

# PROTECTING SALMON AND STEELHEAD

## Endangered Species Act Federal Columbia River Power System 2011 Annual Progress Report - Section 1

SEPTEMBER 2012

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 specific evolutionarily significant units (ESUs) or distinct population segments (DPSs) of salmon and steelhead 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, implement improvements at dams to increase fish survival, and enhance river conditions for migrating fish. This report summarizes the actions implemented by the Action Agencies in 2011 to protect ESA-listed salmon and

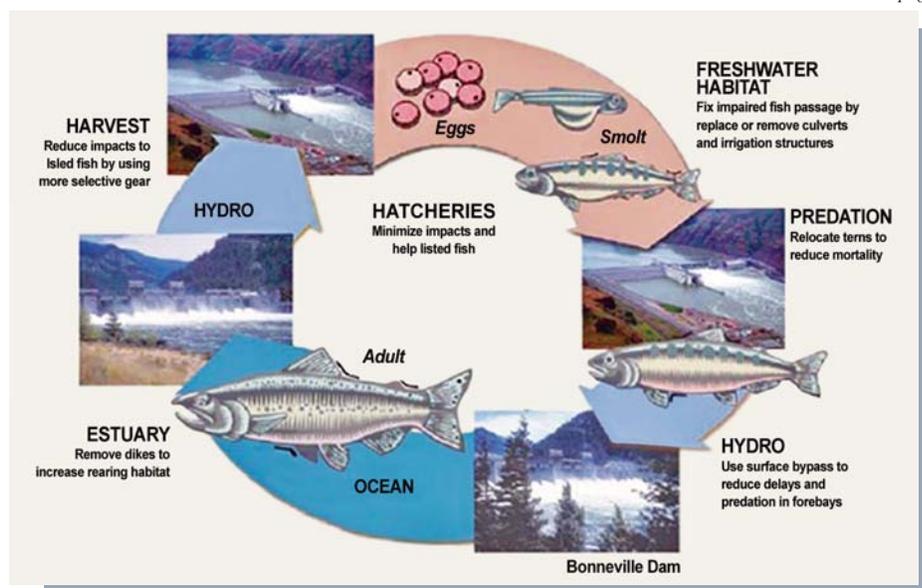
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In May 2008, the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS, also known as NOAA Fisheries) issued a Biological Opinion (BiOp) on the operation of 14 of the projects that make up the Federal Columbia River 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 suite of Reasonable and Prudent Alternative (RPA) actions proposed by the Bonneville Power Administration (BPA), Bureau of Reclamation (Reclamation), and U.S. Army Corps of Engineers (Corps), together referred to as the Action Agencies. These actions, developed through a collaborative process with States and Tribes in the Columbia Basin, were designed to protect salmon and steelhead across their life cycle and were supported by a biological analysis that NMFS concluded would avoid jeopardy to the fish and would not adversely modify their critical habitat.

In 2009, the Obama Administration directed the development of the Adaptive Management Implementation Plan (AMIP), which takes a more precautionary approach in implementation of the RPA actions and provides contingency and rapid-response actions in case of unanticipated, significant fish declines. On May 20, 2010, NMFS completed the 2010 Supplemental BiOp, incorporating the AMIP into the 2008 BiOp.

The Action Agencies committed to implementing the RPA actions, including the use of spill and surface passage structures at dams, management of

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**All-H Problems: All-H Solutions** Samples from the 2010 FCRPS BiOp

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steelhead affected by the operation of the FCRPS<sup>i</sup>. It describes the status of Reasonable and Prudent Alternative (RPA) actions that were implemented in calendar year 2011 to benefit fish at all phases of the life cycle. 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 ESUs or DPSs of salmon and steelhead. The Action Agencies use adaptive management to make adjustments to actions based on new scientific information to meet biological performance objectives effectively and efficiently.

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

<sup>i</sup>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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water releases from storage reservoirs, expanded control of predators that prey on young salmon, improvement of tributary and estuary habitat, and implementation of hatchery reforms. To ensure implementation of the BiOp and promote regional collaboration, the Action Agencies also entered into the Columbia Basin Fish Accords with three States and five Tribes.

To review the 2010 Supplemental FCRPS BiOp in its entirety, please visit: <http://www.salmonrecovery.gov/BiologicalOpinions/FCRPSBiOp/2010SupplementalFCRPSBiOp.aspx>.

The 2008 BiOp can be found at: <http://www.salmonrecovery.gov/BiologicalOpinions/FCRPSBiOp/2008FCRPSBiOp.aspx>.

The AMIP can be found at: <http://www.salmonrecovery.gov/BiologicalOpinions/FCRPSBiOp/2008FCRPSBiOp/AMIP.aspx>.

The Action Agencies are responsible for providing annual progress reports detailing the implementation and progress of the RPA actions. This report meets the requirements of RPA Action 2 and provides implementation progress by the

Action Agencies during the period of January 1 through December 31, 2011.

This report is organized into three sections. RPA action implementation highlights are presented in Section 1, which identifies findings that will inform future RPA action implementation. This section also presents information in formats requested by the Federal-State-Tribal Regional Implementation Oversight Group (RIOG). Section 2 provides 2011 accomplishments on RPA implementation by action. Section 3 lists projects implemented during 2011 and includes habitat metrics completed.

The full FCRPS 2011 Annual Progress Report, which includes the Detailed Description of RPA Action Implementation (Section 2) and Project Tables for RPA Action Implementation (Section 3), is available online at <http://www.salmonrecovery.gov>. Previous FCRPS progress reports and information on other salmon and steelhead protection efforts are also available at the <http://www.salmonrecovery.gov/BiologicalOpinions/FCRPSBiOp/ProgressReports.aspx> site and on additional websites listed at the end of this document.



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

# 2011 Fish Status and Environmental Conditions

## Adult Fish Returns and Trends

In the Pacific Northwest salmon and steelhead status is tracked 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 2011, more than 1.5 million adult and jack salmon (approximately 186,000 were jacks, young males that mature and return to spawning grounds

earlier than others in the age class) and steelhead were counted as they passed Bonneville Dam. This number exceeds historical averages for 2000 and earlier and also exceeds the more recent 10-year average (Figure 2). Total adult fish returns to Bonneville Dam of listed and unlisted salmonids were the fourth highest number since counting began in 1938. Adult return and trend information for the specific fish species addressed in the BiOp are presented beginning on page 31.

As shown in Table 1, counts in 2011 of adult Chinook, sockeye and coho salmon passing Bonneville Dam exceeded the 10-year average; the counts of spring and summer Chinook and of sockeye were substantially above the 10-year average. The count of adult steelhead was 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 (e.g., most of the sockeye that return to Bonneville Dam are unlisted, natural origin fish from the upper Columbia basin).



**Figure 2. Adult and Jack Salmon/Steelhead Returns at Bonneville Dam, 1938 to 2011** (Daytime counts. Includes hatchery and natural-origin fish. Source: U.S. Army Corps of Engineers Fish Passage Report 2011, Table 18b.)

**Table 1. Adult Salmon and Steelhead Returns at Bonneville Dam – 2011 and 10-year average (includes hatchery and natural origin fish).**

Species	2010	10-year average
Chinook – Total <sup>1/</sup>	863,201	736,645
Spring Chinook <sup>2/</sup>	218,092	172,491
Summer Chinook	159,730	107,791
Fall Chinook	485,379	454,363
Steelhead	369,365	388,869
Sockeye	185,796	131,036
Coho <sup>3/</sup>	149,883	130,645
Chum and Pinks	3,878	605
TOTALS of all species for period	1,572,123	1,386,979

## Adult Fish Survival

Adult fish survival in the Columbia and Snake Rivers is influenced by the operation and configuration of fish ladders at the FCRPS dams as well as sea lion predation, levels of straying, and harvest-related mortality. Annual survival rates of listed adult salmonids through defined hydrosystem reaches are estimated based on detections of fish tagged with passive integrated transponder tags (PIT Tags) at Bonneville, McNary, and Lower Granite Dams, with corrections for harvest and straying.

Survival through the hydrosystem for adult fish is evaluated for five stocks using a 5-year rolling average of annual survival estimates. Snake River stocks are used as surrogates for Snake River sockeye and mid-Columbia steelhead.

The 5-year rolling averages (2007-11) for Snake River fall Chinook and upper Columbia River steelhead surpassed the performance standard, while the 5-year rolling averages for the Snake River spring/summer Chinook salmon ESU, the Snake River steelhead DPS, and the upper Columbia River spring Chinook ESU were below adult performance standards (Figure 3).

Adult survival of upper Columbia River steelhead in 2011 was the highest among the last five years at 93.7 percent while survival of upper Columbia River spring Chinook in 2011 was the lowest among the last five years at 84.5 percent.

*Period of 10-year average 2002-2011. Data are for daytime counts – 0400 to 2000 PST. All data from U.S. Army Corps of Engineers Fish Passage Report 2011 (2012), Table 18b, except as noted below:*

<sup>1/</sup> Chinook data are from monthly values in Fish Passage Report 2011 (2012), Table 19, except values for 2002 are from monthly values in Fish Passage Report 2002, Table 18. Values include jacks.

<sup>2/</sup> Assumed Chinook run dates are: Spring = Jan 1–May 31; Summer = June 1–July 31; Fall = Aug 1–Dec 31

<sup>3/</sup> Includes jacks.

Other factors have been identified that likely impede the attainment of adult performance standards. High flows and high spill levels, such as those seen in 2011, are known to increase fallback and delay of adults. Increased fallback and delay can result in increased losses due to sea lion predation, and in additional levels of straying and harvest-related mortality. These potential factors are being assessed through BiOp Research, Monitoring & Evaluation (RME) actions. The Action Agencies continue to investigate adding PIT tag detection capabilities to adult passage facilities at The Dalles and/or John Day Dams and adding PIT tag capability in fisheries above Bonneville Dam to better understand and quantify unexplained and higher than anticipated losses within those reaches.

### Juvenile Fish Survival

Juvenile fish survival through the Columbia and Snake rivers is influenced by, among other things, the operation and configuration of the FCRPS projects. Major improvements and investments in operations and passage facilities have been implemented under the BiOp to achieve hydro performance standards of 96% average dam survival for spring migrating fish and 93% for summer migrating fish, described further in the Hydro section of this report.

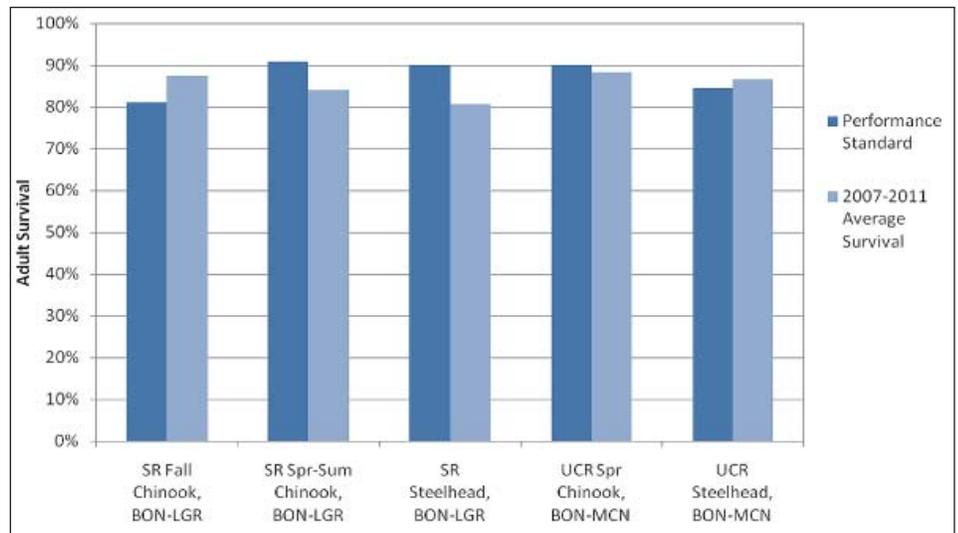
Hatchery and wild juvenile salmon and steelhead that migrate to the ocean through the Snake and Columbia rivers can either be left “in-river”<sup>ii</sup> to migrate past the dams or be transported by barge or truck to below Bonneville Dam. Empirical evidence is used to track the percent of fish that return as adults among those transported and those left in-river to migrate, and generally fish are transported during time periods that yield higher adult returns than in-river migration.

In 2011, less than 40 percent of the Snake River steelhead and Chinook were estimated to be transported. Ninety-eight percent of the transported juveniles were assumed to have survived to the point of release below Bonneville Dam. For juvenile fish, total system survival is a combination of transportation and in-river survival. Total system survival

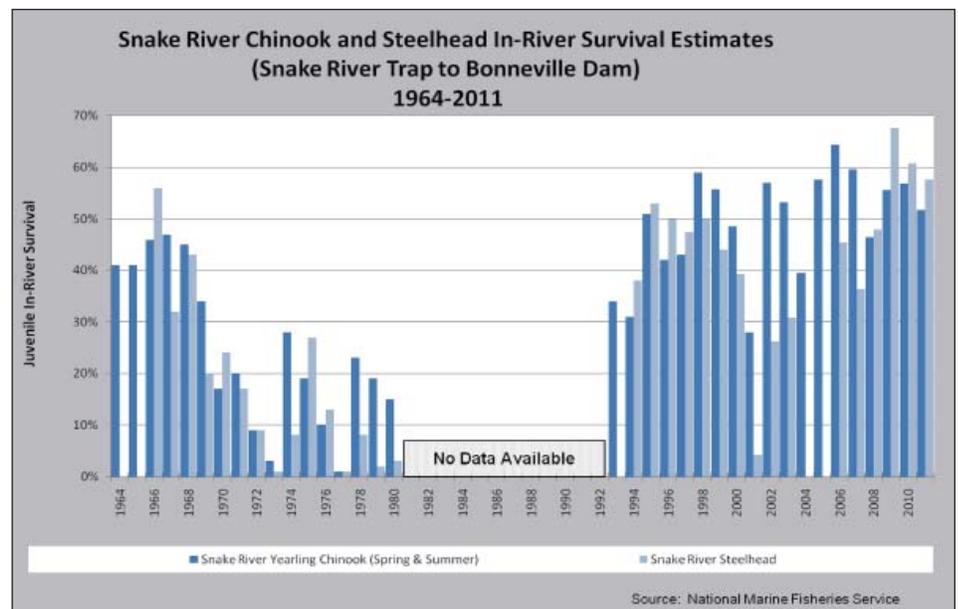
to the Bonneville tailrace (survival of in-river and transported groups combined) was about 80 percent for wild Chinook, 69 percent for combined wild and hatchery Chinook, 69 percent for wild steelhead, and 74 percent for wild and hatchery steelhead. Because significant proportions of juvenile upper Columbia spring Chinook and steelhead are left to migrate in-river, in-river survival rates are equivalent to total system survival rates for these species. Research is

being carried out under the BiOp to better understand any delayed effects of transport.

In-river survival of migrating fish has improved significantly over time as a result of operation and passage improvements at the FCRPS dams. Figure 4 shows the trend of these improvements, including 2011 survivals. To put these results in perspective, while study methods have changed, survival estimates in recent years with improved



**Figure 3. 2008 FCRPS BiOp Adult Survival Standard and Five-Year Rolling Average 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. 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.

fish passage is now higher through eight dams than when fish had to pass only four dams in the 1970's.

Estimated in-river survival for combined hatchery and wild Snake River yearling Chinook salmon and steelhead through the entire hydrosystem (Snake River smolt trap above Lower Granite Dam to the tailrace of Bonneville Dam—a distance of 512 km) was lower in 2011 than in the previous 2 years (Figure 4). For yearling Chinook, the 2011 estimated total in-river survival was 48.3 percent, which was lower than the long-term (1999–2011) average of 49.3 percent, and the 2010 estimate of 55.1 percent. However the difference between the 2010 and 2011 estimate was not statistically significant. For steelhead, estimated in-river survival in 2011 was 59.2 percent, which was higher than the long-term average of 41.8 percent but lower than the 2010 estimate of 61.8 percent. Again, the difference between 2010 and 2011 survival was not statistically significant. To provide some context for these numbers the 2011 in-river survival data indicates that even free-flowing river segments, such as the area above Lower Granite Dam, have substantial mortality. For example, hatchery Chinook survival from release to Lower Granite ranges from 26.4% (McCall Hatchery 457 km from Lower Granite) to 83.3% (from the Nez Perce Tribal Hatchery, 116 km from Lower Granite). Wild Chinook salmon survival from tagging site to Lower Granite Dam ranges from 33.5% from the Red River fish trap (300km above Lower Granite) to 94.3% at the Snake River trap (51km above Lower Granite) (Faulkner et al. 2012).

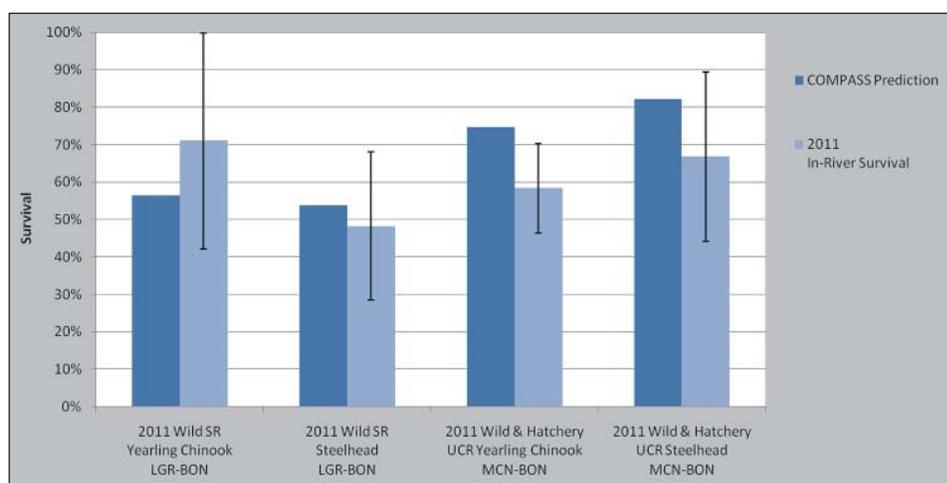
The BiOp included a metric to estimate in-river survival performance for Snake River and upper Columbia River Chinook and steelhead. This metric is intended to provide important information for both the annual adaptive management process and the comprehensive evaluations in 2013 and 2016. The Action Agencies empirically estimated in-river survival for 2011 (Lower Granite to Bonneville and McNary to Bonneville) and compared that with the survival estimates derived

from Comprehensive Fish Passage (COMPASS) Modeling. For this comparison, the COMPASS Model was run with survival estimates for the actions implemented at the start of the 2011 migration season using 2011 river conditions, fish migration patterns, and dam and transport operations. Figure 5 shows the results of these comparisons. Results indicate that the benefits from the hydro operation, passage improvements, and predation deterrent actions implemented to date are generally accruing as expected in the BiOp analysis.

