville Dam and installed sea lion exclusion devices (SLEDs) at Bonneville Dam. • Monitored sea lion abundance, predation, and distribution and the effectiveness of deterrent activities below Bonneville Dam. • Removed more than 147,000 northern pikeminnow from the Columbia River in 2009; reduced their predation of juvenile salmon by about 40 percent since 1990. • Increased northern pikeminnow tagging for evaluative purposes by nearly 80 percent over previous years.

2009 Accomplishments

WHAT ARE OUR GOALS AND STRATEGIES?	WHAT ARE OUR KEY INITIATIVES?	WHAT ARE OUR KEY ACCOMPLISHMENTS?
HABITAT		
Improve tributary and/or estuary habitat used by salmon for spawning or rearing: • Protect and improve tributary habitat based on biological needs and prioritized actions • Improve juvenile and adult fish survival in estuary habitat	Tributary • Increase streamflow via water acquisitions • Address entrainment through screening • Provide fish passage and access • Improve mainstem and side-channel habitat conditions • Protect and enhance riparian conditions Estuary • Acquire, protect, and restore • off-channel habitat • Restore tidal influence and improve hydrologic flushing • Restore floodplain reconnection by removing or breaching dikes or installing fish-friendly tide gates • Remove invasive plants and weeds; replant native vegetation • Protect and restore emergent wetland habitat and riparian forest habitat • Restore channel structure and function • Develop and implement a piling and pile dike removal program	Tributary • Protected more than 190 cubic feet per second (cfs) and 25,000 acre-feet of streamflows throughout tributaries in the Columbia River Basin • Addressed fish entrainment in five locations and installed over 60 fish screens • Improved or opened access to nearly 265 miles of spawning and rearing habitat • Improved nearly 1,900 acres of riparian habitat and increased the complexity of more than 10 miles of streams used by anadromous fish • Leased or purchased more than 9,300 acres of riparian habitat, and improved or relocated more than 3.6 miles of roads located in or along riparian areas Estuary • Improved and restored 6.34 linear miles of stream/channels • Planted and maintained 241 acres of native vegetation • Removed invasive plant species from 25 acres • Restored one acre of riparian/wetland • Restored 210 acres of riparian forest habitat • Restored 87 acres of backwater shallow water habitat • Funded acquisition of 200 acres of land for protection and/or restoration
HATCHERIES		
Use hatcheries to address the biological priorities of ESA-listed salmon and steelhead: • Implement safety-net programs to avoid extinction • Implement conservation hatchery programs to build genetic resources and assist with promoting recovery • Reduce potentially harmful effects of artificial production	• Intervene with artificial production techniques to avoid extinction of fish populations facing a high risk of extinction • Use artificial production techniques to build genetic resources and abundance of listed populations at low levels. • Modify hatchery practices or facilities, if needed, to reduce or eliminate detrimental genetic and ecological effects on listed populations	• Funded safety-net hatchery programs that reduced the extinction risk of populations of Snake River sockeye, and spring/summer Chinook. • Funded conservation hatchery programs for populations of Upper Columbia River spring Chinook salmon and steelhead, Mid-Columbia River steelhead, Snake River steelhead, and Columbia River chum salmon. • Action Agency-funded hatchery operators continued to develop updated Hatchery Genetic Management Plans (HGMP) that will be submitted to NOAA Fisheries for ESA consultation. In 2009 HGMPs for Leavenworth, Entiat and Winthrop hatcheries were submitted to NOAA Fisheries.

2009 Accomplishments

WHAT ARE OUR GOALS AND STRATEGIES?	WHAT ARE OUR KEY INITIATIVES?	WHAT ARE OUR KEY ACCOMPLISHMENTS?
RESEARCH, MONITORING AND EVALUATION		
Provide information needed to support planning and adaptive management and demonstrate accountability. The Action Agencies are undertaking RME through project implementation and compliance monitoring, status monitoring, action effectiveness research, and critical uncertainties research in nine strategic areas.	Implement RME in nine strategic areas: • Fish population status monitoring • Hydro RME • Tributary habitat RME • Estuary and ocean RME • Harvest RME • Hatchery RME • Predation and invasive species management RME • Coordination and data management • Project implementation and compliance monitoring	• The Action Agencies worked with regional fish and wildlife agencies and tribes to develop the Columbia Basin Anadromous Salmonid Monitoring Strategy, which identifies monitoring projects that meet RPA requirements for fish population status monitoring and habitat and hatchery action effectiveness research. BPA implemented 60 projects to monitor status of selected fish populations' viability attributes related to FCRPS actions and supported annual population status assessments. • BPA implemented 23 projects to monitor and evaluate fish survival, migration characteristics, and river conditions within the FCRPS to support findings of improved hydro system survival. • BPA and Corps implemented 29 projects to monitor and evaluate the effects of configuration and operation of the FCRPS. • BPA and Corps implemented 21 projects to investigate critical uncertainties related to hydropower operations and investigated new technologies. • BPA and Reclamation implemented 52 projects to monitor and evaluate tributary habitat conditions and limiting factors and evaluated the effectiveness of tributary habitat actions. • BPA and Corps implemented 10 projects to monitor and evaluate estuary and nearshore ocean fish performance, migration characteristics, and environmental conditions. • BPA and Corps implemented seven projects to monitor and evaluate the effects of habitat actions in the estuary. • BPA and Corps implemented 10 projects to investigate critical uncertainties related to the estuary and ocean. • BPA implemented 47 projects for select harvest investigations; including genetic stock identification, linked to FCRPS interests. • BPA and Corps implemented 57 projects to monitor hatchery management effectiveness and investigated critical uncertainties related to hatcheries. • BPA and Corps implemented eight projects to monitor and evaluate piscivorous, avian, and marine mammal predation and the effectiveness of management actions. • BPA and Reclamation implemented 12 RME projects to facilitate coordination activities between other federal, state, and tribal agencies to support implementation of the RME work group recommendation report through standardization of methods and protocols and implement BiOp monitoring needs. • BPA and Reclamation implemented nine projects focused on archiving information in appropriate data management systems to support BiOp assessments. • The Action Agencies implemented RME action tracking systems to better support NOAA Fisheries data needs. This alignment supports comprehensive implementation monitoring and the evaluation of ecological and fish response suites of habitat actions.

Overview by Species

The following summaries primarily describe abundance and abundance trends at the species or ESU level as of December 2009. Species-level status is determined based on a review of population-level status and includes consideration not just of abundance, but also productivity, spatial structure, and diversity. These are the attributes of a viable salmonid population. The following section includes a brief review of some of the population-level information in the 2008 FCRPS BiOp, which contains a much more thorough review of the status of independent populations within each ESU. Figures 21 through 27 display natural spawners only (with the exception of sockeye populations, which are sustained through a captive broodstock program).[6]

Snake River Fall Chinook Salmon

The Snake River fall Chinook salmon ESU was listed under the ESA as a threatened species in 1992. This ESU is composed of only one extant population, which spawns and rears in the mainstem Snake River and in the lower reaches of its major tributaries below Hells Canyon Dam. It is estimated that 85 percent of the ESU's historical spawning habitat was lost as a result of construction of the privately owned Hells Canyon Dam complex, which blocks all fish passage.

The most recent 10-year average return of natural-origin fish (through 2008) is estimated to be 2,540 adults. The most recent four-year average return is 2,307 adults (Figure 21). Estimates of natural-origin adult abundance were not available for 2009.

Returns of natural-origin Snake River fall Chinook salmon have trended upward since 1990. The FCRPS BiOp considered trends of natural-origin adults based on two time periods with differing management actions and climate: 1977-2004 and 1990-2004. Although abundance trends were positive for both periods, productivity measured as returns-per-spawner (R/S – a measure of productivity) were positive only for 1990-2004. These estimates represent average survivals during the periods in question and do not fully reflect survival improvements resulting from more recent hydrosystem improvements and other management changes.

[6] *Abundance charts in this report show ESU-level abundance from 1990 until the most recent available observation, consistent with the 2008 BiOp's "short-term" trend estimation period. The exception is the Middle Columbia Steelhead DPS, which is represented by the Yakima River Major Population Group. Estimates are of naturally produced adult returns provided by NOAA Fisheries. Trend lines are shown where the 1990-present trend is statistically significant (p<.05). The trend estimation method is taken from Good et al. (2005).*

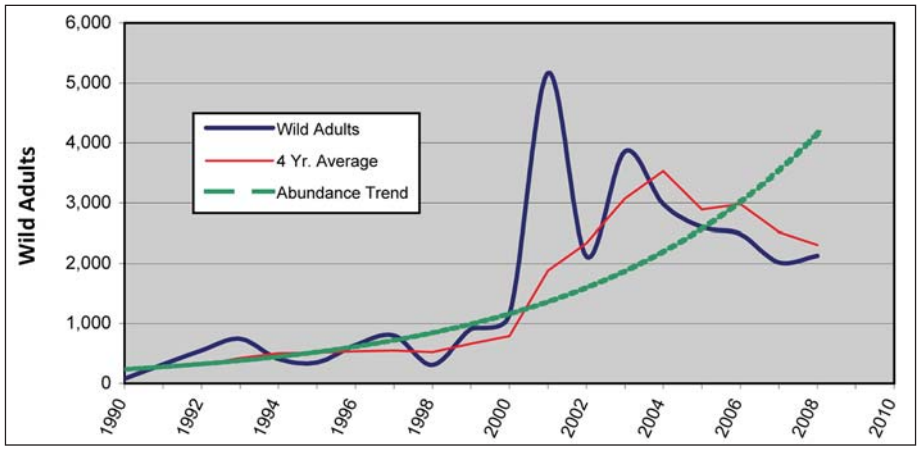


Figure 21. Returns of Naturally Produced Adult Snake River Fall Chinook Salmon at Lower Granite Dam, 1990-2008.

Snake River Spring/Summer Chinook

The Snake River spring/summer Chinook salmon ESU was listed under the ESA as a threatened species in 1992. The ESU is composed of 28 extant populations in five major population groups. The populations in this ESU spawn and rear in the tributaries of the Snake River between its confluence with the Columbia River and the Hells Canyon Dam.

The most recent 10-year average return of natural-origin Snake River spring/summer Chinook salmon was 19,367 adults. The most recent four-year average return was 12,040 adults (Figure 22). An analysis of adult returns from 1990-2009 indicates that the ESU-level trend in abundance was positive during this period, though the trend was not statistically significant.

The FCRPS BiOp considered population-level information based on adult returns from 1984-1986 through 2003-2005. Population-level abundance trends of natural-origin adults during this time period were generally positive. However, recruit-per-spawner productivity estimates were generally negative. These estimates represent average survivals during the periods in question and do not fully reflect survival improvements resulting from more recent hydrosystem improvements and other management changes.

Table 4 summarizes the tributary habitat metrics completed since 2005 with Action Agency support in areas used by Snake River spring/summer Chinook.