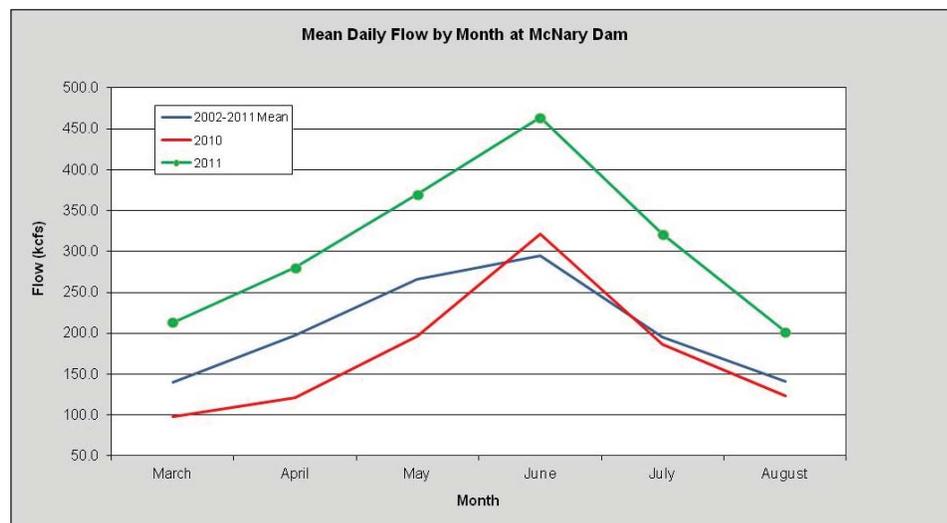
In 2011, PIT tag in-river juvenile survival estimates for wild Snake River steelhead,

for wild and hatchery upper Columbia River yearling Chinook, and for wild and hatchery upper Columbia River steelhead were all less than the mean COMPASS estimates. However, for Snake River steelhead and for upper Columbia steelhead the differences were not statistically significant. The PIT tag in-river juvenile survival estimate for wild Snake River yearling Chinook was higher than the mean COMPASS estimate, although the difference was not statistically significant.

Travel time through the hydropower system during 2011 was among the fastest observed in recent years for both yearling Chinook salmon and steelhead.



**Figure 5. 2011 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 percent confidence intervals. (BON = Bonneville, MCN = McNary, LGR = Lower Granite)



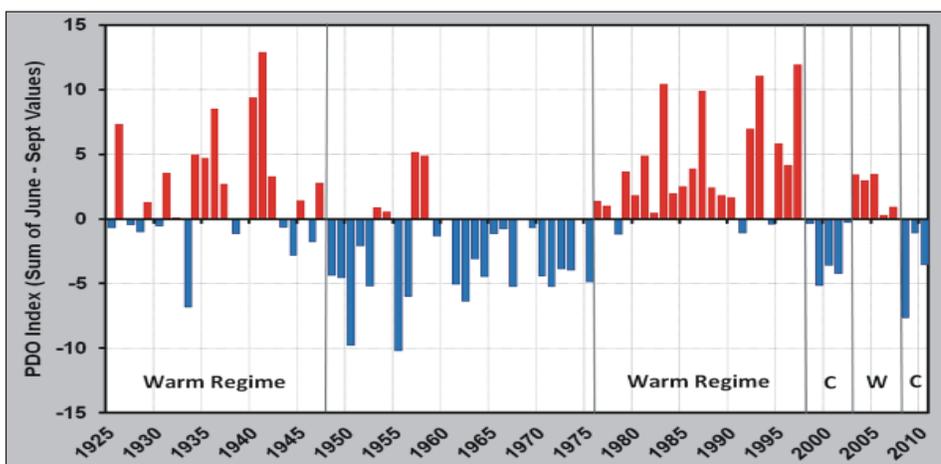
**Figure 6. Mean Daily Flow by Month at McNary Dam, 2010 and 2011, with average values for the 2002-2011 period.**

During 2011, flows at Snake River dams were above the historic average (1994-2010) and increased to high levels during May. These high river flows resulted in increased water velocity and spill in excess of fish passage spill. Travel time was likely shortened by these high levels of flow and spill and by the use of surface bypass structures at most projects during 2011 (Faulkner et al. 2012); however the faster travel time did not result in higher in-river survival than 2010.

## Water Year and Streamflow Summary

In 2011, Columbia River Basin flows from March through August were substantially above average (Figure 6). The Columbia River had an above-average water year, with the January through September volume as measured at The Dalles Dam at 138 percent of average. For much of the fall and early winter, while precipitation was slightly above normal across the southern half of the basin, mountain snowfall lagged

well below normal across Canada. Record low snowpack was noted in December and the first half of January in the northernmost portions of the basin. At the same time, the Northwest River Forecast Center's water supply forecast for The Dalles and Grand Coulee hovered near the 30-year average. By March though, persistently heavy precipitation was finally falling in Canada and above-average precipitation continued basin-wide through June. In addition, temperatures remained well below average, in a few places setting new records, with snow accumulation occurring much later than normal at unusually low elevations and delayed seasonal snow melt. Forecasts reflected these unprecedented increases between the March and June final forecasts. It became apparent by early April that runoff would be above average and, by early May, that it would be well above average. Between March and June, the January-July volume forecast for The Dalles increased by 32 million acre-feet; a 29 percent increase. That was the largest such increase the Northwest River Forecast Center ever recorded in its monthly forecasts. Also, the forecasted April-August runoff increased from 97 percent of average in January to 138 percent of average by July.



**Figure 7. Time Series of Shifts in Sign of the Pacific Decadal Oscillation (PDO), 1925 to 2011.** Values are averaged over the months of May through September. Red bars indicate positive (warm) years; blue bars negative (cool) years. Note that 2008 was the most negative since 1956. From <http://www.nwfsc.noaa.gov/research/divisions/fed/oeip/ca-pdo.cfm>.

	Juvenile migration year				Forecast of adult returns	
	2008	2009	2010	2011	Coho 2012	Chinook 2013
<b>Large-scale ocean and atmospheric indicators</b>						
PDO	■	■	■	■	●	●
ONI (Jan-Jun)	■	■	■	■	●	●
<b>Local and regional physical indicators</b>						
Sea surface temperature anomalies	■	■	■	■	●	●
Coastal upwelling	■	■	■	■	●	●
Physical spring transition	■	■	■	■	●	●
Deep water temperature and salinity	■	■	■	■	●	●
<b>Local biological indicators</b>						
Copepod biodiversity	■	■	■	■	●	●
Northern copepod anomalies	■	■	■	■	●	●
Biological spring transition	■	■	■	■	●	●
June spring Chinook	■	■	■	■	--	●
September Coho	■	■	■	■	●	--

Key	■ good conditions for salmon	● good returns expected
	■ intermediate conditions for salmon	— no data
	■ poor conditions for salmon	● poor returns expected

**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 2011. From <http://www.nwfsc.noaa.gov/research/divisions/fed/oeip/g-forecast.cfm>, see this site for more information on terminology.

## 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.<sup>iii</sup>

NOAA Fisheries' Northwest Fisheries Science Center (NWFSC) administers the Ocean Ecosystem Indicators Project to track specific climatic and biological indicators believed to influence the growth and survival of juvenile salmon once they reach the ocean. The NWFSC forecasts the returns of coho and Chinook salmon based on a survey of a range of ecosystem indicators.

A La Niña condition began in July 2010 characterized by cooler than normal ocean temperatures in the North Pacific, which are generally more favorable for salmon survival. La Niña conditions continued throughout

2011, though other factors thought to influence overall salmon survival were less favorable. Figure 8 presents a somewhat mixed picture with respect to predicted Chinook salmon returns in 2013. However, 2011 returns, which show a similar picture based on ocean conditions, have been above the 10 year average.

### **New Climate Change Information**

The 2010 Supplemental BiOp contained a thorough review of new climate science, and concluded that "new observations and predictions regarding physical effects of climate change are within the range of assumptions considered in the 2008 BiOp and the AMIP." The Supplemental BiOp went on to state: "New studies of biological

effects of climate change on salmon and steelhead provide additional details on effects previously considered and suggest that adult migration conditions in the mainstem lower Columbia may need particular attention through monitoring and proactive actions." The BiOp also included additional RPA actions requirements to address this concern.

NWFSC conducted a literature review of climate change studies published during 2011. This review is included as an attachment to Section 2 of the 2011 APR. NWFSC concluded that new analyses were generally consistent with previously reported historical trends of climate change although some studies report on new areas of concern for salmon. For more detail, please see Section 2, AMIP III.F.1.

## **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 Section 2, the RPA action implementation portion of this 2011 progress report.

### **Hydropower**

Actions to improve survival of fish through the hydro system are an essential part of BiOp commitments. Over the past decade, juvenile fish survival past the dams has improved dramatically through dam modifications and improved operations designed to achieve hydro performance standards. Current hydro performance standards in the 2008 BiOp set a high bar, calling for juvenile dam survival of 96% for spring migrating fish and 93 percent for summer migrating fish. Under the hydropower strategy, the Action Agencies implemented juvenile and adult dam passage modification, 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 improvements in turn increase overall system survival and in-river survival. Results in 2011 continue to show the success of these efforts.

### **Improvements for Fish at the Dams**

Most salmon and steelhead in the Columbia River Basin encounter one or more hydropower dams as they migrate to and from the ocean. 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. Juvenile bypass systems, spill, and other surface passage routes are used to divert the vast majority of migrating fish away from the turbines. Depending on location, time of year, and species, about 76 percent to 99 percent of the juvenile fish use these non-turbine routes.

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 40 to 50 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 an improved passage option; these more surface oriented routes of dam passage reduce passage delay and improve survival. These routes are generally very effective at passing large numbers of fish safely (e.g., 32 percent of steelhead that pass John Day dam pass over one of the two spillway weirs with an estimated passage survival of 99 percent). Survival through surface passage spill is often higher than conventional spill while using less water. Juvenile bypass outfall location improvements were underway at Lower Monumental and McNary and will be completed in 2012. In 2011, surface passage survival for spring migrants ranged from 95 to 100 percent.

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 the flow toward the turbine intakes, the guidance screens redirect them up through channels in the dam, routing them away from the turbines. The fish are then either passed back to the river below the dam or loaded into barges or trucks for transport downstream past the remaining dams. In 2011, bypass survival for spring migrants ranged from 94 to 100 percent.

Passage improvements, identified in coordination with the region, have been completed at five of eight Snake and lower Columbia river dams. With these improvements in place, the Action Agencies anticipate meeting the BiOp performance standards.

### Juvenile Salmonid Dam Passage Survival

In 2010 and 2011, full performance standard testing was conducted at The Dalles Dam for spring migrants. The 2010 estimates of juvenile steelhead dam passage survival were slightly below the performance standard of 96 percent at 95.3 percent; however, elevated levels of avian predation occurred downstream of the dam during testing (Table 2). Additional avian deterrent wires were installed following 2010 performance standard testing, which helped reduce avian predation and as a result, estimates of juvenile steelhead dam passage survival increased in 2011 to 99.5 percent (Table 2). Estimates of yearling Chinook dam passage survival were either at or above the performance standard in 2010 and 2011 (Table 2).

Based on 2010 and 2011 test results, the Action Agencies believe the BiOp performance standard has been met for yearling Chinook and juvenile steelhead at The Dalles Dam. The Action Agencies in coordination with NOAA Fisheries and an appropriate regional forum will review 2010/2011 testing results to confirm that the standard has been met.

Full performance standard testing was also conducted at Bonneville and John Day dams during spring 2011. Results from performance standard testing

**Table 2. Juvenile dam passage survival estimates with standard errors, passage times, and spill passage efficiency for juvenile spring migrants derived from performance standard tests at Bonneville Dam in 2011, The Dalles Dam in 2010 and 2011, and John Day Dam in 2011. Spill Passage Efficiency includes spillway and other surface passage routes. Johnson et al. 2011 and Skalski et al. 2011a, b, and c.**

Species	Dam Passage Survival (SE)	Median Forebay Passage Time (hours)	Spill Passage Efficiency
<b>Bonneville Dam - 100 kcfs Spill (April 30-May 13)</b>			
Yearling Chinook	95.7% (0.4%)	na	na
Juvenile Steelhead	97.6% (1.8%)	na	na
<b>The Dalles Dam (2010) – 40 Percent Spill</b>			
Yearling Chinook	96.4% (1.4%)	1.28	94.7%
Juvenile Steelhead	95.3% (1.4%)	1.28	95.4%
<b>The Dalles Dam (2011) – 40 Percent Spill</b>			
Yearling Chinook	96.0% (1.0%)	0.97	83.1%
Juvenile Steelhead	99.5% (0.8%)	0.81	89.1%
<b>John Day Dam - 30 Percent Spill</b>			
Yearling Chinook	96.7% (1.0%)	na	na
Juvenile Steelhead	98.4% (0.9%)	na	na
<b>John Day Dam - 40 Percent Spill</b>			
Yearling Chinook	97.8 (1.1%)	na	na
Juvenile Steelhead	99.0 (1.0%)	na	na

indicated marked improvements in juvenile dam passage survival of spring migrants. Juvenile dam passage survival of yearling Chinook salmon either met or exceeded the spring migrant performance standard of 96.0 percent at John Day Dam, with survival being slightly below the performance standard at Bonneville Dam in 2011 (Table 2). Dam survival of juvenile steelhead exceeded the spring juvenile migrant performance standard of 96.0 percent at all three dams in 2011 (Table 2).

### 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 2010 BiOp recommended that fish transport operations be adaptively managed on an annual basis. The timing and conditions for fish transportation are based on annual research comparing adult returns to

Lower Granite Dam of transported fish versus fish that migrated in-river. In general, Chinook survive better when migrating in-river in early April, but survive better when transported beginning in late April or early May. Also, steelhead generally exhibit higher survival when transported during the spring migration.

In 2011, through coordination with the Technical Management Team, smolt transportation began on May 1 at Lower Granite Dam, May 5 at Little Goose Dam, May 8 at Lower Monumental Dam, and July 21 at McNary Dam. Until these dates, smolts collected at Snake River dams were bypassed back to the river. Estimated percentages of non-tagged spring/summer Chinook salmon smolts that were transported during the entire 2011 season were 35.2 percent for wild fish and 40.7 percent for hatchery fish. For non-tagged steelhead, estimated percentages transported were 36.1 percent and 37.8 percent for wild and hatchery smolts, respectively (Figure 9). Of the fish transported, 95.5 percent were barged, and the balance transported by truck.

The 2011 estimated number of fish transported was substantially lower than the number transported in years prior to 2007. This reduction likely resulted from installation of the surface passage structures and the increased proportion of spill relative to total river flow as well as regional recommendations to keep more fish in the river. In general, transportation results continue to indicate higher adult returns of yearling Chinook salmon and juvenile steelhead that are collected and transported compared to those that migrate in-river during part of April and all of May, indicating that fish survival to adult would be higher with a greater transportation of fish in the spring. Adult returns in 2011 indicate the greatest transport benefit for wild Chinook salmon usually occurs after May 1, but in most years transport is beneficial by the 3rd week of April. Transport is beneficial to hatchery Chinook salmon and hatchery and wild steelhead starting April 15 in most years. The Action Agencies will continue to evaluate information on transportation and confer with NOAA and the RIOG on an annual basis to determine when transportation will begin each year.

## 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.

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 balance salmon flows, protect resident fish, manage flood risks, and serve other authorized purposes.

In late 2010, the Action Agencies, in coordination with the Technical Management Team, updated the annual Water Management Plan (WMP) for use in 2011 to incorporate any changes to the operating plans from the previous year. Both the storage projects (Libby, Hungry Horse, Albeni

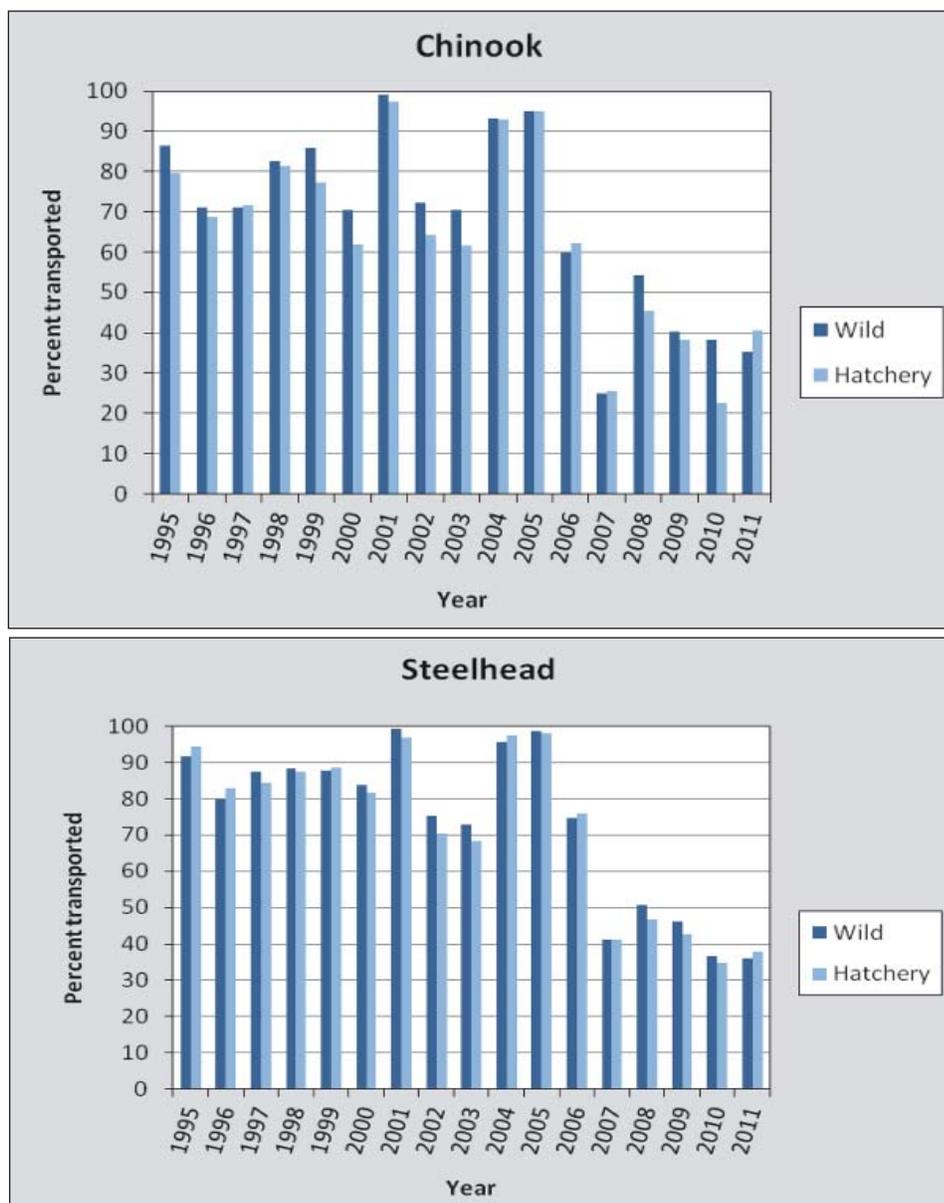


Figure 9. Estimated percent of yearling Chinook salmon and steelhead, respectively, transported to below Bonneville Dam, by year (1995-2011) (Faulkner et al. 2012).