Snake River Sockeye Salmon ESU

The Snake River sockeye salmon ESU was listed under the ESA as endangered in 1991. The ESU includes all anadromous and residual sockeye in the Snake River Basin, as well as the artificially propagated fish from the Redfish Lake Captive Broodstock Program. This species was thought by

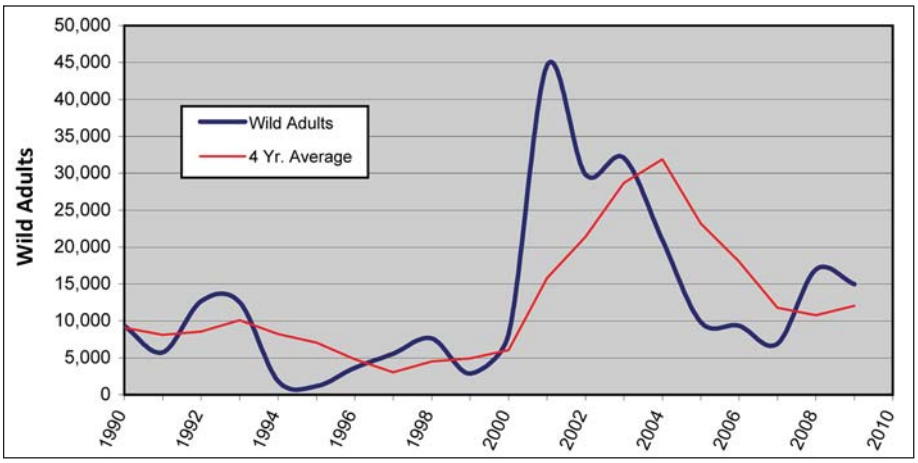


Figure 22. Returns of Naturally Produced Adult Snake River Spring/Summer Chinook Salmon at Lower Granite Dam, 1990-2009. The ESU-level trend in abundance was positive during this period, though the trend was not statistically significant and therefore is not displayed on this graph.

Table 4. Snake River Spring/Summer Chinook Tributary Habitat Improvement Metrics, 2005-2009

Metric	2009	2005-2009
Acre-feet/year of water protected	4623	48007
Acres improved	280	1744
Acres protected	221	1067
Water flow protected (cfs)	58	464
Miles of enhanced or newly accessible habitat	87	277
Miles of improved stream complexity	4	13
Miles protected	12	44
Screens installed or addressed	10	39

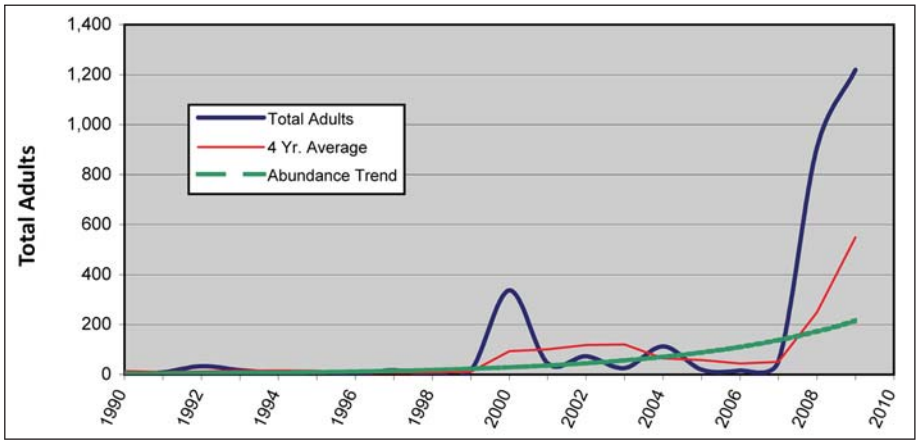


Figure 23. Returns of All Snake River Sockeye Salmon at Lower Granite Dam, 1990-2009.

some to be functionally extinct at the time of its listing. It had suffered from significant long-term harvest pressures, a state-sponsored fish eradication program that eliminated it from three of its natal lakes, private dams with little or no fish passage, construction of the federal dams on the lower Snake River, and a major detrimental ocean/climate shift in the mid 1970s.

An experimental captive broodstock program was initiated at the time of listing in an effort to forestall complete extinction in the near term and to preserve the species' remaining genetic diversity. The program has achieved its original purpose and is now being expanded to help support recovery.

The average annual adult return from the captive broodstock program between 1991 and 1999 was 11 fish. The average return from 2004 to 2007 was 50 fish. 2008 and 2009 saw extraordinary returns of 907 and 1,219 fish, respectively, as counted at Lower Granite Dam (Figure 23). These were the largest sockeye returns since fish counts began at Lower Granite Dam in 1975. The Northwest Fisheries Science Center attributed the increased numbers in 2008 to favorable ocean conditions and an increase in smolt releases from the captive broodstock program (Factors Affecting Sockeye Salmon Returns to the Columbia River in 2008, by NOAA-NWFSC, 2009).

Snake River Steelhead DPS

The Snake River steelhead distinct population segment (DPS) was listed as threatened in 1997. The DPS is composed of 24 individual populations in five major population groups. Steelhead of the Interior Columbia River Basin, and especially the Snake River DPS, are commonly referred to as either A-run or B-run. These designations are based on migration timing, age, and size at return. There is only marginal information regarding the status of most individual populations of Snake River steelhead, but it is believed that B-run steelhead spawn almost entirely in the Clearwater and Salmon rivers, while A-run steelhead occur throughout the Snake River Basin.