Falls, Grand Coulee, and Dworshak) and the run-of-river Columbia River and Snake River projects (Bonneville, The Dalles, John Day, McNary, Chief Joseph, Ice Harbor, Lower Monumental, Little Goose, and Lower Granite) were operated under the WMP, in part, to aid juvenile fish passage.

The Columbia River Treaty Operating Committee Agreement on Operation of Treaty Storage for Non-Power Uses for December 11, 2010, through July 31, 2011 (Non-Power Uses Agreement) was executed on November 30, 2010. Under this agreement, one maf (one million acre-feet) of flow augmentation

water was stored in Canada's Mica Reservoir from late January 2011 through early February 2011. All flow augmentation storage was released by July 31, 2011 under the Non-Power Uses Agreement. Treaty operations were coordinated during spring 2011 and fall 2011 stakeholder briefings.

A new Non-Power Uses Agreement for 2012 was executed on November 30, 2011, which provides for one maf of flow augmentation water storage under the same terms as the prior agreement.

In 2011, Reclamation provided 487,000 acre-feet 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, 2011, Annual Progress Report for Reclamation's Salmon Flow Augmentation Program at: <http://www.usbr.gov/pn/programs/fcrps/uppersnake/>.

## 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 provide limited exceptions to these standards for juvenile fish passage spill. The Corps monitors TDG levels in the river and adjusts spill patterns and spill rates consistent with applicable standards.

BPA adopted an Interim Environmental Redispach policy designed to maintain system reliability consistent with its environmental responsibilities, including ESA and applicable state water quality standards established under the Clean Water Act. See BPA's Interim Environmental Redispach and Negative Pricing policy, 6-15 (May 2011) at: [http://www.bpa.gov/corporate/pubs/RODS/2011/ERandNegativePricing\\_FinalROD\\_web.pdf](http://www.bpa.gov/corporate/pubs/RODS/2011/ERandNegativePricing_FinalROD_web.pdf). Under this policy during high runoff conditions, BPA replaced other generation with Federal hydro generation to reduce uncontrolled spill. By doing this, BPA maximized Federal hydro generation during high-water events, thus reducing uncontrolled spill and reducing TDG levels to the extent practicable. BPA implemented this policy for over 200 hours during May 18 through July 10, 2011.

To help manage water temperatures in the lower Snake River in the summer, cold water is released from Dworshak Dam on the North Fork Clearwater River from early July through mid-September. The tailwater temperature at Lower Granite Dam did not exceed 68°F at any time during this augmentation season. For a more thorough discussion of how the system was operated in 2011, see the "2011 Dissolved Gas and Water

Temperature Report: Columbia River Basin" at [http://www.nwd-wc.usace.army.mil/tmt/wqnew/tdg\\_and\\_temp/2011](http://www.nwd-wc.usace.army.mil/tmt/wqnew/tdg_and_temp/2011).

## Adult Passage Improvements

The vast majority of fish ladders at Columbia and Snake river dams continue to perform well for adult salmon and steelhead. However, John Day Dam ladders have been a concern, with problems including adult fish dropping back out into the tailrace after entering the ladders, long passage times, fish jumping out of the ladder in the exit sections, and difficulties with fish counting related to fish delaying just above the count stations. At the John Day north ladder, these problems have been attributed primarily to hydraulic issues at two separate locations: the count station exit section area and the lowest section of the ladder from the entrance to the transition pool.

Modifications to the John Day north lower ladder entrance area, including a non-mechanical keyhole weir entrance, removal of lower weirs, re-plumbing and new pumps for the auxiliary water supply system (AWS), and other Pacific lamprey modifications began in 2011 and are expected to be completed for the 2013 passage season.

## Kelt Management

Kelts are steelhead that survive to spawn again in subsequent years. The goal of kelt management actions is to improve survival and productivity of listed steelhead by facilitating kelt survival through transport, in-river migration improvements, and reconditioning. The objective of kelt reconditioning is to improve kelt condition through collecting, holding, and feeding after their migration and spawning to support their recuperation. A 2011 Snake River Kelt Management Plan (KMP) supplement document built upon the framework of previous plans, but also identified future direction for 2012 and 2013 and beyond. The 2011 KMP includes a review of goals, studies, and reconditioning efforts and can be found at [https://www.salmonrecovery.gov/Files/2011 APR files/2011\\_Snake\\_River\\_Kelt\\_Management\\_Plan.pdf](https://www.salmonrecovery.gov/Files/2011%20APR%20files/2011_Snake_River_Kelt_Management_Plan.pdf)

Beginning in 2010, Snake River B-run steelhead kelts were collected at Lower Granite Dam and taken to Dworshak National Fish Hatchery for reconditioning. This experimental phase continued in 2011. Water quality issues in 2011 resulted in some loss of fish, but survival was 30-50% for remaining fish that were reconditioned. These results support that Snake River B-run steelhead kelts can survive and recondition.

In-river enhanced migration research continued to inform best practices and strategies. A study on distribution of adult steelhead that fall back through the powerhouse at McNary Dam during winter months was in its first year in 2011. Study results from this project will have implications for best location of any surface bypass improvements and their operational dates at the McNary project. Results from hydro-acoustic monitoring at The Dalles Dam suggest that steelhead-sized fish actively used the Ice and Trash Sluiceway to pass the dam in December and March. Additional research will assess the relative utility of alternative passage routes for safely passing kelts.

## Habitat Protection and Improvement Actions

Productive Columbia River habitat, both estuary and tributary, is critical to the complex life cycle of salmon. Each year, the Action Agencies spend tens of millions of dollars under the BiOp and the Columbia Basin Fish Accords to implement actions that improve the quantity and quality of salmon habitat in the estuary and tributaries. This program, one of the largest and most complex of its kind in the nation, is designed to provide "offsite mitigation" for hydro impacts that remain after dam operations and structural improvements. The Columbia Basin Fish Accords and the Northwest Power and Conservation Council's Columbia Basin Fish and Wildlife Program provide implementation certainty and science oversight for these efforts.

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 expand access to blocked habitat, and acquiring easements or other protective interests for riparian areas along tributaries.

### Tributary Habitat

In 2011, the Action Agencies continued to expand an already significant tributary habitat program. The program focuses on tributary habitats used by populations of fish identified in the BiOp as having the greatest biological needs. The main goal of the program is to increase survival

of the BiOp priority populations by addressing key habitat factors that limit spawning and rearing success. To support this goal, Reclamation initiated tributary and reach assessments and increased technical planning and design assistance and BPA increased implementation funding in key watersheds. In addition to the expanded efforts for BiOp priority populations, the Action Agencies continued to improve habitat for other anadromous fish populations throughout the Columbia Basin.

All of the habitat projects implemented under BPA's Fish and Wildlife Program were reviewed by the Northwest Power Planning Council's (NPPC) Independent Scientific Review Panel (ISRP). The ISRP provides advice on whether project proposals are based on sound science principles, benefit fish and wildlife, have clearly defined objectives and outcomes, and have provisions for monitoring and evaluation of results. This review and advice is considered by the NPCC and BPA for subsequent implementation and funding decisions.

In the BiOp priority areas, the Action Agencies conduct expert panel processes that result in estimates of habitat quality improvements from proposed projects based on the best available scientific information. To illustrate up-to-date biological information, the Action Agencies prepared maps to highlight areas with the most intrinsic potential for spawning and rearing and the status of the factors that most limit habitat conditions in those areas. Reclamation's tributary and reach assessments, the new maps, and other biological information have been made available to local implementers to help propose and prioritize habitat improvement actions that work with the river systems and will improve fish survival in the short- and long-term. Results from the expert panel processes are considered by the Action Agencies when selecting projects to meet BiOp performance targets.

See Section 3 for a comprehensive list of completed projects implemented by the Action Agencies for the FCRPS BiOp in 2011.



Water efficiency and conservation helps improve water quantity and quality on Bayhorse Creek.

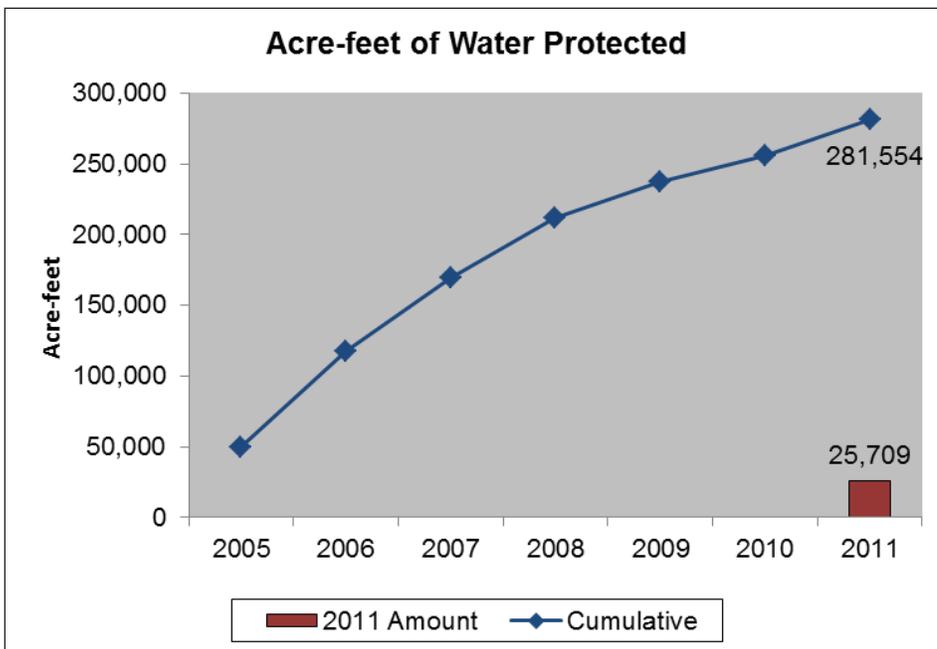
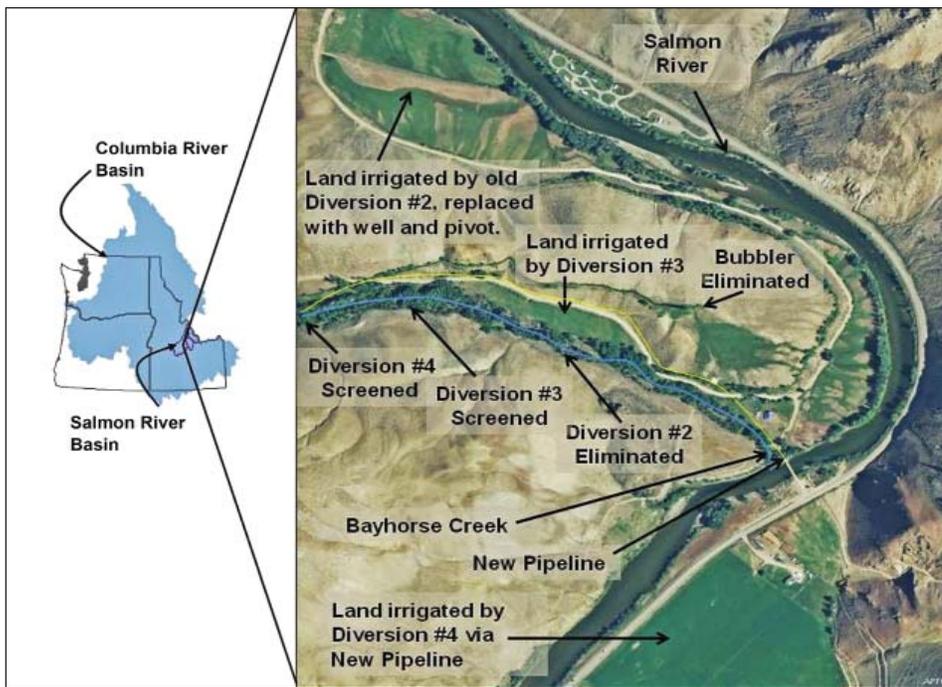


Figure 10. Water secured and protected, in acre-feet of instream flow, 2005-2011. Cumulative acre-feet/year can include annually renewed water leases.



**Figure 11. Map showing diversions and irrigated areas on Bayhorse Creek.**

Projects to protect or improve critical fish habitat employ different approaches, depending on location, targeted to the specific limiting factors affecting each population. The following sections summarize Action Agency accomplishments from 2005 to 2011 and provide examples of the work completed in 2011.

### Protecting and Improving Instream Flow

Fish survival can suffer 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 take to improve fish habitat is to install water efficiency improvements or lease or purchase water rights to increase the amount of water in streams. This in turn provides immediate improvements to salmon and steelhead survival by cooling water temperatures and providing higher quality habitat for spawning and juvenile rearing. Since 2005, the Action Agencies secured water rights for and protected approximately 281,554 acre-feet of instream water in the Columbia River Basin (Figure 10).

In 2011, the Action Agencies worked with State fish and wildlife agencies, local land owners, and others to

implement multiple water efficiency and conservation actions. Additionally, BPA worked with the National Fish and Wildlife Foundation, State water agencies, local water trusts, and others to implement 35 water transactions in streams as part of the Columbia Basin Water Transactions Program, as well as through associated water transaction projects under the Idaho Accord and the Umatilla Accord. These funded efforts in 2011 resulted in approximately 25,709 acre-feet/year of instream water to enhance flows benefitting anadromous fish in the Columbia River Basin.

Just one of the many highlights from 2011 was the completion of the Bayhorse Creek Reconnection Project on Bayhorse Creek, a tributary to the Salmon River (Figure 11) near Challis, Idaho. Reconnecting tributaries to rivers is a vital component for meeting FCRPS BiOp commitments. Bayhorse Creek is seasonally flow-limited or dewatered during the irrigation season. It provides spawning and rearing habitat for Snake River summer steelhead, and rearing habitat for juvenile spring/summer Chinook salmon, as well as cold water refugia and cold input into the Salmon River. The goal for Bayhorse Creek is to

meet the needs of the fishery resource without adversely impacting the agriculture industry.

Four active irrigation diversions on this small stream were consolidated and modified to more efficiently provide water and improve conditions for fish. A pipeline replaced one diversion and nearly a mile of open ditch to convey water more efficiently and eliminate a bubbler system that wasted water and harmed juvenile fish. A well and sprinkler irrigation system replaced another diversion and flood irrigation system, and fish screens were installed on the remaining diversions. In addition, several short sections of the stream were rechanneled to concentrate Bayhorse Creek flows for better connectivity to the Salmon River. Following completion in 2011, all of these measures provided approximately 5 to 8 cubic feet per second of additional in-stream flow in Bayhorse Creek, and a water rights transfer protects the flow.

The field shown in Figure 11 was irrigated with an open ditch from the version #4 that was porous, and conveyance losses were high. The old system diverted several cubic feet per second, and the ditch had at least three breaches that were creating erosion. The new design placed a pipeline from the ditch's point of diversion down the Bayhorse Creek Road to the Bayhorse Bridge. The new pipeline was coupled to the existing pipeline at that point. The old ditch was abandoned.

### Improving Habitat Complexity

Salmon evolved in streams that exhibited a variety of natural functions, such as seasonal flooding and riparian successional processes that culminated in large wood inputs into the stream, movement of large and small sediment, and natural connections of multiple meandering channels. The complex habitats, with a variety of pools, runs, and riffles provided important spawning and 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, interrupting some

of these natural processes and 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 (i.e., adding large wood or boulder clusters to create pools, simulate natural river processes, and improve instream habitat conditions. The Action Agencies have improved 195 miles of stream since 2005, with 34 miles completed in 2011 (Figure 12).

One example of many, for this type of work involved the Oxbow Conservation Restoration Project, located on the Middle Fork of the John Day River. The Oxbow Conservation area was historically used for cattle ranching and was dredge mined, leaving much of the river valley highly disturbed. This project is being completed in phases. Phase I which was implemented in the south channel in 2011 used approximately 400 logs to construct 32 log structures, salvaged and placed approximately 200 torrent sedge clumps, planted hundreds of willow cuttings, and removed one small area of dredge tailings from the floodplain. These actions improved habitat complexity and floodplain conditions in this stream by adding pools and cover for Chinook salmon and steelhead rearing habitat. This phase prepared the south channel for additional instream flows when the north channel is blocked off in Phase II of the project. Future phases of this project will increase instream flows in the south channel and further improve salmon and steelhead habitat.

### Improving and Protecting Riparian Areas to Improve Water Quality

Riparian habitat—the streamside environment—makes a major contribution to water quality and long-term salmon survival. While only the short-term anticipated impacts of actions to improve and restore degraded riparian habitat are credited toward achieving the BiOp targets, many of those actions will continue

to accrue benefits beyond 2018. In addition, 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



Oxbow Creek after placement of large woody debris

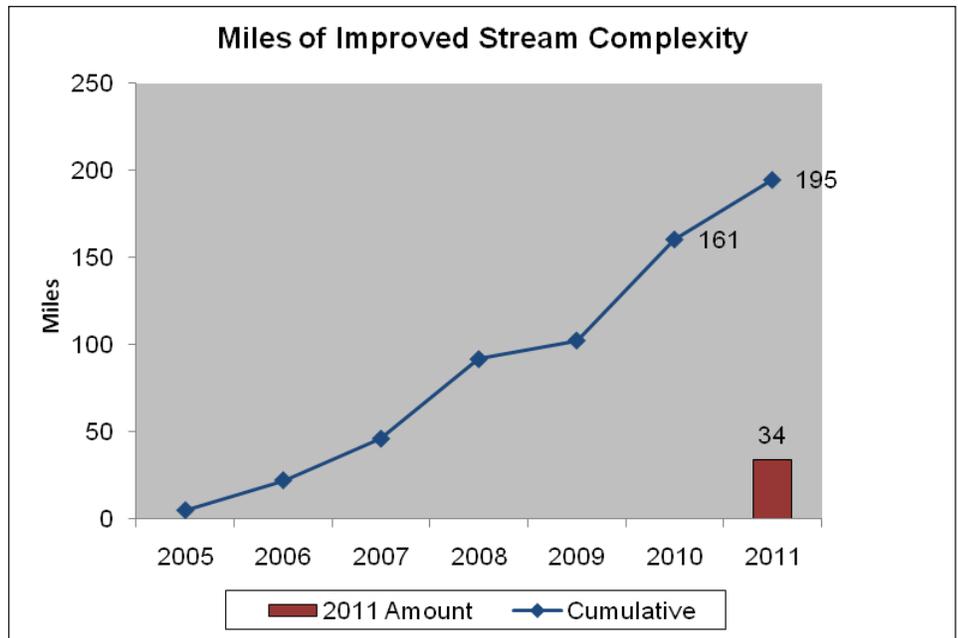


Figure 12. Miles of improved stream complexity, 2005–11.

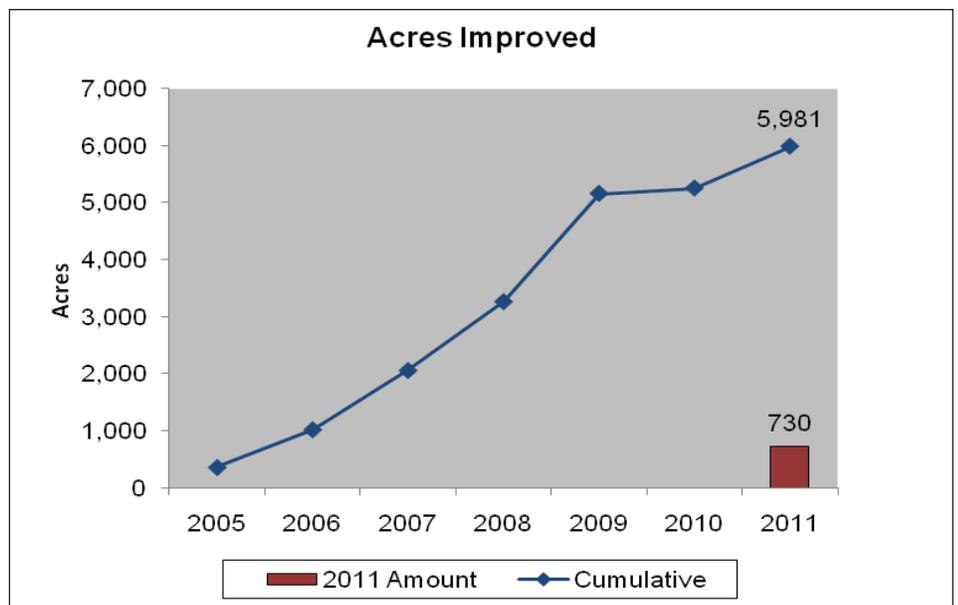


Figure 13. Acres of riparian habitat improved, 2005–11. Note: Improvement measures include creating, connecting, or realigning channels; conducting controlled burns; planting; practicing no-till farming; removing mine tailings and invasive plant species; enhancing floodplains; or improving wetlands.

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 approximately 5,981 acres and protected 51,125 acres. These improvements provide habitat benefits that will help keep water cool and clean for ESA-listed populations (Figure 13).

One example of riparian habitat improvement is the Entiat Riparian Project, located on the Entiat River, tributary to the Columbia River. This project consists of improvement, enhancement and protection of 4.1 acres and/or 1.1 miles of riparian habitat directly adjacent to the Entiat River. In 2011, three projects were implemented. These projects addressed water quality and fish habitat concerns by repairing ecosystem functions associated with native plant communities. Efforts included planting native riparian shrubs, grasses, and trees; installing livestock exclusion fencing; and controlling noxious weeds. These actions will, over time, increase shade to reduce temperature, increase large wood availability and biological diversity, reduce noxious weed viability within the project footprint, and minimize the introduction of weed

seed farther downstream.

### 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, or entrained, in irrigation ditches, where they can perish. The fish screens, which are designed according to State and Federal criteria, keep fish in the streams—and out of irrigated fields—and thus provide immediate improvements to juvenile fish survival. Diversion consolidation projects combine two or more surface diversions into one, reducing the number of diversion and screen facilities fish must navigate. Some fish screen projects entirely eliminated the need for screens and associated surface water diversions by replacing surface diversions with groundwater wells. The latter type of screen elimination project also results in more instream flow for fish while maintaining the original off-stream water use. Screens also are installed where irrigation canals rejoin the main river to protect adults returning to spawn that can potentially be attracted by irrigation “return flows” and swim up into the canal. In 2011, the Action Agencies addressed fish entrainment with installation of 46 fish screens (Figure 14).



**Before: Non-native plant species and weeds on the Entiat River.**



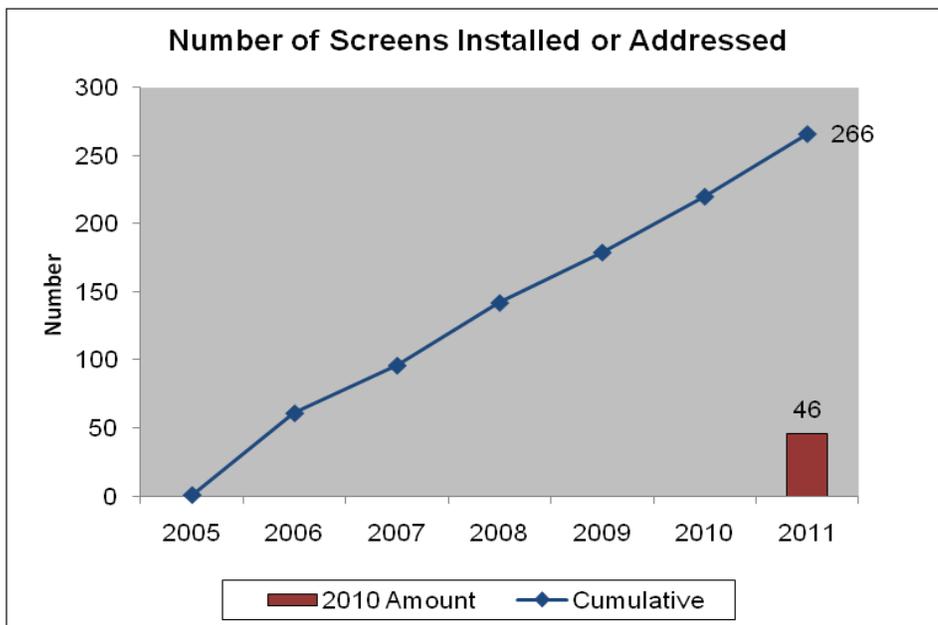
**After: Riparian planting of native shrubs, bushes, and grasses on the same section of the Entiat River.**



**Before: No fish screen on Dixie Creek**



**After: Fish screen installed on Dixie Creek.**



**Figure 14. Number of fish screens installed or improved, 2005–11.**



Before: Original wood diversion structure on Wimpey Creek.



Before: Concrete slabs in Wimpey Creek.



After: Removed diversion and rubble, weir installed, and channel rehabilitated on Wimpey Creek.



After: View of Wimpey Creek from downstream after removal of diversion and rubble, weir installation, and channel rehabilitation

One example of this type of work involved the installation of a screen on Dixie Creek, tributary to the John Day River. The goal of this project was to help prevent loss of juvenile and adult salmonids to unscreened irrigation diversions and to improve fish passage and habitat connectivity. The new screen installed at this diversion provides immediate and long-term protection for anadromous fish in the John Day River Basin.

### 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 without adversely affecting agricultural activities. Since 2005, the Action Agencies have improved access to approximately 1,590 miles of instream habitat for anadromous fish (Figure 15).

In 2011, the Action Agencies funded projects that opened or enhanced access to 281 miles of fish habitat. One example of this type of action is in the Wimpey Creek, a tributary to the Lemhi River near Salmon, Idaho. The WC-2 diversion on Wimpey Creek consisted of a wooden check structure that spanned

the creek channel. The creek channel was also partially blocked with concrete rubble downstream from the diversion structure. When in use, the diversion was a barrier to upstream migration and at times of low stream flow, virtually dewatered the stream channel below.

The Wimpey Creek diversion replacement project primarily improved fish access within Wimpey Creek, but also provided multiple benefits such as riparian rehabilitation and protection, stream channel rehabilitation, and water management. Reclamation and Trout Unlimited obtained funding from BPA and permission from the landowners and irrigators to replace the wooden check structure with a series of rock A-Weirs and rehabilitate approximately 100 yards of stream channel and embankment severely degraded by cattle grazing. In addition to a new diversion and channel rehabilitation, additional project features included new headworks, ditch enlargement, riparian vegetation planting, a water measurement device, and a cattle water gap. Upon completion of the project, fencing was erected to exclude cattle from the rehabilitated section of stream.

### Estuary Habitat Actions

Fish from throughout the Columbia River Basin use the Columbia River Estuary

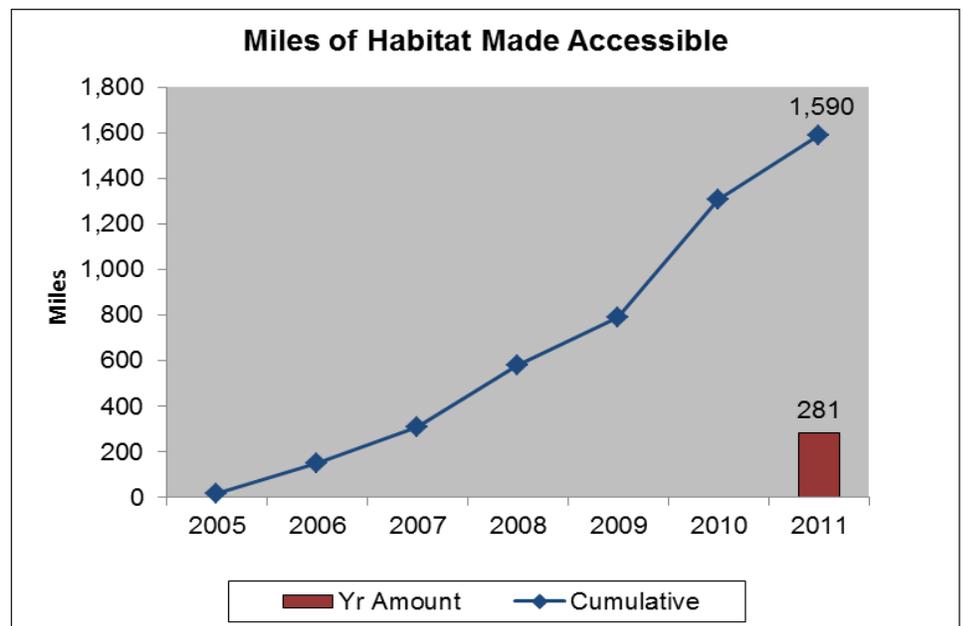


Figure 15. Miles of Habitat Made Accessible, 2005–11.

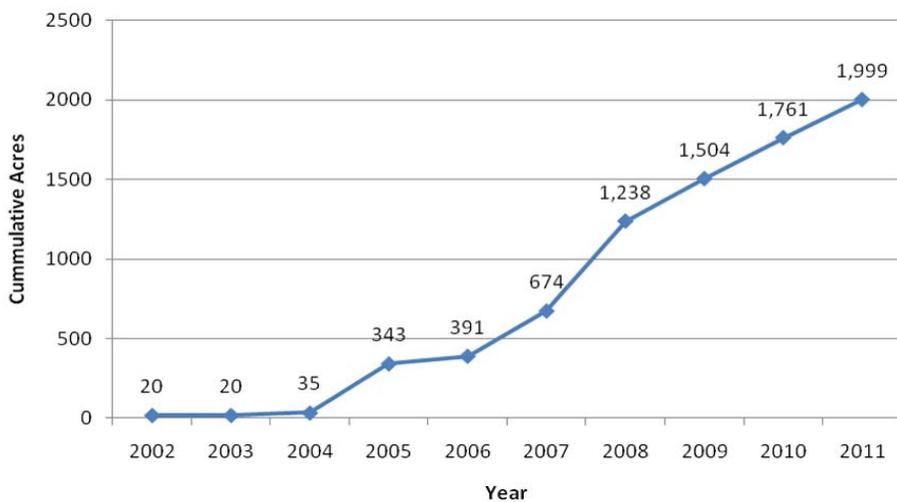
**Table 3. Summary of Estuary Habitat Restoration Metrics, 2011.**

Action	Metric
Identify and implement dredged material beneficial use demonstration projects (CRE 6.2)	4.3 acres
Improve and restore streams/channels (CRE 9.4)	9.2 acres
Area reconnected through dike modification (CRE 10.1 )	46 acres
Area reconnected through culvert or tidegate removal (CRE 10.2)	4 acres
Area reconnected through tidegate or other muted reconnection (CRE 10.3)	113.9 acres
Plant/maintain native vegetation and remove invasive species in riparian or wetlands (CRE 15.3)	61.1 acres
<b>Total</b>	<b>238.7 acres</b>

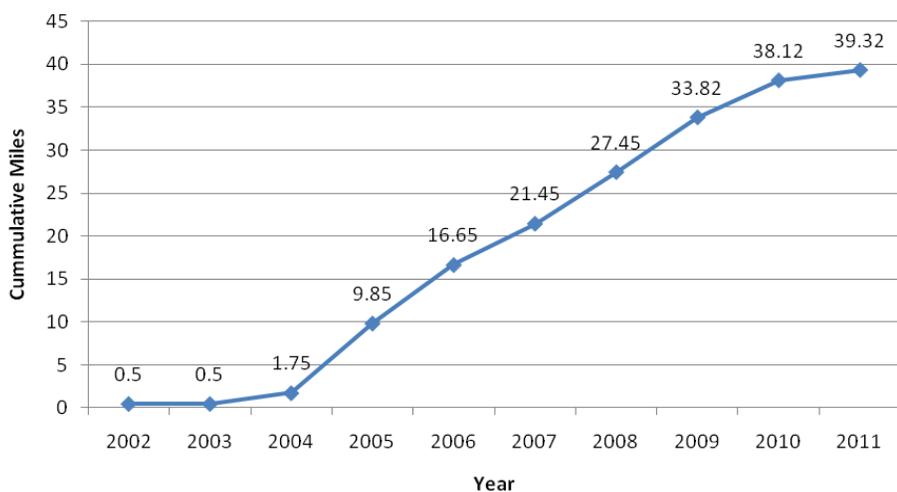


**Mill Road Restoration Project**

### Estuary Floodplain Improved, 2002 - 2011



### Estuary Riparian Areas Improved, 2002 - 2011



**Figure 16a and 16b. Cumulative summary of Estuary Acres of Floodplain Improved, 2011 and Cumulative summary of Estuary Acres of Riparian Areas Improved, 2011, respectively.**

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 pass through the estuary as they migrate to their spawning grounds. Action Agency projects in the estuary are targeted at biological benefits for the salmon and steelhead, relying on guidance and advice from a panel of regional scientists chosen for their expertise.

In 2011, working with state and federal agency partners, as well as conservation groups, the Action Agencies expanded their already substantial estuary efforts, initiating and completing on-the-ground projects in the estuary and acquiring land in support of future restoration. They also continued planning and development of additional projects for future implementation. Table 3 and Figures 16a and 16b summarize the estuary habitat metrics accomplished in 2011, and cumulatively from 2002-2011 regarding floodplain and riparian area improvements.

One of the estuary habitat projects implemented by the Action Agencies in 2011 was the Mill Road Restoration Project. This project restored much of the natural hydrologic connectivity to 46 acres of disconnected tidal floodplain. The project also reconnected 1.5 miles of historical tidal channels to the estuary, removed and controlled invasive plants and planted native shrubs/

trees on approximately 46 acres. This project resulted in the restoration and enhancement of 46 acres of tidally influenced emergent wetlands within the Columbia River Estuary, including providing diverse off-channel habitat for juvenile salmonids.

In 2011, the Corps completed a study of pile structures for a structural, hydraulic, and environmental analysis of Columbia River pile dikes and began evaluation of options based on the report findings and identified those pile structures eligible for further work. Structures that are not necessary for navigation are being considered for removal to decrease predation (by both avian and fish predators). Structures necessary for navigation may be modified to improve access to shallow-water habitat and/or to increase the complexity of juvenile salmon habitat as long as these efforts do not detract from the navigational functions.

In 2011, the Action Agencies developed the first draft of the Columbia Estuary Ecosystem Restoration Plan (CEERP) strategy and action plan. The purpose of CEERP is to establish the strategic, adaptively managed scientific basis for the ecosystem restoration and associated

research, monitoring, and evaluation (RME) that the Action Agencies are funding in the lower Columbia River and Estuary (LCRE). The overall goal of the CEERP is to understand, conserve, and restore ecosystems in the LCRE.

The Action Agencies continued developing an expanded portfolio of high-quality projects in the estuary including: working with major restoration practitioners and partners to identify and evaluate all potential restoration projects for outyear 2014–2018 planning purposes; incorporating measures of cost per “survival benefit unit” and implementation likelihood into their decision process; and continuing to have all proposed estuary projects reviewed and scored by the Expert Regional Technical Group (ERTG), refining the ERTG process and sharing the results of the ERTG process with our project partners.

## Hatchery Actions

The Action Agencies continued to fund an extensive existing hatchery program as off-site mitigation for the Federal dams, including conservation hatcheries for ESA-listed fish. In order to ensure that these programs do not impede recovery

of ESA-list salmon and steelhead, the agencies worked with hatchery operators to prepare updated hatchery and genetic management plans (HGMPs) (Figure 17). The HGMPs identify operations to meet production requirements and to reduce or eliminate detrimental genetic and ecological effects on listed species. 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 the close of 2011, the Action Agencies had reviewed draft HGMPs for 43 of the 44 Action Agency-funded hatchery programs and provided comments to hatchery operators. All 43 of these draft HGMPs have been revised by hatchery operators and submitted to NOAA for review. By the end of 2011, a total of 23 HGMPs had been determined by NOAA to be sufficient for formal ESA consultation.

Significant progress was made in 2011 on the specific hatchery reform measures included in the BiOp.

- As part of their review of the John Day Mitigation Program, the Corps, in conjunction with the United States v. Oregon Strategic Work Group, started work on an alternatives study of the program. The study will evaluate mitigation production objectives, analyze alternatives, and prepare preliminary designs and cost estimates for the most feasible alternatives.
- To help implement the transition of the Winthrop National Fish Hatchery (NFH) Methow River steelhead program to local broodstock, efforts to manage returning Winthrop hatchery-origin adults were continued. Reclamation also sponsored a series of facilitated meetings with Methow Valley stakeholders to discuss local steelhead broodstock collection and possible hatchery reforms to more effectively manage returning adults. Construction started at Winthrop NFH to remove and replace outdated structures and install new holding and rearing ponds.