The most recent 10-year average return of natural-origin Snake River steelhead was 25,109 adults (2000-2009). The most recent four-year average return was 21,050 adults (Figure 24). An analysis of adult returns

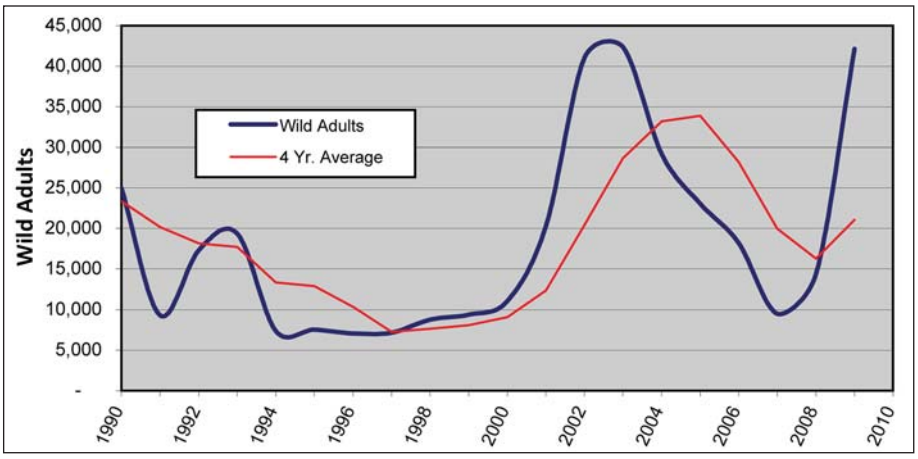


Figure 24. Returns of Naturally Produced Adult Snake River Steelhead at Lower Granite Dam, 1990-2009. DPS-level trend in abundance was positive during this period, though the trend was not statistically significant, and therefore is not displayed on this graph.

Table 5. Snake River Steelhead Tributary Habitat Metrics, 2005-2009

Metric	2009	2005-2009
Acre-feet/year of water protected	4623	48007
Acres improved	448	2314
Acres protected	221	1068
Water flow protected (cfs)	58	464
Miles of enhanced or newly accessible habitat	96	304
Miles of improved stream complexity	4	43
Miles protected	12	44
Screens installed or addressed	10	39

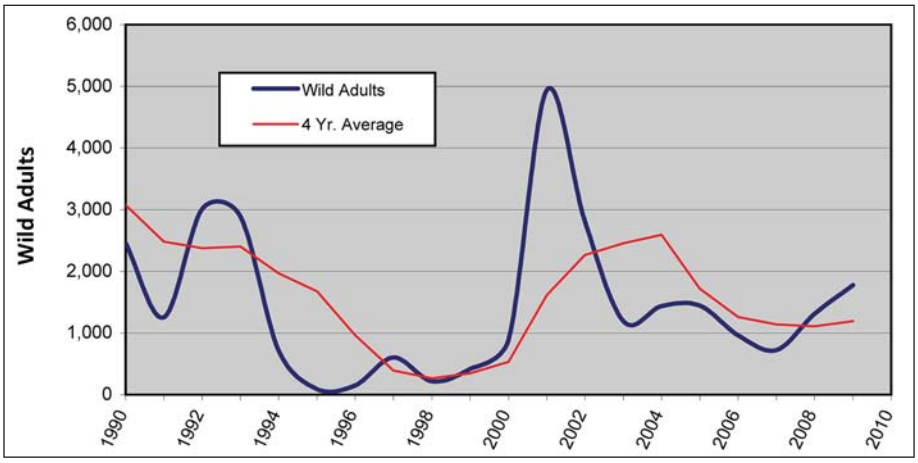


Figure 25. Returns of Naturally Produced Adult Upper Columbia River Spring Chinook Salmon at Rock Island Dam, 1990-2009. ESU-level trend in abundance remained generally flat during this period, though the trend was not statistically significant, and therefore is not shown on this graph.

from 1990-2009 indicates that the DPS-level trend in abundance was positive during this period, though the trend was not statistically significant.

For most populations in this DPS, the 2008 FCRPS BiOp applied "average" A-run and B-run population profiles, based on counts of returning adults at Lower Granite Dam. Based on these profiles, the BiOp concluded that most individual A-run populations in the DPS have trended upward since 1990, while B-run populations have not. Recruit-per-spawner productivity estimates have been positive for A-run populations generally over the 20-year period, but not for most B-run populations. These estimates represent average survivals during the periods in question and do not fully reflect survival improvements resulting from more recent hydrosystem improvements and other management changes.

Table 5 summarizes the tributary habitat metrics completed since 2005 with Action Agency support in areas used by Snake River steelhead.

Upper Columbia River Spring Chinook Salmon

The Upper Columbia spring Chinook salmon ESU was listed as endangered in 1999. The ESU consists of three extant populations in one major population group. These populations spawn and rear in the mainstem Columbia River and its tributaries between Rock Island Dam and Chief Joseph Dam (a barrier to upstream migration).

The most recent 10-year average return of natural-origin Upper Columbia River spring Chinook salmon was 1,748 adults (2000-2009). The most recent four-year average return was 1,193 adults (Figure 25). An analysis of adult returns from 1990-2008 indicates that the ESU-level trend in abundance was slightly positive during this period, though the trend was not statistically significant.

The FCRPS BiOp considered population-level information based on adult returns from 1984 through 2003. The BiOp concluded that 1990–2003 abundance trends for the Wenatchee River and Entiat River populations were generally stable, while the Methow River population saw a slight decline over that period. During the 1984-2003 base period analyzed in the

BiOp, these populations failed to replace themselves. These estimates represented average survivals during the periods in question and do not fully reflect survival improvements resulting from more recent hydrosystem improvements and other management changes.