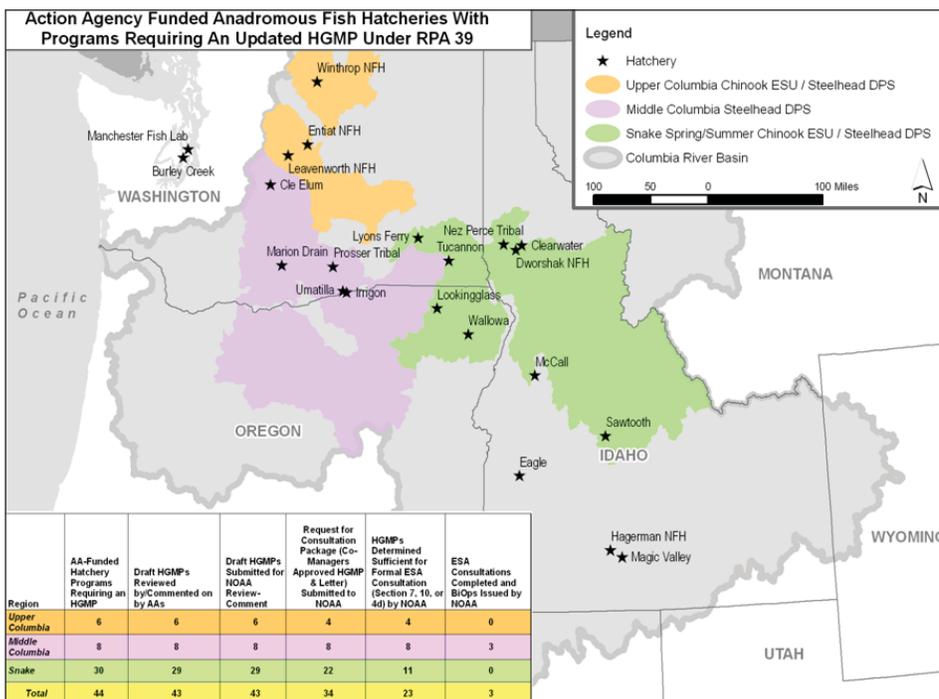
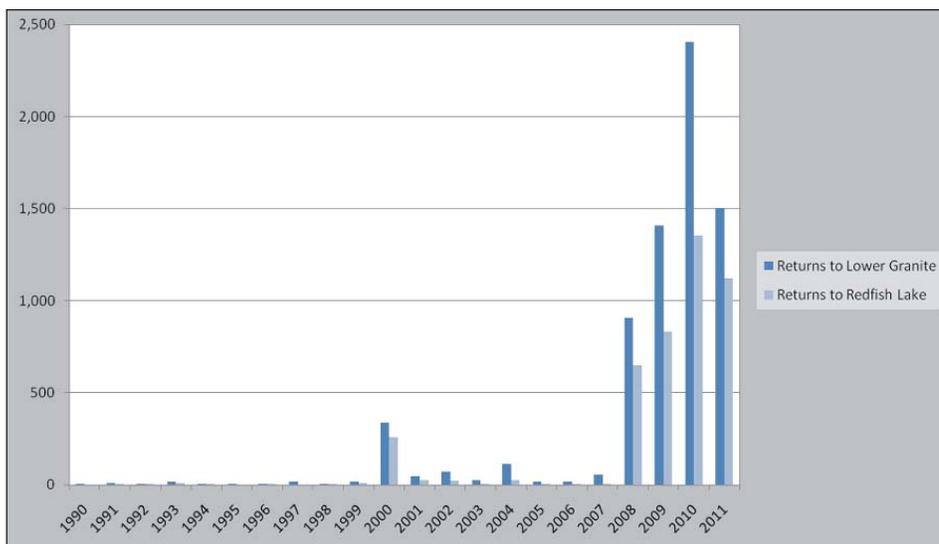


Figure 17. Action Agency-funded anadromous fish hatcheries with hatchery programs requiring an updated HGMP and ESA consultation under BiOp RPA Action 39.



**Figure 18. Adult sockeye salmon returns to Lower Granite and to Redfish Lake/Sawtooth Hatchery weir on the upper Salmon River, Idaho, 1991–2011.**

- As a reform action for the Tucannon River steelhead supplementation program, the Washington Department of Fish and Wildlife developed a revised HGMP to eliminate releases of Lyons Ferry Hatchery steelhead in the Tucannon River and to increase production of the endemic summer steelhead program.

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 captive broodstock hatchery program has produced hundreds of thousands of progeny from the remnants of the wild stock. This hatchery program, which is carefully managed to preserve genetic diversity, annually produces fry and smolts that are released in natural habitat to migrate downstream and return from the ocean as adults. The program also produces mature adults for release into Redfish Lake to spawn naturally. Since 1999, 4,311 adults from the program have returned to Idaho’s Redfish Lake or to the Sawtooth Hatchery weir on the upper Salmon River (Figure 18). In 2011, 1,118 adults returned to these two locations. The

Action agencies implemented research in 2009 and 2010 to investigate the source of disparity between returns to Lower Granite and returns to Redfish Lake/Sawtooth Hatchery weir. The Action Agencies, along with NOAA Fisheries, are continuing to work with the region to further evaluate contributing factors.

The BiOp calls for the Action Agencies to expand the program to produce between 500,000 and 1 million smolts annually. For several years, BPA worked with the State of Idaho and the Idaho Department of Fish and Game to acquire a hatchery site with adequate water quantity and quality to achieve the expanded production level. In 2010, the Springfield Hatchery property in southeastern Idaho was acquired to help meet this BiOp RPA action. In 2011, the NPCC approved the Master Plan for the construction and operation of the Springfield Sockeye Hatchery. Construction of the hatchery is expected to begin in 2012 and be completed in 2013.

The Action Agencies continued to fund hatchery conservation programs for salmon and steelhead to preserve and rebuild genetic resources and assist in promoting recovery of listed ESUs and DPSs. During 2011, BPA:

1. Continued to fund two projects to recondition upper and mid-Columbia River steelhead kelts and

increase spawner abundance of these threatened DPSs.

2. Began funding construction of a kelt reconditioning facility at Winthrop NFH.
3. Continued funding of conservation programs for Snake River steelhead and Snake River sockeye.
4. Continued funding a project aimed at reintroducing Columbia River chum salmon in lower Columbia River tributaries below Bonneville Dam and increasing the abundance of this threatened ESU.
5. Construction of the Chief Joseph Hatchery continued in 2011, with completion expected in 2013. The hatchery is anticipated to serve as the production facility for ESA-listed upper Columbia River spring Chinook for reintroduction in the Okanogan Basin.

## Harvest

Harvest impacts on ESA-listed fish species in the Columbia River Basin are managed primarily through states, tribes, and federal agencies other than the Action Agencies, and are addressed in separate BiOps. The Action Agencies have supported the identification and implementation of approaches or conservation measures to reduce the effects of harvest on ESA-listed species and/or increase the precision of enumeration of impacts. In 2011 the Action Agencies continued funding the 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. In addition, the action agencies funded an analytical



**Adult sockeye salmon in Redfish Lake**

investigation into the harvest managers sampling regime and estimation model to assess if methodologies could be changed to improve precision of estimation.

## 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, but at lower numbers. Reducing avian predation of juvenile salmonids would result in increased adult returns. Both Caspian terns and double-crested cormorants are protected under the Migratory Bird Treaty Act of 1918 (MBTA); which complicates the Action Agencies' ability to reduce the impact of these birds on the ESA-listed salmon and steelhead.

Among fish, northern pikeminnow are voracious consumers of juvenile salmon and steelhead. Predation by introduced fish species such as smallmouth bass and walleye is also a concern. California and Steller sea lions are known to consume substantial numbers of adult spring Chinook salmon and winter steelhead below Bonneville Dam, and injure many fish that pass upstream. Under the BiOp, however, the Action Agencies efforts to manage predation by sea lions are limited to non-lethal deterrent actions at Bonneville Dam, while NOAA and others take the lead on lethal removal options and permits.

Federal and State agencies, and other entities, are cooperating in efforts to manage and 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 2011, the Action Agencies continued these efforts to control specific predators and improve survival of juvenile fish.



**Caspian Tern.** Photo courtesy of Bird Research Northwest.

## Avian Predation

Avian predation, primarily from terns, gulls, and most recently cormorants, has become an increasing concern for juvenile salmon survival. This problem is confounded by the fact that these birds are protected by the MBTA. Management actions must be coordinated/approved by the US Fish & Wildlife Service which administers the MBTA.

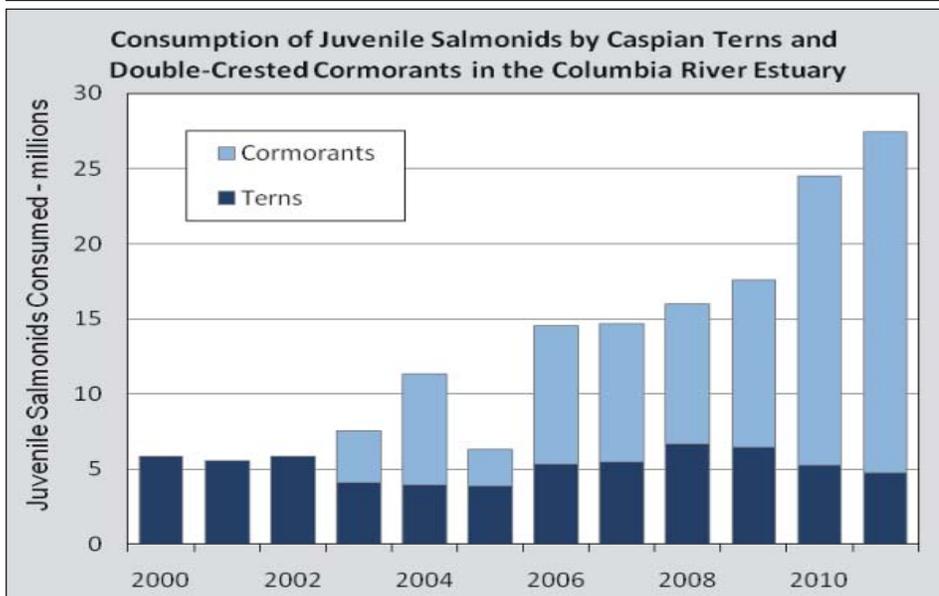
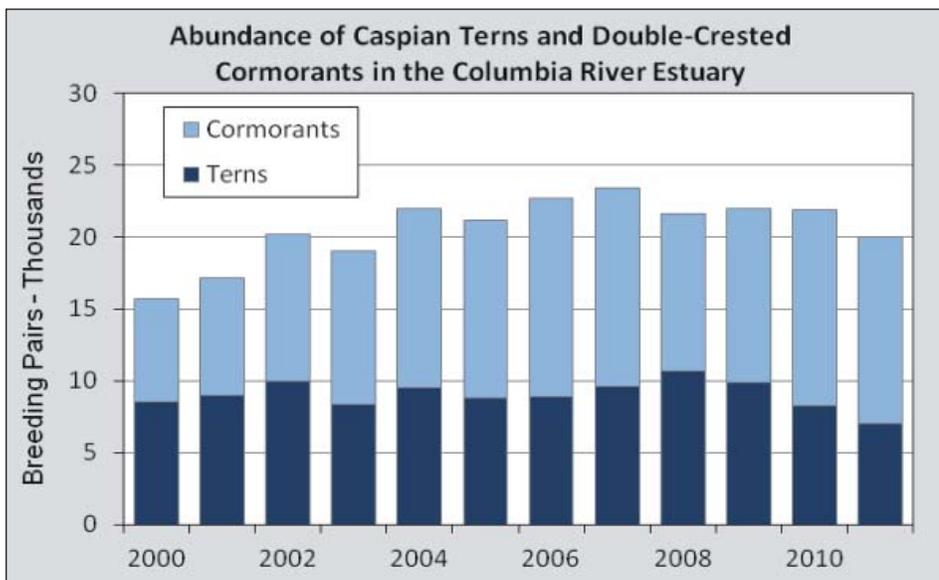
Preliminary results indicate that a combination of hazing from boats and improved avian line arrays in the tailraces at The Dalles and John Day dams helped reduced estimated gull predation from 124,000 in 2010 to 22,000 in 2011. The federal agencies have been addressing growing populations of Caspian terns and double-crested cormorants nesting in the estuary as well as those in the mid-Columbia River that prey on juvenile salmon.

In 2011, the Caspian tern colony on East Sand Island in the Columbia River estuary consisted of about 7,000 breeding pairs, smaller than in 2010 and the smallest the colony has been since it became fully established in 2001 (Figure 19a). Caspian terns nesting at the East Sand Island colony consumed about 4.8 million juvenile salmonids (95 percent confidence interval = 4.0–5.6 million) in 2011 — lower but not significantly different from the smolt consumption estimates from the previous two years.

Implementation of the Caspian Tern Management Plan for the Columbia River Estuary continued in 2011. Available nesting acreage for Caspian terns on East Sand Island was reduced to 2.0 acres.

Management options to reduce or limit smolt losses to the double-crested cormorant colony on East Sand Island are being evaluated with a management plan expected by December 2012. On an experimental basis in 2011, fencing and barriers were erected to deter double-crested cormorants from using 15 percent of the available nesting habitat, but these obstructions had little to no effect on nesting numbers. In 2011, East Sand Island was again home to the largest double-crested cormorant colony in western North America, consisting of about 13,000 breeding pairs (Figure 19a), similar to 2010. In 2011, double-crested cormorants at East Sand Island consumed approximately 22.6 million juvenile salmonids (Figure 19b), the highest smolt consumption estimate ever recorded at the East Sand Island cormorant colony.

Farther upriver in the Columbia Plateau region, Caspian terns and double-crested cormorants are also responsible for most of the smolt losses to avian predators. In 2011, the largest breeding colonies of Caspian terns in the Columbia Plateau region were on Crescent Island (in McNary Pool near Pasco, WA) and on Goose Island (in Potholes Reservoir near Othello, WA), where a nearly equal number (about 420) of breeding pairs nested in 2011. In 2011, young salmon smolts represented 84 percent of tern prey items at the Crescent Island colony, the highest percentage ever recorded at that colony, and 24 percent of tern prey items at the Goose Island colony. The largest colony of double-crested cormorants on the mid-Columbia River was on Foundation Island (in McNary Pool), where 318 pairs nested in 2011. Diet sampling during 2005–10 indicated that about 50 percent (by mass) of the Foundation Island cormorant diet was juvenile salmonids during May (the peak of smolt out-migration), while less than 10 percent of the diet was salmonids during early April, June, and July. Long term management actions are being developed through regional input. Completion of the plan is expected in early 2013.



**Figure 19a and 19b. Abundance of colonial birds in the Columbia River Estuary and Consumption of juvenile salmon in the Columbia River Estuary, respectively.** Estimates of consumption by cormorants not available for 2000–2002.

### 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 2011, the BPA monetary reward for the catch of this predator was sustained at a higher level initiated in 2005. This reward structure helps sustain the higher catches. In addition, program managers continued

the dam-angling program component initiated in 2009. This program provided two fishing crews that focused on the forebay and tailrace sections of The Dalles and John Day dams—areas not accessible to the general fishing public. A total of 3,964 northern pikeminnow were caught at those locations in 2011. This represents a 14-percent increase in catch from 2010.

In 2011, the exploitation rate on northern pikeminnow was 15.6 percent. This rate was based on a numerical catch of 178,981 from the sport reward and dam angling fisheries.

The NPMP has removed close to 3.5

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, 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 middle 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.

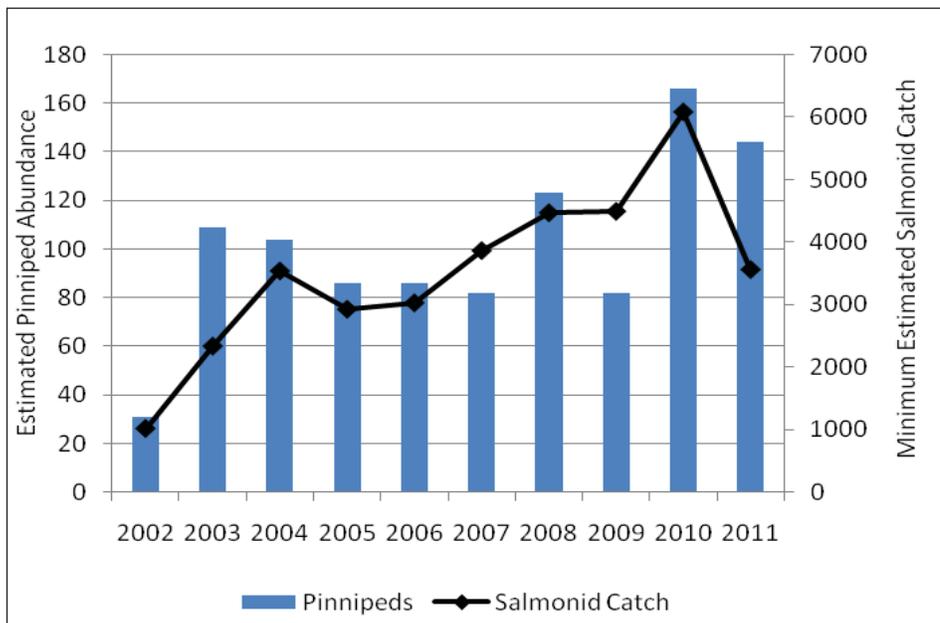
Corps biologists began gathering data on sea lion presence and predation at the dam in 2001, when six California sea lions were documented. From 2006 to 2008, the number went from 72 to 84. Not all sea lions counted were at the dam at the same time; usually about 30 were present on any one day. The number of fish eaten by sea lions has increased every year from 2006 to 2010 (Table 4). 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. The 2011 expanded adult salmonid catch estimate for the Bonneville Dam tailrace observation area was 3,557 (Figure 20), or about 1.6 percent of the adult salmonid run at Bonneville Dam from January 1 through May 31, 2011. This is the lowest percentage since 2003. Although California sea lions



**Sea lion with a salmon in its mouth.**

**Table 4. Consumption of Salmonids by California Sea Lions, Steller Sea Lions, and Harbor Seals at Bonneville Dam, from Surface Observations Conducted Between 2002 and 2011.** 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. Stansell et al. 2011.

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 %
2010	267,194	6,081	2.2 %	6,321	2.4 %
2011	223,380	3,557	1.6%	3,970	1.8%



**Figure 20. 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 2011.** In 2005, regular observations did not start until March 18. Pinnipeds observed included California sea lions, Steller sea lions, and harbor seals. Stansell et al. 2011.

remained the primary adult salmonid predator, accounting for 71 percent of the observed salmonid catches, catches by ESA listed Steller sea lions increased, from 0.3 percent in 2007 to 16 percent in 2010 and to 29 percent of total salmonid take in 2011.

The Corps has implemented a variety of sea lion deterrents, from physical

barriers to nonlethal 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, and Columbia River Inter-Tribal Fish Commission (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 2011, a total of 13 different California sea lions were trapped at Bonneville. These were branded (if not already so), tagged, and released. In addition, 10 Steller sea lions were trapped, branded, and tagged. Of the California sea lions, three were on the list for removal, and another seven would have qualified, had the States' removal permit not been vacated for most of the season.

## Research, Monitoring, Evaluation, and Adaptive Management

The Action Agencies provide tens of millions of dollars each year for an extensive Research, Monitoring, and Evaluation (RM&E) Program. This program supports accountability for implementation of BiOp actions and addresses critical uncertainties through adaptive management. The Action Agencies use the best available scientific information from this Program to ensure actions meet the BiOp goals and performance standards.

RME is implemented through various programs: the NPCC Fish and Wildlife Program (BPA), the Corps' Anadromous Fish Evaluation Program, and Reclamation's technical assistance activities. The programs are coordinated with RME activities of other regional agencies. The Action Agencies work closely with 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 through a forum called the Pacific Northwest Aquatic Monitoring Partnership (PNAMP).

The RM&E Program uses a regionally coordinated approach to fish and habitat status monitoring, action effectiveness research, critical uncertainty research, and data management, memorialized in the Anadromous Salmonid Monitoring

Strategy (ASMS). The ASMS identifies and prioritizes monitoring of salmonid population indicators, habitat action effectiveness, and hatchery action effectiveness needed to support the BiOp.