Table 6 summarizes the tributary habitat metrics completed since 2005 with Action Agency support in areas used by Upper Columbia River spring Chinook.

Upper Columbia River Steelhead

The Upper Columbia River steelhead DPS was listed as endangered in 1997 but was recently relisted as threatened. The DPS consists of four populations in one major population group. These populations spawn and rear in the rivers and tributaries draining the eastern slope of the Cascade Mountains upstream of Rock Island Dam.

The most recent 10-year average return of natural-origin Upper Columbia River steelhead was 2,669 adults (1998-2007). The most recent four-year average return was 2,628 adults (Figure 26). An analysis of adult returns from 1990-2007 indicates that the ESU-level trend in abundance was positive during this period.

The FCRPS BiOp considered population-level information based on adult returns from between 1985 or 1986 through 2004 or 2005, depending on the population. Hatchery returns have dominated natural spawning in all populations in this DPS. Historical broodstock protocols included the use of out-of-basin broodstock and extensive mixing of stocks from different populations within the DPS. This may be a major contributor to the poor productivity seen in these populations.

The BiOp concluded that short- and long-term abundance trends for all populations were positive. During the 20-year base period analyzed in the BiOp, these populations failed to replace themselves. The estimates represent average survivals during the periods in question and do not fully reflect survival improvements resulting from more recent hydrosystem improvements and other management changes.

Table 7 summarizes the tributary habitat metrics completed since 2005 with Action Agency support in areas used by Upper Columbia River steelhead.

Table 6. Upper Columbia River Spring Chinook Tributary Habitat Metrics, 2005-2009

Metric	2009	2005-2009
Acre-feet/year of water protected	4422	9293
Acres improved	36	37
Acres protected	42	233
Water flow protected (cfs)	35	69
Miles of enhanced or newly accessible habitat	3	4
Miles of improved stream complexity	2	1
Miles protected	1	3
Screens installed or addressed	1	1

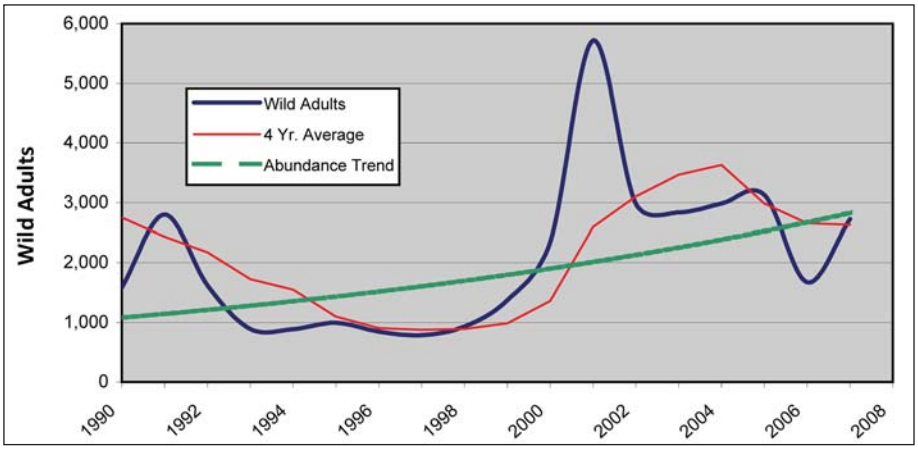


Figure 26. Returns of Naturally Produced Adult Upper Columbia River Steelhead at Rock Island Dam, 1990-2007.

Table 7. Upper Columbia River Steelhead Tributary Habitat Metrics, 2005-2009

Metric	2009	2005-2009
Acre-feet/year of water protected	5152	11416
Acres improved	49	72
Acres protected	46	337
Water flow protected (cfs)	65	150
Miles of enhanced or newly accessible habitat	17	18
Miles of improved stream complexity	2	2
Miles protected	1	4
Screens installed or addressed	1	1

Middle Columbia River Steelhead

The Middle Columbia River steelhead DPS was listed as threatened in 1999. The DPS is composed of 17 individual populations in four major population groups. These populations spawn in Oregon and Washington drainages

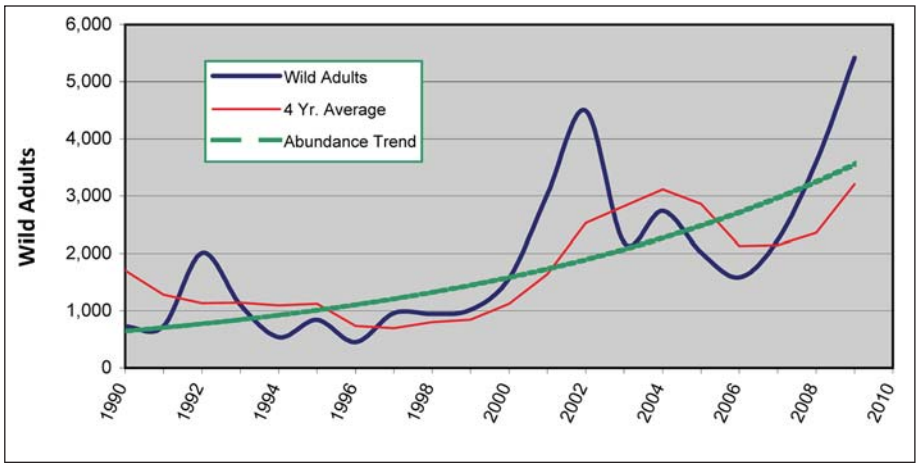


Figure 27. Returns of Naturally Produced Adult Middle Columbia River Steelhead (Yakima River Major Population Group) at Prosser Dam, 1990-2009.