Taken as a whole, the Action Agencies' RME actions are focused on answering five key management questions:

1. Are actions being implemented and accomplished as proposed?
2. Are we meeting biological and programmatic performance objectives established within the Columbia Basin Fish and Wildlife Program, FCRPS BiOp, and ESA Recovery Plans?
3. Where objectives are not being met, what factors are limiting our ability to achieve performance standards or objectives?
4. What is the effectiveness of different mitigation actions in addressing factors limiting achievement of performance standards and objectives?
5. Is research and monitoring information accessible to the region and compatible with regional standards and protocols for monitoring, data collection, and access?

The Action Agencies implemented RME projects within nine strategic focus areas to support the implementation of the all-H action strategy. These strategic focus areas are:

- Fish Population Status Monitoring (RPA Actions 50-51)
- Hydro RME (RPA Actions 52-55)
- Tributary Habitat RME (RPA Actions 56-57)
- Estuary and Ocean RME (RPA Actions 58-61)
- Harvest RME (RPA Actions 62)
- Hatchery RME (RPA Actions 63-65)
- Predation and Invasive Species Management RME (RPA Actions 66-70)
- Coordination and Data Management (RPA Actions 71-72)
- Project Implementation and Compliance Monitoring (RPA Action 73)

## Fish Population Status Monitoring

The fish population status and trend monitoring program supports monitoring of population and ESU/DPS indicators of wild and hatchery adult and juvenile abundance, distribution, productivity, survival, and genetic diversity. This information provides important indicators of the condition of fish populations relative to performance targets and AMIP contingency triggers. These indicators support assessments of the priority and benefits of tributary and estuary restoration actions, hatchery management actions, predation management, and hydropower actions.

### What Was Achieved in 2011?

- The Action Agencies continued to monitor the status of ESA-listed fish and enhance the existing status monitoring performed by regional fish management agencies through implementation of approximately 50 projects. This effort reflects a regional strategy to monitor a minimum of one population per each Major Population Group (MPG) for each listed species.
- This monitoring program continued to be enhanced through further expansion of a regional PIT tag array network in tributaries to support spawner abundance surveys. In addition, an expansion of juvenile trapping and surveys was implemented for key populations to improve both fish status monitoring and habitat effectiveness studies.
- Genetic stock identification techniques were used to establish population baselines and help to identify the origin or parentage of untagged Snake River Chinook and steelhead.

### What Was Learned from 2011 Project Results?

- Significant increases in natural-origin adult spawners and reduction of hatchery-origin spawners occurred for many populations across the basin, improving wild/natural spawning viability attributes for these species.

- Total adult fish returns to Bonneville Dam of listed and unlisted salmonids was the fourth highest number since counting began in 1938.
- Genetic typing of all steelhead broodstock in Idaho has been shown to be feasible. Methods were shown to be successful for the accurate assignment of offspring to brood year, hatchery stock, and even individual parents. This will help support B-run steelhead pedigree analysis, which supports the 2011 population assessments as well as provides a baseline for potential future assessments with genetics data.
- Connectivity and habitat size of spawning areas was shown to be the strongest predictor of redd distribution. The results demonstrate that the size and connectivity of existing habitat networks should be maintained or prioritized in actions whenever possible.

### Related Observations and Modifications to Achieve BiOp Strategies

- Neither the AMIP Early Warning Indicator nor the Significant Decline triggers were tripped for any ESU in 2011.
- Data access and sharing needed for the assessments of key fish population indicators was significantly advanced through ongoing development of monitoring documentation tools.

### Hydro RME

Hydro RME studies were conducted on the juvenile fish transportation program, turbine survival, and juvenile and adult dam passage. Many of these studies and what we have learned from them are covered in earlier subsections.

### What Was Achieved In 2011?

*Action Effectiveness Monitoring and Research*

- Adult and juvenile hydro migration distribution timing and survival continued to be monitored to support real time operations and mitigation planning and assessments.

- The PIT Tag database system, PTAGIS, was upgraded and web-based tools were released for faster processing of raw detection data of adults and juveniles.
- Performance standards testing was conducted at Bonneville, The Dalles, and John Day dams in the spring. The planned summer migrant performance standard testing was canceled due to high river flows.
- A study completed in 2011 compared smolt-to-adult return ratios of barged juvenile fish released at the historic site near Beacon Rock to those of fish released at an alternative site in the estuary near Astoria.
- An evaluation compared direct injury rates to steelhead kelt from downstream passage via the Bonneville Dam Powerhouse 1 ice and trash sluiceway and the Powerhouse 2 corner collector.
- The spill pattern at Little Goose Dam was evaluated at the physical hydraulic model at the Corps' Engineering Research and Development Center for adjustments to minimize adult Chinook salmon passage delays observed in previous years with operation of the spillway weir for total river flows ranging up to 100,000 cubic feet per second.

#### *Critical Uncertainty Research*

- Juvenile Chinook were tagged at Lower Granite Dam for a multiyear study on potential latent mortality resulting from transportation. A regional workshop was held in May 2011.
- Updated COMPASS Model parameters describing route-specific survival through lower and upper Columbia dams, and post-hydrosystem survival rates for steelhead and yearling Chinook.
- Juvenile sockeye salmon from Idaho were PIT tagged and used for a second year of evaluation of the feasibility of transport from Lower Granite Dam. 2012 will be the final year of tagging for this pilot study.

A final report will be available upon completion of all adult returns in fall 2014.

- A PIT Tag study to evaluate weekly smolt-to-adult returns (SAR) for natural spring Chinook and steelhead transported from Lower Granite Dam continued in 2011.
- Design and installation criteria were developed for Lower Granite Dam as a part of the evaluation of the feasibility of installing spillway PIT detectors at FCRPS dams.

#### **What Was Learned from 2011 Project Results?**

##### *Action Effectiveness Monitoring and Research*

- No difference in Chinook salmon adult return rates was observed for transported fish released at two different sites (Beacon Rock vs. Astoria) in any year examined. However, steelhead had significantly higher return rates for fish released near Astoria relative to Beacon Rock in one year (2008), but not the other two years (2006-2007). A much higher stray rate was observed for steelhead released near Astoria relative to steelhead released near Beacon Rock nullifying any potential gains from increased adult return rates. The study did find clear evidence that the release location near Astoria provided a reduced vulnerability to avian predators for both yearling Chinook salmon and juvenile steelhead.
- Survival estimates at Bonneville, The Dalles, and John Day Dams suggest these dams have high enough dam survival levels to nearly attain or exceed performance standards.
- Results from the evaluation comparing downstream passage via Bonneville Dam ice and trash sluiceway and the second powerhouse corner collector by outmigrating steelhead kelts found few direct injuries for either route of passage and no differences in injury rates.
- A change in the operation of spillbays at Little Goose Dam to prioritize early spill-season use of spillbay 8 proved

to break up the effects of the spillway weir-powered eddy that may have been a cause of adult passage delay. This change was implemented in the Fish Passage Plan for 2011.

- For Snake River yearling Chinook salmon, estimated survival through the entire hydropower system in 2011 (from the head of Lower Granite Pool to Bonneville tailrace) was 0.483, below the average for the last 13 years (0.493). Juvenile steelhead survival was 0.592, higher than the 13-year average (0.418), but lower than 2009 and 2010 estimates. Flow and spill rates at Snake River dams were at relatively high levels, juvenile travel time through the system was the fastest recorded, and the proportion of fish transported was relatively low compared to past years of study.

##### *Critical Uncertainty Research*

- NOAA-Fisheries evaluations of smolt-to-adult return ratios from wild fish transported in the spring, compared to those left in-river, continued to indicate benefits from transport over in-river migration during certain time periods, especially for steelhead smolts.
- The survival probability of juvenile steelhead and Chinook salmon from release sites upstream to Lower Granite Dam suggests that substantial pre-dam mortality occurs upstream from the Snake and Clearwater River confluence prior to entering the FCRPS.
- A multi-year analysis of PIT tagged Snake River hatchery steelhead and yearling Chinook salmon found a correlation between the number of juvenile bypass events and reduced adult return rates. However, the causative mechanism(s) of the reduced adult return rates were not identified. Individuals that were only bypassed at Lower Granite, McNary, John Day, or Bonneville (and no other dams) showed no statistically significant reduction in expected adult returns, while individuals bypassed at either Little Goose or Lower Monumental produced fewer than expected

adult returns. Juveniles bypassed at multiple dams, including dams that individually showed no effect, usually returned fewer adults than expected. One proposed mechanism for the observed correlation between JBS exposure and lower SARs was that JBS's are selective for weaker fish. This may explain why some JBS's are associated with reduced SARs and others are not. The ISAB has recommended further study of this selectivity mechanism. Several JBSs have been improved since the data in the multi-year study was collected. Many dams now have direct bypass to the river, and several dams have had their JBS outlets relocated. Future research will monitor the effects of these changes.

- It was possible to differentiate four regional groups of Snake River fall Chinook using otolith microchemistry.
- An analysis of smolt survival rates showed that differential susceptibility to predation by smolt size could produce different mortality rates between hatchery and wild release groups.

#### **Related Observations and Modifications to Achieve BiOp Strategies**

- Dam modifications and spill/surface passage improvements appear to be on track to achieve the hydrosystem performance standards of 96 percent and 93 percent average dam survival for spring and summer migrating fish, respectively.
- Completion of the new JVS outfall before the 2012 passage season is expected to be the last major modification necessary at both McNary and Lower Monumental dams to reach juvenile performance standards.
- Lower Granite Dam remains the last dam where the actions necessary to reach juvenile performance standards are still being developed.
- In 2011, PIT tag in-river juvenile survival estimates for wild Snake River steelhead, for wild and hatchery upper Columbia River yearling Chinook, and for wild and hatchery

upper Columbia River steelhead were all less than the mean COMPASS estimates. However, for Snake River steelhead and upper Columbia River steelhead the differences were not statistically significant. The PIT tag in-river juvenile survival estimate for wild Snake River yearling Chinook was higher than the mean COMPASS estimate, although the difference was not statistically significant.

- Survival rates of ESA-listed adult Snake River spring/summer Chinook and steelhead and upper Columbia River spring Chinook through the FCRPS remained below adult passage performance standards in 2011, although just barely so in the case of the latter. Survival rates for Snake River fall Chinook and upper Columbia River steelhead exceeded the performance standards. Adult system survival reductions may be related to dam modifications to improve juvenile outmigration, injuries, and mortalities related to sea lion predation, unquantifiable levels of mortality related to fisheries, and unaccounted levels of straying. In addition, 2011 was a high-flow year, which may have further increased adult fallback and delay. The addition of adult PIT tag detectors at The Dalles and John Day dams and in tributaries may help pinpoint the section of the river where fish are being lost. Adult return data continue to confirm that smolt transportation during May is typically associated with higher adult steelhead returns than are in-river migration and somewhat higher returns for Chinook. Nevertheless, under adaptive management (as discussed with RIOG), 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.

#### **Tributary Habitat RME**

Information to support habitat action planning and assessment needs was implemented in 2011 with ongoing and expanded efforts in status and trend monitoring, action effectiveness research,

and analytical approaches. Status and trend monitoring supports assessments of limiting habitat factors and development of relationships between habitat condition and fish productivity and capacity. Action effectiveness monitoring and research helps to refine information regarding the beneficial effect of habitat actions on fish populations and habitat conditions at both the local (project) level and the broader watershed level – and to identify the most effective actions to enhance fish survival.

The Columbia Habitat Monitoring Program (CHaMP) was initiated to assess multiple parameters of habitat status and trend in eight subbasins in 2011. Tributary habitat conditions and limiting factors were evaluated through state-of-the-art “intensively monitored watersheds” (IMW), which provided data to quantify the relationships between habitat conditions and fish productivity.

#### **What Was Achieved in 2011?**

- Habitat status and trend monitoring coverage continued to expand via the first year of implementation for the CHaMP program. The CHaMP program was able to successfully implement the planned study design and then report on results from the first year of data collection in a November workshop.
- Habitat action effectiveness studies continued through assessments of large-scale IMWs and individual projects. The effectiveness of restoration treatments relative to fish populations at watershed and reach scales was evaluated at three IMWs participating in the Integrated Status and Effectiveness Monitoring Program (John Day, Lemhi, and Entiat), Okanogan Basin Monitoring & Evaluation Program, and at one Reclamation-led IMW (Methow).
- Several modeling efforts were underway in 2011. Substantial progress was made on the development of life-cycle and aquatic productivity models to analyze habitat treatments in the Methow IMW. For example, the coupled smolt decision and bioenergetic model was completed; a published

paper described the results of an application of the model. The temperature calibration of a 2D hydraulic model was also completed. Methow IMW monitoring partners began development of study design for a significant floodplain reconnection and complexity project, and a river nutrient treatment.

### **What Was Learned from 2011 Project Results?**

- A synthesis was prepared of lessons learned from the Integrated Status and Effectiveness Monitoring Program, which covered material from 2003 to 2011. This synthesis provided details on how habitat measurements were standardized and refined in a manner that was adopted as the basis of CHaMP. Relationships between fish abundance and changing habitat conditions that were developed using data from the Wenatchee River were presented as a potential method to inform project selection.
- In the Methow River, field sampling efforts since 2008 are revealing much information on fish assemblage, fish abundance, fish growth, fish movement behavior, habitat availability, habitat quality, side-channel connectivity, and stream productivity; including spring Chinook their life history expression, smolting, survival, and habitat use.
- A passage study in Beaver Creek, a tributary to the lower Methow River, indicated that adult steelhead were migrating into upper Beaver Creek 2 to 3 years after barrier modification. Migration data from juvenile fish tagged in Beaver Creek showed that they returned to Beaver Creek as adults, indicating the establishment of the full expression of anadromy in the study area. Researchers presented results from the Beaver Creek barrier removal studies in a special session on colonization of salmonids at the national American Fisheries Society meeting during September 2011 in Seattle, WA.

### **Related Observations and Modifications to Achieve BiOp Strategies**

- The habitat program structure, which

consists of biologically targeted projects, assessment of habitat quality improvements, use of expert panels, and independent scientific review continues to function well. The Fish Accord partnerships, and other partnerships, are effectively supporting tributary habitat project implementation.

- Under the tributary habitat RME strategy, the Action Agencies continue to monitor the action effectiveness of on-the-ground actions that were completed throughout the Columbia River Basin in 2011 to improve tributary spawning and rearing habitat for numerous populations of salmon and steelhead. New projects continue to be identified and scheduled for future implementation.
- BPA continued plans to implement a programmatic approach to project-level habitat action effectiveness to restructure the NPCC Fish and Wildlife Program to align with the PNAMP's habitat action effectiveness monitoring strategy.

### **Estuary and Ocean RME**

Estuary and ocean studies were conducted to determine the status and condition of estuarine and ocean habitat to support the evaluation of how fish performance and life history diversity are affected by changes in key environmental attributes. These findings inform habitat restoration strategies by addressing those factors and threats that most prominently influence juvenile survival and productivity.

### **What Was Achieved in 2011?**

- Estuary research informed management decisions and adjustments under the Columbia Estuary Ecosystem Restoration Program (CEERP) through changes in habitat restoration planning and prioritization (e.g., projects that restore connections to floodplain habitats), designs (e.g., restoration of natural processes) and assessment of expected benefits to juvenile salmon (e.g., distinguishing between ocean type and stream type life history strategies), including actions that might most significantly contribute

towards the fitness of marked and unmarked as well as lower and Interior Columbia basin ESUs/DPSs.

- The early life history diversity index and habitat connectivity index for juvenile salmon in the LCRE were further developed. These indices contribute to our understanding of the reaches and habitats frequented by at-risk stocks at representative locations in the estuary. Coastal Ocean Acoustic Salmon Tracking assessed the movement and relative survival of Columbia River salmon stocks through the lower river, estuary, plume, and early ocean phase off the west coast of North America. This information is used to determine the physical, biological and ecological mechanisms that control survival of juvenile salmonids through these geographic regions.
- A conceptual species-habitat model that relates habitat restoration to benefits derived by juvenile salmon was completed. The model is organized into three basic tiers (physical, biotic, and salmon) and suggest that juvenile salmon (ocean and stream type) derive benefits via residency and refugia, feeding and growth.

### **What was Learned from 2011 Project Results?**

#### *Estuary*

- Action effectiveness research continues to show that juvenile salmon begin using restored habitats almost immediately after floodplain habitats and wetlands are reconnected. Restored marsh plant communities support both prey production for juvenile salmonids and the export of macro-detritus in the lower river and estuarine habitats. Tide gate and culvert removals or retrofits, levee breaches, and other habitat protection and restoration actions that support ecosystem processes have shown positive effects on the lower river and estuarine habitats and growth and condition of ESA-listed juvenile salmonids.
- Estuary habitat use varies by season, stock of origin, life-history stage, and

other factors. Unmarked Chinook salmon are the most common salmon species in estuary tidal freshwater, followed by juvenile chum and coho. Genetic survey results showed that stock compositions of Chinook salmon juveniles are highly variable spatially and seasonally during juvenile migration. These trends are spatially and temporally consistent between years, suggesting that major stock distribution patterns in Columbia River tidal freshwater habitats may remain relatively stable across years.

- Juvenile salmon (Chinook and coho) used tidal freshwater portions of the estuary for extended periods from mid-winter through early spring months. They are most abundant in the spring. Abundance generally decreases into summer/fall and increases in winter. Juvenile salmon use shallow, tidal freshwater habitats to feed and grow year-round.
- The most important prey taxa in the diets of Chinook salmon, as indicated by the Index of Relative Importance, included dipterans, amphipods, and cladocerans, although the importance of these prey items were variable over time. Based on an “electivity” index, these taxa were never consumed in proportion to their abundance in the environment. Dipterans were taken at a lower proportion than would be expected although they consistently accounted for large proportions of prey in gut contents of juvenile salmon. Trends in fish community composition at the Sandy River Delta are similar to those observed during previous years of sampling. Beach seine catches were dominated by native fish species. Densities were highest for native species (excluding salmon) in the summer and for non-native species in the fall. Results suggest that fish assemblages are most closely explained by seasonal trends as opposed to trends linked to sites, habitat strata, or study region. Preliminary results from gut content analysis at the Sandy River Delta show little dietary overlap between

juvenile salmon and four resident fish, suggesting low potential for inter-specific competition.

#### Ocean

- Columbia River salmon populations migrate at different times and speeds. During their first months at sea, mean northward migration rates of interior Columbia River yearling Chinook are higher during years of poor ocean conditions, suggesting that juveniles may modify their migratory behavior based on ocean conditions. The growth rates of juvenile coho, Chinook, and steelhead were positively associated with ocean survival and adult returns. For yearling Chinook, body size and early marine growth were positively correlated with ocean survival. Results suggest that the primary factors affecting juvenile salmon ocean survival occur within the first year of marine residency and are partially related to food-web structure and growth conditions in the plume and coastal ocean.
- Predation by piscine predators (e.g., Pacific hake) can be higher during years of warm ocean conditions because these oceanic fishes move into warm continental shelf waters. In contrast, avian predation appears to affect juvenile salmon survival at a local level (in and around the Columbia River plume and associated ocean-plume fronts). Data indicate that ocean temperatures, forage fish abundance, and, possibly, predator abundance strongly influence smolt-to-adult returns. The movement of forage fish to the mouth of the Columbia River appears to happen suddenly and is strongly controlled by ocean conditions.
- Studies of acoustically tagged yearling Chinook showed that smolt travel times through the estuary and Columbia plume are highly variable by week of migration. Transported smolts generally have survival rates similar to in-river migrants. Most smolts travel northward along the coast.

#### Related Observations and Modifications to Achieve BiOp Strategies

- It is increasingly clear that ocean conditions and food webs have a dominant impact on overall fish survival and SARs, notwithstanding the FCRPS hydro and habitat mitigation programs.
- The estuary habitat program structure, which consists of ecologically targeted projects, assessment of potential improvements, use of an expert panel and independent scientific review, is under way and functioning well. The Fish Accord partnerships, and other partnerships with conservation groups in the estuary, are effectively supporting habitat project selection and implementation.
- Projects that restore natural hydrologic processes and historical habitats, increasing estuarine and tidal freshwater habitat capacity, are a priority (e.g., floodplain reconnection, dike breaches, levee laybacks) because they result in greater benefits to juvenile salmonids.
- Estuarine and tidal freshwater habitats with edges/buffers are more resilient to changing environmental conditions (e.g., changing climate) than those without.
- Results to date suggest that restoration projects closer to the Columbia River mainstem benefit upriver stocks more than restoration projects farther from the mainstem.
- Results continue to indicate that juvenile salmon expressing “ocean” type life histories (e.g., sub yearling Chinook) occupy shallow water estuarine habitats in greater proportions and for longer periods of time, than juvenile salmon expressing “stream” type life histories (e.g., steelhead).
- Genetic stock groups (e.g., upper Columbia River summer/fall Chinook) reside for different amounts of time and in different

locations throughout the estuary; suggesting upriver stocks will benefit differently from restoration projects in upper fluvial reaches than from restoration projects in the lower brackish portion of the estuary.

- Estuary habitat actions targeted at improving the quality of and access to a variety of shallow tidal freshwater habitats will benefit a variety of salmon stocks, at different times of the year. River flow (discharge) and tidal flux are key factors affecting habitat availability and habitat quality in the estuary.

### **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.

### **What Was Achieved in 2011?**

- The Action Agencies continued to fund the development and implementation of selective fishing gear for harvesting anadromous salmonids in the Columbia and Okanogan rivers.

### **What Was Learned from 2010 Project Results?**

- In 2011, the Colville Confederated Tribe (CCT) select harvest yielded a total of 1,156 salmonids. The significantly lower salmonid harvest in 2011 compared to 2010 was due to high flows in the Similkameen & Okanogan Rivers in the late spring – early summer which led to a late and only brief (~1 week) establishment of a thermal barrier. Establishment of the thermal barrier is what enables the CCT to harvest large numbers of chinook and sockeye in the Wells pool below the mouth of the Okanogan River.
- Uncertainty exists regarding whether high observed survival from immediate release techniques for

the selected fishery equates to high long-term survival and spawning success resulting from the use of selective fishing techniques.

- Techniques for the genetic monitoring of stocks have made considerable headway toward identifying markers associated with adaptive traits such as anadromy as well as distinguishing hatchery from wild stock. These improved techniques will allow for more effective monitoring of hatchery and wild fish.
- Harvest managers were able to collect PIT tag data from commercial catch in 2011, thus improving interrogation techniques and better informing harvest managers of stock composition of catch and impacts by gear.

### **Related Observations and Modifications to Achieve BiOp Strategies**

- Purse seines are an effective management tool for harvest with very minimal immediate mortality due to handling and release techniques in the upper Columbia and Okanogan rivers and Lake Osoyoos.
- The transfer of fishing and gear technology may be feasible for other fishing areas within the Columbia River Basin.

### **Hatchery RME**

BPA continued to fund monitoring and evaluation of BiOp hatchery actions throughout the Columbia River Basin and continued relative reproductive success (RRS) studies for several ESA-listed salmon and steelhead populations. These RRS studies compare reproductive success of hatchery-origin fish to reproductive success of natural-origin fish. Hatchery studies also continue to assess the effects that specific implemented reform actions have on native populations.

### **What Was Achieved in 2011?**

- NOAA Fisheries and the Action Agencies determined that a Snake River fall Chinook RRS study would not be feasible and have instead

identified several related monitoring and evaluation projects which will contribute to understanding the effects of hatchery produced fish on the wild population.

- The RRS studies of hatchery-origin fish compared to natural-origin fish continue to be assessed for Grande Ronde Chinook salmon and Hood River steelhead populations.
- Two projects focusing on Chinook and steelhead in the Tucannon River completed their first year of pit tagging and data collection. Additionally, a new RRS study on steelhead in the Methow reported its first year of results.
- A newly implemented Snake River sockeye juvenile migration and survival study reported little differences in survival across three hatchery release sites.

### **What Was Learned from 2011 Project Results?**

- Grande Ronde monitoring of spring Chinook has shown that survival of natural origin out-migrating juveniles did not differ significantly from hatchery origin juveniles, however mean fork length of hatchery origin Chinook was ~30mm longer than the mean fork length of natural origin juveniles. Additionally, significant differences were found between natural and hatchery mean brood year age class structure. Overall, natural origin Chinook salmon had significantly higher rates of smolt to adult survival than hatchery counterparts.
- Research on hatchery emergence techniques for steelhead revealed that steelhead smolts that were reared for two years survived to the first point of detection at significantly higher rates than age 1 smolts. These findings have strong implications for broodstock management of steelhead, particularly in the upper Columbia.
- Monitoring of spring Chinook in Lostine River in the Grande Ronde reported that natural origin spawner abundance of was estimated at 30%

of total spawners.

- The John Day River Basin was monitored as a reference stream and it was calculated that hatchery origin fish comprised of approximately 5% of the steelhead estimated in the basin. In addition to monitoring proportionate estimates of strays versus wild, research will continue to investigate the impact of these strays.
- Findings from an RRS steelhead study in Abernathy Creek show that because hatchery smolts emigrated shortly after their release they had little adverse effect on the native steelhead population. Despite efforts to integrate steelhead broodstock, the population shows decreased genetic variation and significant divergence from the wild population.
- Steelhead kelt condition data suggests that kelts from the Yakima River Basin generally appear in better shape than fish from the Snake River.
- Steelhead studies in the Deschutes River found that hatchery steelhead appeared at the weirs later compared to wild spawners and that hatchery fish in Buck Hollow Creek may not be spawning as high in the basin as wild fish.

#### **Related Observations and Modifications to Achieve BiOp Strategies**

- Future monitoring and evaluation efforts should continue to track natural and hatchery adult size at return by age class over time, brood year age class structure, and adult spawning distribution to determine if differences exist and if those differences may contribute to decreased productivity.
- The Snake River sockeye captive broodstock and conservation/supplementation program again returned high numbers of adult fish in 2011. 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 spring Chinook captive propagation program has successfully maintained these ESA-listed populations in captivity and provided fish for use in restoration. The captive broodstock and captive rearing programs provide seawater rearing facilities that help ensure the retention of anadromous traits. This program, united with the Oregon Department of Fish and Wildlife captive broodstocks, has returned 4,205 maturing adults over the course of 12 Brood Years that have been used to aid in the restoration of self-sustaining natural runs of spring/summer Chinook to the Grande Ronde River Basins.
- To support the effective monitoring of hatchery-origin fish, a 100 percent marking strategy of all hatchery fish was implemented in 2010. Marking of hatchery fish techniques include Coded Wire Tag and/or adipose fin clipping. One hundred percent marking of hatchery fish helps support estimating pHOS (proportion hatchery-origin spawners), pNOB (proportion natural-origin broodstock), escapement of NOF (natural-origin fish), and stray rates (out of population and MPG). Information learned from determining pHOS, escapement, and stray rates will contribute to the assessment of the status of wild populations as well as future population management of both hatchery and natural-origin populations.

#### **Predation and Invasive Species Management RME**

Predation RME studies were conducted to evaluate and monitor the pikeminnow management results, avian predation rates on juvenile salmon in the lower Columbia River and on the Columbia Plateau, and predation rates of California sea lions on adult salmon below Bonneville Dam. Continued monitoring on the effectiveness of predation management actions were implemented as a component of most

predator management projects.

#### **What Was Achieved in 2011?**

- The Corps and other Federal, State, and Tribal agencies implemented a variety of sea lion deterrents at Bonneville Dam in 2011. Physical barriers called sea lion exclusion devices were installed at all primary fishway entrances, and floating orifice gate barriers continue to be effective in preventing sea lions from entering fishways.
- Both the Double-Crested Cormorant Management Plan and the Inland Avian Management Plan continued to progress, with draft plans expected in 2012. The expected benefits to listed salmonids from reductions to inland bird colonies were analyzed.
- Continued research and monitoring on shad interactions with non-indigenous predators (small mouth bass and walleye) to understand impacts on predator over-wintering survival.

#### **What Was Learned from 2011 Project Results?**

- The number of adult salmonids consumed by pinnipeds in 2011 was the lowest since 2006, even with marked increases of take by Steller sea lions. The reduced consumption by California sea lions may indicate that lethal removal is beginning to have a measurable effect.
- Evaluations showed that sea lions in the Bonneville tailrace consumed an estimated 3,557 adult salmonid; the lowest since 2006. Steller sea lions were responsible for a record 16% of this consumption.
- Other non-native fish predators on juvenile salmon (smallmouth bass, walleye) are not compensating for the removals of northern pikeminnow by either consuming more juvenile salmon or increasing reproductive success.
- The diet of smallmouth bass and walleye contain high proportions of juvenile shad during the mid-late fall of the year. Channel catfish do not have evidence of juvenile shad consumption during this timeframe.

- Acreage size for Caspian tern nesting habitat was successfully decreased for East Sand Island. Studies indicated that consumption of juvenile salmonids by Caspian terns dropped considerably in 2011. Total nesting failure, resulting from the effects of both harsh weather and eagle and gull predation on adult birds and eggs, was a major factor in this reduced consumption.

- Preliminary results indicate that a combination of hazing from boats and improved avian line arrays in the tailraces at The Dalles and John Day dams helped reduced estimated avian predation, primarily by gulls, from 124,000 in 2010 to 22,000 in 2011.

**Related Observations and Modifications to Achieve BiOp Strategies**

- Predation continues to be a serious issue for the survival of both juvenile and adult salmon and steelhead.
- The amount of fish eaten by sea lions decreased noticeably in 2011, with a catch estimate of 3,557 adult salmon and steelhead. However, the expected reductions from efforts by the States to remove California sea lions maybe offset to some degree by increases in Steller sea lion abundance.
- Additional island construction in 2012 should allow a reduction in available Caspian tern nesting habitat on East Sand Island to 1.5 acres, and is expected to decrease smolt consumption by Caspian terns even further.
- The increases in numbers of double-crested cormorant nesting pairs and smolt consumption in 2011 are of heightened concern. Development of cormorant management plans is moving forward that will include methods for reducing consumption of juvenile salmon.
- Predation by northern pikeminnow is being successfully controlled, with significant ongoing salmon survival benefits. Examination of predation by non-native species, such as shad, walleye, and bass, is underway

with projects initiated in 2010. 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. The Action Agencies will proceed with sensitivity to other management jurisdictions through well-designed basic research within this topic area.

**Regional Coordination, Data Management and Implementation**

RM&E Regional Coordination, Data Management and Implementation RM&E were conducted to improve efficiencies in the management of the research and monitoring program in the Columbia River. Work is ongoing to improve coordination of RM&E among the Action Agencies and other regional resource managers and to inform managers of key results on a timely basis.

**What Was Achieved in 2011?**

- The PNAMP developed a production model of a protocol manager tool for BPA and Reclamation to support the standardization of data collection and analysis methods at [www.monitoringmethods.org](http://www.monitoringmethods.org).
- The BPA funded CHaMP pilot project demonstrated that integration between field biologists and data managers helps to document methods and provide field data collection tools and entry forms to improve data storage processes.
- The Coordinated Assessments project developed data exchange templates and agency data management strategies to support exchange of adult abundance, smolt-to-adult returns, and adult productivity data to the NOAA Salmon Population Summary Database to support timely exchange of critical data on viable salmonid populations.
- BPA developed a web services exchange mechanism in the Taurus database at [www.cbfish.org](http://www.cbfish.org) to report to the database NOAA Fisheries maintains for the Pacific Northwest Salmon Habitat

Restoration Project and the NOAA Pacific Coastal Salmon Recovery Fund. The new tool will make it easier to document a comprehensive list of federally funded salmonid restoration activities.

**What Was Learned from 2011 Project Results?**

- Standardization of methods is an ongoing process and significant work is still needed. In particular broader participation across the northwest region by all environmental resource management agencies (State, Federal and Tribal) at [www.monitoringmethods.org](http://www.monitoringmethods.org) is needed to standardize data collection and analysis methods to assess salmonids and their habitat with economic efficiencies.
- Proper data management in the CHaMP project allowed for annual reports to be developed on a timely basis to inform management decisions.
- Data collection and analysis methods would benefit from the publication of data entry forms that feed to common data exchange templates for proper storage and communication of RME results.

**Related Observations and Modifications to Achieve BiOp Strategies**

- Mechanisms to identify the best handheld tools for data collection are being pursued to improve the quality and timeliness of data exchange.
- Improved data management and development of the Taurus tool at [www.cbfish.org](http://www.cbfish.org) will improve future project BiOp reporting for BPA projects, by improving communication of BiOp reporting requirements in 2012.

# 2011 Accomplishments at a Glance

## WHAT ARE OUR GOALS AND STRATEGIES?

## WHAT ARE OUR KEY ACCOMPLISHMENTS?

### HYDROSYSTEM

Increase the survival rates of fish passing through the hydrosystem:

- Manage water to improve juvenile and adult fish survival.
- Configure dam facilities to improve juvenile and adult fish passage survival.
- Operate and maintain fish passage facilities to improve fish survival.

- The Action Agencies actions are meeting or are making good progress toward hydro performance standards for dam passage survival. Dam passage survival estimates for yearling Chinook salmon either met or exceeded the spring juvenile migrant performance standard of 96.0 percent at The Dalles and John Day Dams, with survival being slightly below the performance standard at Bonneville Dam. Dam passage survival estimates for juvenile steelhead exceeded 96.0 percent at all three dams.
- Storage and run of river projects were operated to support juvenile and adult salmon survival. Managing the high flows in the late spring was aided by using regionally coordinated spill priority lists.
- Began construction of new juvenile bypass system outfall at McNary Dam. (Construction was completed in early 2012, prior to the start of the juvenile passage season.) New outfall location is expected to increase survival of juveniles.
- Began construction of new juvenile bypass system outfall at Lower Monumental Dam. (Construction was completed in early 2012, prior to the start of the juvenile passage season.) New outfall location is expected to increase survival of juveniles.
- Constructed and improved avian deterrent wire array over the tailrace at The Dalles Dam.

### PREDATOR MANAGEMENT

Reduce the number of juvenile fish consumed by predators:

- Redistribute avian predators.
- Reduce fish predation.
- Manage sea lion predation.

- Caspian tern predation was reduced in 2011 due to management actions which included reduction of habitat for Caspian tern nesting on East Sand Island to 2.0 acres to encourage tern redistribution.
- Completed engineering and design of a new Caspian tern island on the Malheur National Wildlife Reserve. (Construction was completed in early 2012, before the start of the nesting season.)
- Removed more than 155,312 northern pikeminnow from the Columbia River in 2011; reduced their predation of juvenile salmon by about 40 percent since 1990.

### HABITAT

Improve tributary and 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.

- A full suite of targeted habitat restoration actions was implemented.
- Streamflows were increased by securing 25,709 acre-feet and 235 cubic feet per second of water in tributaries throughout the Columbia River Basin.
- Fish entrainment was addressed with the installation of 46 fish screens in tributaries.
- Projects were implemented that improved or opened access to 281 miles of tributary spawning and rearing habitat
- Habitat actions improved 730 acres of riparian habitat in tributaries and increased the complexity of 34 miles of streams used by anadromous fish.
- Leases and purchases in 2011 obtained 997 acres of riparian habitat in tributaries.
- Improved and restored 9.2 acres of streams and channels in the estuary.
- Removed tide gates to open up 117.9 acres of historic tide channels in the estuary.
- Dikes were modified to open up 46 acres of historic tide channels in the estuary.
- Estuary projects removed invasive plant species and planted and maintained native vegetation in riparian wetlands on 46 acres.

### 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.

- By the end of 2011, the Action Agencies had reviewed HGMPs for 43 of the 44 Action Agency-funded programs and provided comments to hatchery operators. The updated and complete HGMPs have been, or will be, submitted to NOAA Fisheries for analysis of hatchery impacts on listed salmon and steelhead as part of NOAA's ESA consultation process.
- The Snake River sockeye salmon captive broodstock safety-net program contributed to a 2011 return of 1,118 adults to Redfish Lake.
- The Corps started work on an Alternatives Study on the John Day Mitigation Program that will evaluate mitigation production objectives, analyze alternatives, and prepare preliminary designs and cost estimates for the most feasible alternatives.
- In the Methow River basin, efforts to manage hatchery-origin steelhead adults were continued, and Reclamation sponsored a series of facilitated meetings with stakeholders to discuss broodstock collection and potential reforms for better management of returning steelhead adults.
- Construction began on an Upper Columbia steelhead kelt reconditioning facility at Winthrop National Fish Hatchery.

## Overview by Species

The following summaries primarily describe abundance and abundance trends at the species or ESU level as of December 2011. 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 attributes of a viable salmonid population.

Species-level abundance is an important indicator under the 2009 AMIP. The AMIP includes abundance and trend-based indicators intended to signal significant declines at the ESU/DPS level. Such declines—in the unlikely event they occur—would trigger contingency actions. This process is more thoroughly described in the Action Agencies' Rapid Response and Long Term Contingency Plan:

[https://www.salmonrecovery.gov/Files/2011 APR files/2011\\_RRandLTC\\_Plan.pdf](https://www.salmonrecovery.gov/Files/2011%20APR%20files/2011_RRandLTC_Plan.pdf)

Figures 21 through 27 display natural spawners only (with the exception of the Snake River sockeye ESU, which is sustained through a captive broodstock program).<sup>iv</sup> It should be noted that natural annual variation in populations and productivity can be substantial so longer term trends are more significant than annual or shorter term results.

### 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 2011) is estimated to be 3,419 adults. The most recent four-year average return is 4,708 adults (Figure 21). An analysis of

adult returns from 1990–2011 indicates that the ESU-level trend in abundance was positive during this period. Neither the AMIP early warning indicator nor the significant decline trigger for this ESU were tripped in 2011.

The 2008 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 was 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.

### 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 comprises 28 extant populations in five MPGs. 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 18,953 adults. The most recent four-year average return was 20,135 adults (Figure 22). An analysis of adult returns from 1990–2011 indicates that the ESU-level trend in abundance was positive during this period. Neither the AMIP Early Warning Indicator nor the Significant Decline trigger for this ESU were tripped in 2011.