Table 8. Middle Columbia River Steelhead Tributary Habitat Metrics, 2005-2009

Metric	2009	2005-2009
acre-feet/year of water protected	6622	24214
acres improved in various ways	1391	3613
acres protected	1071	12903
cubic-feet per second (cfs) of water flow protected	31	142
miles of habitat accessed	147	514
miles of stream with improved complexity	4	55
miles protected	116	581
Screens installed or addressed	24	136

upstream of the Hood River and Wind River systems up to and including the Yakima River Basin. Almost all populations within this DPS are summer-run steelhead; the exceptions are the winter-run populations returning to the Klickitat Creek and Fifteen Mile Creek watersheds.

The most recent 10-year average return of natural-origin Middle Columbia River steelhead was 17,201 adults (1996-2005). The most recent four-year average return was 21,985 adults (Figure 27). An analysis of adult returns from 1990-2005 indicates that the ESU-level trend in abundance was positive during this period. Due to the difficulty in obtaining timely estimates of DPS-level abundance for Middle Columbia River steelhead, the Adaptive Management Implementation Plan relies on abundance estimates based on dam counts for the Yakima River Major Population Group (MPG) of this DPS. Based on preliminary estimates, the most recent 10-year average return from this MPG was 2,888 natural-origin adults (2000-2009). The abundance trend for this MPG between 1990 and 2009 was positive.

The 2008 FCRPS BiOp considered population-level abundance estimates of natural-origin Middle Columbia River steelhead based on adult returns through 2004 or 2005. Eleven of the 13 populations for which adequate information is available had a positive trend in abundance since 1990. Over the most recent 10 years, the average abundance of three populations has been more than the minimum level needed for recovery, as identified by the Interior Columbia Technical Recovery Team. However, over the 20 years considered in the BiOp (concluding with the adult returns for 2004 or 2005), only eight of those 13 populations had positive recruit-per-spawner productivity.

Table 8 summarizes the tributary habitat metrics completed since 2005 with Action Agency support in areas used by Middle Columbia River steelhead.

Lower Columbia and Willamette River ESUs

These ESUs are currently threatened by a broad array of habitat and other environmental factors. Because they largely do not migrate through the federal dams on the Columbia and lower Snake rivers, the proposed operation of the Columbia/Snake projects of the FCRPS has a limited impact on these populations and there is limited potential to improve their status with improvements to these dams. The Action Agencies will provide an update on the status of these ESUs as part of the Comprehensive Evaluations called for in 2013 and 2016.

2009 Observations

The FCRPS BiOp is premised on adaptive management and accountability for results. The Action Agencies use the best available scientific information to achieve performance standards and make needed adjustments so that actions meet the BiOp goals.

The Obama Administration undertook an extensive effort to review the 2008 FCRPS BiOp. The process included listening to the views of the parties to the litigations, as well as those of agency and independent scientists. The Administration determined that the science underlying the BiOp is fundamentally sound, but there are uncertainties in some predictions regarding the future condition of the listed species. As a result of this review, the Administration developed the Adaptive Management Implementation Plan (AMIP) too include:

Accelerated and enhanced actions, include commitments to additional estuary actions under a new agreement with the state of Washington, efforts to control predators and invasive species, and biologically based changes to spring and summer spill;

Enhanced research and monitoring, improvements include expanding adult status and trend monitoring, expanding intensively monitored watershed (IMW's), a new life-cycle model to evaluate contingency actions, and enhanced research on predators, invasive species and potential reintroduction of fish into areas not currently occupied;

Biological triggers for contingencies, linked to declining abundance of listed fish at odds with BiOp expectations. The triggers, if tripped, would activate rapid or long-term responses to address significant declines in the abundance of naturally produced salmon and steelhead. A Significant Decline Trigger will result in implementation of Rapid Response contingency actions. An Early Warning Indicator will focus attention on possible problems to come and may result in implementation of Rapid Response contingency actions if deemed necessary;

Contingency actions, Rapid Response Actions, which are short term contingency actions to improve fish survival, include additional hydro operations, increased predator controls, certain harvest controls, and safety net hatcheries. Long-Term Contingency Actions are measures taken across "all Hs," including the study of Snake River dam breaching as a contingency of last resort; and

Continued collaboration and independent scientific review, continue the partnerships with states and tribes to provide for ongoing science input and to ensure transparent reporting on progress.

Based on 2009 research and implementation, the Action Agencies have developed questions and identified issues that affect BiOp implementation. This information will be used to inform future actions.

For hydropower actions, the Action Agencies have observed the following:

- Dam modifications and spill/surface passage improvements appear to be on track to achieve the hydrosystem performance standards of 96 and 93 percent average dam survival for spring and summer migrating fish, respectively.
    - In response to reduced juvenile fish survival due to avian predation at John Day Dam observed during the summer 2008, an expanded avian deterrent wire array was installed downstream of the dam and predator hazing efforts were increased. Future actions will include installing a new spillway deflector in spillbay 20, which will allow more flexibility in spill operations and may help further reduce avian predation by allowing smolts to exit the tailrace faster.
- Mean PIT tag in-river juvenile survival estimates for Upper Columbia River steelhead and Snake River steelhead were higher than mean COMPASS estimates. Snake River Chinook PIT tag mean estimate was the only estimate lower than mean COMPASS estimates, and was within the 95 percent confidence interval (i.e, the difference was not statistically significant). These results suggest that steelhead may be deriving more benefits from recently installed surface flow weirs compared to Chinook. Improvements planned to deter predation near dams (avian wires and egress improvements) are expected to result in additional benefits to all species.
- Survival rates of ESA-listed adult Chinook and steelhead through the FCRPS dipped below adult passage performance standards in 2009 for five of the six stocks. Three of the five stocks that fell short of the BiOp performance standard were within five percent. Two stocks, Snake River spring/summer Chinook salmon ESU and Snake River steelhead DPS, were significantly outside the adult performance standard. Adult system survival reductions may be related to modifications made at dams to improve juvenile outmigration, injuries and mortalities related to sea lion predation, unquantifiable levels of mortality related to fisheries, and unaccounted levels of straying.
- Adult return data continue to confirm that smolt transportation during May is correlated with higher adult steelhead returns than is in-river migration and somewhat higher returns for Chinook. Nevertheless, under adaptive management (as discussed with the Regional Implementation Oversight Group), the Action Agencies are continuing to spill during this time period (May 7-20) and monitoring the adult return data to see whether this relationship changes based on improved in-river conditions.
- Pursuant to court-ordered operations, spill continued through August 31, 2009. For comparison, under 2008

BiOp criteria, spill in August at Snake River dams may be curtailed on or after August 1 to coincide with juvenile fish migration. The range of spill curtailment dates for Lower Granite Dam observed in recent years using BiOp criteria has ranged from as early as August 1 to as late as August 31. According to August spill curtailment criteria, spill would have been curtailed on August 3 at Lower Granite Dam, August 12 at Little Goose Dam, August 15 at Lower Monumental Dam, and August 17 at Ice Harbor Dam.

For habitat actions, the Action Agencies have observed the following:

- The habitat program structure, which consists of biologically targeted projects, assessment of habitat quality improvements, use of expert panels, and independent scientific review, is under way and functioning well overall.
  - Hundreds of on-the-ground actions were completed throughout the Columbia Basin in 2009 to improve tributary spawning and rearing habitat for numerous populations of salmon and steelhead. Many new projects are being prepared for future implementation.
  - Several estuary projects were successfully completed in 2009. A few are behind schedule but are scheduled for completion in 2010. Many new estuary projects are under development for completion in 2011-2012.
- Tangible habitat benefits are being achieved by specific projects. For example:
  - Idaho Department of Water Resources developed agreements with local landowners to secure over 1,800 acre-feet of water annually to increase streamflows in the Lemhi River by 25-35 cfs during spring and summer migration periods.
  - The Sandy River Project is part of a larger 1,500-acre long-term restoration project. In 2009, 201 acres of riparian habitat along 1.2 stream miles were planted with native vegetation; 35 acres of riparian shrubs were planted; and 45 acres of native vegetation were maintained. Sandy River Delta historically was a wooded, riparian wetland with components of ponds, sloughs, bottomland woodland, oak woodland, prairie, and low- and high-elevation floodplain. Restoration of historical landscape components is a primary goal for this land, with current focus on restoration of riparian forest and wetlands.
  - In the estuary, long-term action effectiveness is ongoing for four habitat restoration projects, and the data/information being collected will be compared to reference sites. The data collected from the action effectiveness monitoring will aid in adaptively managing estuary restoration.

For predator management, the Action Agencies have observed the following:

- Predation continues to be a serious issue for the survival of both juvenile and adult salmon and steelhead. Future management actions must focus on controlling predation by native and non-native species.
- Predation by Caspian terns on juvenile fish continues to suggest that successfully relocating much of the tern nesting colony away from East Sand Island, where fish are most vulnerable to predation, will reduce mortality of juvenile salmonids. Diet studies have shown that steelhead smolts appear to be particularly vulnerable to predation, especially by Caspian terns.
- However, total avian predation on young fish has increased as a result of a nearly threefold expansion of a colony of double-crested cormorants on East Sand Island and predation by terns and cormorants from other colonies (Crescent Island, Rock Island, Foundation Island, Potholes Reservoir, etc.). Successful management of avian predation must be based on a broader framework, both in terms of the geographical area covered and the community of all potential avian predators present within that area. In recognition of the seriousness of this issue, the Action Agencies will be working with the RIOG to discuss and identify potential management actions.
- Predation by northern pikeminnow is being successfully controlled, with significant survival benefits. Examination of predation by non-native species, such as shad, walleye, and bass, is under way. Management of non-native species predation may conflict with state management of exotic warm-water game species (walleye, largemouth and smallmouth bass, Northern pike, catfish, etc.) for sport fisheries. Action agencies must proceed with sensitivity to other management jurisdictions through well designed basic research within this topic area.
- The amount of fish eaten by sea lions continued to increase in 2009, with an expanded catch estimate of 4,489 adult salmon and steelhead. Increases in Stellar sea lion abundance and salmon predation in 2009 may be countering some of the expected reductions from efforts by the states to remove sea lions.

For hatchery actions, the Action Agencies have observed the following:

- The Snake River sockeye captive broodstock and conservation/ supplementation program returned high numbers of adult fish in 2008 and 2009. This indicates that conditions have potentially moved from handfuls of adult fish on the brink of extinction to a more stable base for this program, which will be expanded in future years under the BiOp.
- The Hatchery Scientific Review Group process that concluded in 2009 developed useful guidelines for hatchery reforms, although each hatchery facility will need to be considered case by case.
- Reconditioning of wild-born female kelt steelhead may increase the abundance of repeat spawners, but there is not yet enough information from ongoing research

For harvest, the Action Agencies have observed the following:

- In the Colville selective fisheries study, the immediate release survival of summer/fall Chinook and steelhead was assessed for three gear types. Mortality was lowest for fish captured in the purse and beach seines (100 and 99 percent immediate release survival, respectively), compared to traditional hoop, dip, and tangle nets, which had only an 80 percent immediate release survival. Pursuit of purse-seining for longer-term post research is currently planned for the Confederated Colville Tribes. Tests of the technology on the lower Columbia River below Bonneville Dam in the non-treaty commercial salmon fishery occurred in 2009.

Regarding fish status, the Action Agencies have observed the following:

- Adult fish returns in 2009 were good, with counts of adult and jack summer Chinook, fall Chinook, and sockeye passing Bonneville Dam all exceeding the 10-year average; spring Chinook, steelhead, and coho counts being below the 10-year average. The Snake River sockeye return was particularly strong with a record 1,219 adults counted at Lower Granite Dam. Snake River steelhead returns also broke records for both the overall return and the wild component of the run. This is likely a result of both the survival improvements made in recent years and excellent ocean conditions. It is not likely that current levels will be sustained, and future variability is expected. Action Agencies will be looking for overall trends that are stable and increasing at the species level.

Working with the Region

Regional efforts to protect and recover threatened and endangered fish in the Columbia River Basin reflect the complex life cycles of the fish themselves. Progress has been made each year by building on successful efforts in previous years. It will take many years to rebuild sustainable populations of some species.

The Action Agencies work with regional interests to improve regional coordination and collaboration, and to implement actions to strengthen Columbia River Basin salmon and steelhead stocks. Tribal, state, and federal agency representatives are jointly looking at options for a better way to stabilize salmon and steelhead populations in the Columbia River Basin and bring these fish back to sustainable levels. The Action Agencies work closely with the region through the federal-state-tribal Regional Implementation Oversight Group (RIOG), the Columbia Basin Fish Accords, and NPCC's Fish and Wildlife Program.

Regional Implementation Oversight Group

In 2008, the RIOG was established to provide high-level policy review for the Columbia River Basin—to discuss and coordinate implementation of the FCRPS and related BiOps. The RIOG is the successor to the Policy Working Group formed in 2005 to address court concerns and collaborate on development of the BiOp. The RIOG involves federal, state, and tribal agencies actively engaged in salmon recovery efforts. The group reviews the Action Agencies' progress reports under the BiOp, considers adaptive management decisions based on emerging scientific information, evaluates contingency plans, and helps to resolve policy and technical disputes. The group encourages collaboration, accountability, and transparency for BiOp implementation. The RIOG structure includes technical subgroups for each H (e.g., the Technical Management Team or TMT) to support regional review.

Columbia Basin Fish Accords

In 2008, the Action Agencies entered into the Columbia Basin Fish Accords with the Confederated Tribes of the Warm Springs Reservation of Oregon, the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes and Bands of the Yakama Nation, the CRITFC, the Confederated Tribes of the Colville Indian Reservation, the Shoshone-Bannock Tribes of Fort Hall, and the states of Idaho and Montana. In addition, in 2009, the Action Agencies entered into an Estuary Habitat Memorandum of Agreement with the state of Washington. These historical, long-term agreements are intended to support and strengthen RPA implementation, foster cooperation and partnership, and advance fish recovery for all. These partnerships help accomplish "on-the-ground" implementation of actions that are beneficial to listed fish.

In 2009, tribal, state, and federal partners implemented new projects and expanded existing projects under the Columbia Basin Fish Accords. Projects under way include improvements in passage and assurance of sufficient water for the Walla Walla River's salmon populations, recovery of sockeye runs in Redfish Lake, installation of lamprey passage systems at Bonneville Dam, and numerous other projects designed to restore critical habitat from the estuary to the tributaries.

Northwest Power and Conservation Council Fish and Wildlife Program

Under the Northwest Power Act, the NPCC works to protect, mitigate, and enhance Columbia River Basin fish and wildlife and their related spawning grounds and habitat that have been affected by hydropower development. The council's Columbia Basin Fish and Wildlife Program guides BPA's funding and must be taken into account by all federal agencies that manage, operate, or regulate hydropower dams in the basin. The Council's amended program (finalized in 2009) can be found at *http://www.nwcouncil.org/library/2009/2009-09/Default.asp*.

Conclusion

In 2009, as the result of a multi-year collaboration process, the Action Agencies continued the second year of implementing the 2008 FCRPS BiOps. This progress report summarizes the second year of implementation. Major dam improvements occurred, acres of habitat were improved, predators were controlled, and fish status overall was good. Working with our regional partners, the Action Agencies will build on these accomplishments in the years ahead.

For More Information on Regional Efforts:

- Pacific Coastal Salmon Recovery Fund: *http://www.nwr.noaa.gov/Salmon-Recovery-Planning/PCSRF/*
- Columbia River Inter-Tribal Fish Commission: *http://www.critfc.org*
- Upper Columbia United Tribes: *http://www.ucut.org*
- Columbia Basin Fish and Wildlife Authority: *http://www.cbfwa.org*
- Northwest Power and Conservation Council: *http://www.nwcouncil.org*
- Oregon Watershed Enhancement Board: *http://www.oregon.gov/OWEB/index.shtml*
- Washington Salmon Recovery Office: *http://www.rco.wa.gov/salmon_recovery/gsro.shtml*
- Idaho Office of Species Conservation: *http://www.species.idaho.gov*
- Federal Columbia River Power System 2008 Annual Report, website links, and more information on federal agency efforts for salmon and steelhead: *http://www.salmonrecovery.gov*