Table 5 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

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

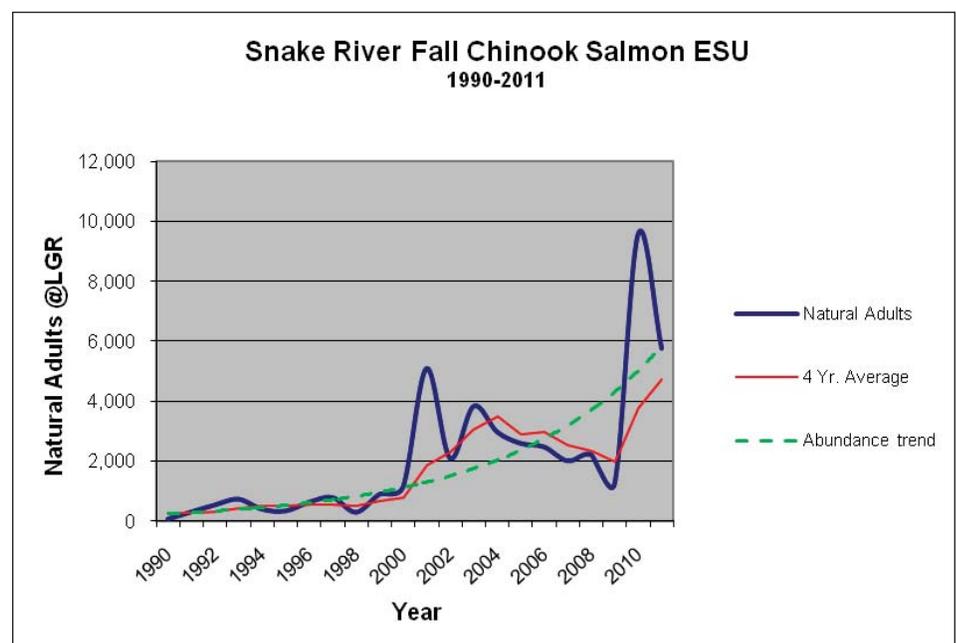


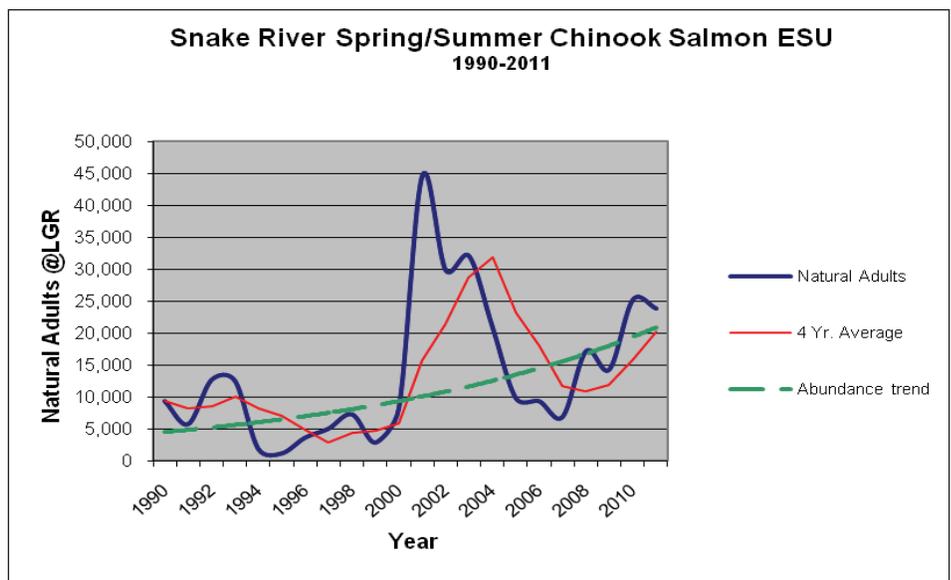
Figure 21. Returns of naturally produced adult Snake River fall Chinook salmon at Lower Granite Dam, 1990–2011.

Program. This species was thought by 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. The years 2008–11 saw extraordinary returns of 907, 1,219, 2,406, and 1,502 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 NWFSC attributed the increased numbers in 2008 to favorable ocean conditions and an increase in smolt releases from the captive broodstock program (NOAA-NWFSC 2009). Factors affecting sockeye salmon returns to the Columbia River in 2008 are reported in [http://www.nwcouncil.org/library/isab/2010-2/NOAA%202008%20sockeye%20returns-final\\_2-6-09.pdf](http://www.nwcouncil.org/library/isab/2010-2/NOAA%202008%20sockeye%20returns-final_2-6-09.pdf).

### Snake River Steelhead

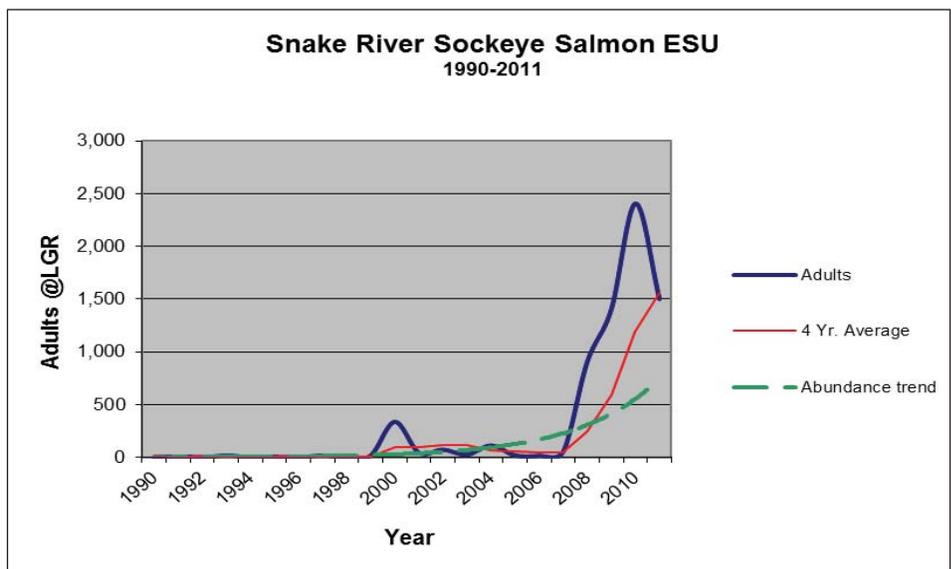
The Snake River steelhead DPS was listed as threatened in 1997. The DPS comprises 24 individual populations in five MPGs. Steelhead of the interior Columbia River Basin, and especially the Snake River DPS, are commonly referred to as either A-run or B-run. These designations are based on migration timing, 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



**Figure 22. Returns of naturally produced adult Snake River spring/summer Chinook salmon at Lower Granite Dam, 1990-2011.** The ESU-level trend in abundance was positive during this period.

**Table 5. Snake River Spring/Summer Chinook Tributary Habitat Improvement Metrics, 2005-2011**

Metric	2011	2005-2011
Acre-feet/year of water protected	7,615	59,566
Acres protected	428	2,669
Acres treated	272	1,400
Miles of enhanced or newly accessible habitat	41	390
Miles of improved stream complexity	18	72
Miles protected	21	67
Screens installed or addressed	13	54



**Figure 23. Returns of all Snake River sockeye salmon at Lower Granite Dam, 1990–2011.** The ESU-level trend in abundance was positive during this period.

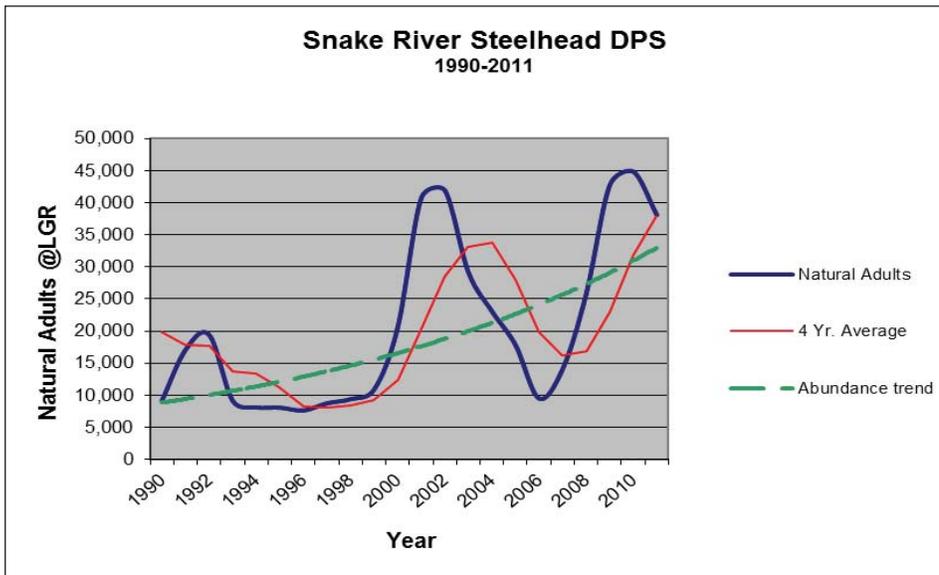


Figure 24. Returns of naturally produced adult Snake River steelhead at Lower Granite Dam, 1990–2011. The DPS-level trend in abundance was positive during this period.

Table 6. Snake River Steelhead Tributary Habitat Metrics, 2005–11.

Metric	2011	2005-2011
Acre-feet/year of water protected	7,615	59,566
Acres protected	428	3,239
Acres treated	284	1,423
Miles of enhanced or newly accessible habitat	47	449
Miles of improved stream complexity	18	102
Miles protected	22	68
Screens installed or addressed	13	54

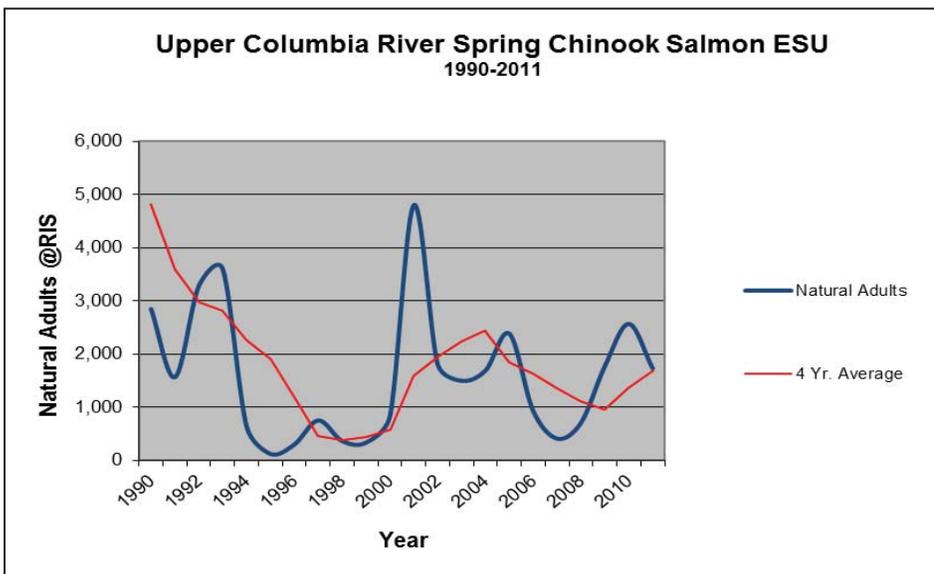


Figure 25. Returns of naturally produced adult Upper Columbia River spring Chinook salmon at Rock Island Dam, 1990–11.

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 28,696 adults (2002–2011). The most recent four-year average return was 37,848 adults (Figure 24). An analysis of adult returns from 1990–2011 indicates that the DPS-level trend in abundance was positive during this period. Neither the AMIP early warning indicator nor the significant decline trigger for this ESU were tripped in 2011.

Table 6 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 MPG. 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 1,550 adults at Rock Island Dam (2002–11). The most recent four-year average return was 1,695 adults (Figure 25). An analysis of adult returns from 1990–2011 indicates that there was no statistically significant ESU-level trend in abundance during this period. Neither the AMIP Early Warning Indicator nor the Significant Decline trigger for this ESU were tripped in 2011.

## 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 MPG. 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 3,786 adults (2002-2011). The most recent four-year average return was 5,382 adults (Figure 26). An analysis of adult returns from 1990-2007 indicates that the ESU-level trend in abundance was positive during this period.

## Middle Columbia River Steelhead

The middle Columbia River steelhead DPS was listed as threatened in 1999. The DPS comprises 17 individual populations in four MPG. These populations spawn in Oregon and Washington drainages 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.

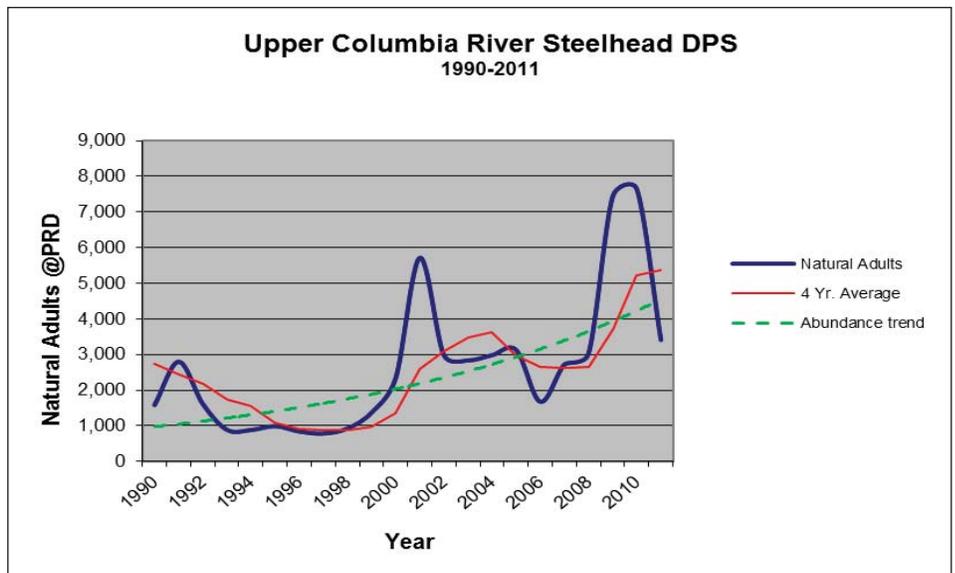
Due to the difficulty in obtaining estimates of DPS-level abundance for middle Columbia River steelhead, the AMIP relies on abundance estimates based on dam counts for the Yakima River MPG of this DPS. Based on preliminary estimates, the most recent 10-year average return from this MPG was 3,579 natural-origin adults (2000–11). The most recent four-year average return was 5,207 natural-origin adults (Figure 27). The abundance trend for this MPG between 1990 and 2010 was positive. Neither the AMIP early warning indicator nor the significant decline trigger for this MPG were tripped in 2011.

## Lower Columbia and Willamette River ESUs

A total of six ESUs in the Willamette and lower Columbia rivers are currently listed under the ESA. The two listed ESUs in the Willamette River are also covered by a separate BiOp for the Willamette Project. Quantitative status

**Table 7. Upper Columbia River Spring Chinook Tributary Habitat Metrics, 2005–11.**

Metric	2011	2005-2011
Acre-feet/year of water protected	387	10,267
Acres protected	0	37
Acres treated	1	236
Miles of enhanced or accessible habitat	60	129
Miles of improved stream complexity	1	4
Miles protected	3	5
Screens installed or addressed	9	12



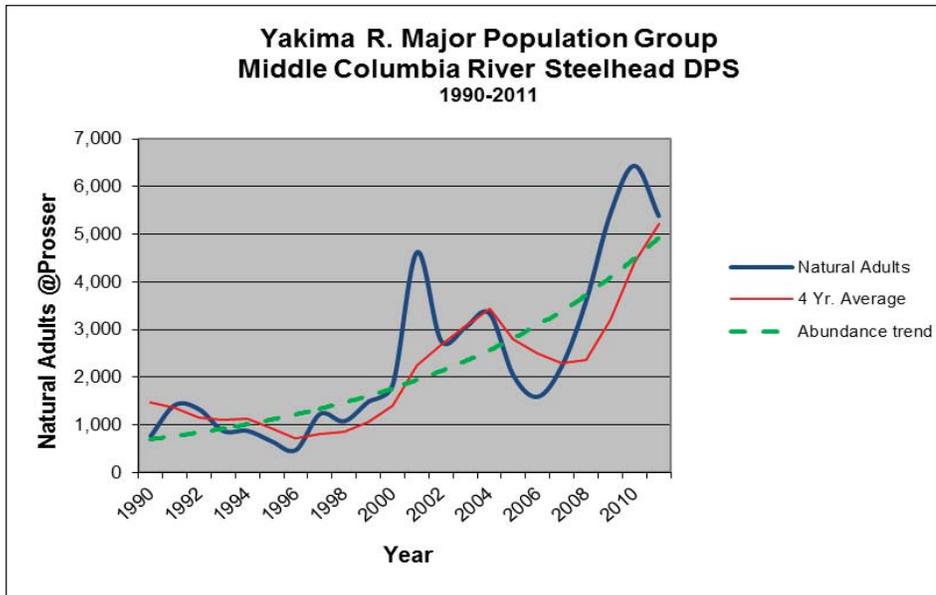
**Figure 26. Returns of naturally produced adult Upper Columbia River steelhead at Rock Island Dam, 1990–2011. 2011 Preliminary data is provided.**

**Table 8. Upper Columbia River Steelhead Tributary Habitat Metrics, 2005–11.**

Metric	2011	2005-2011
Acre-feet/year of water protected	1,087	14,289
Acres protected	6	86
Acres treated	186	525
Miles of enhanced or newly accessible habitat	75	161
Miles of improved stream complexity	2	8
Miles protected	4.1	8
Screens installed or addressed	9	12

**Table 9. Middle Columbia River Steelhead Tributary Habitat Metrics, 2005–11.**

Metric	2011	2005-2011
Acre-feet/year of water protected	17,008	54,411
Acres protected	1,851	7,261
Acres treated	260	13,184
Miles of enhanced or newly accessible habitat	160	1,024
Miles of improved stream complexity	14	68
Miles protected	88	743
Screens installed or addressed	24	197



information is lacking for many of the populations in these ESUs. For those populations for which data are available, the information indicates that abundance, while well below historic levels, is stable or increasing.<sup>v</sup> 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, with the exception of certain populations located in the upper Columbia River gorge. However, the Action Agencies’ estuary habitat program will provide survival benefits for all populations in these ESUs, including those that spawn below Bonneville Dam.

**Figure 27. Returns of naturally produced adult Middle Columbia River steelhead (Yakima River major population group) at Prosser Dam, 1990–2011.**

## Working with the Region

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 how best to use the BiOp’s adaptive management processes 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 RIOG, the Columbia Basin Fish Accords, NPCC’s Fish and Wildlife Program, and the Regional Forum.

### Regional Implementation Oversight Group

The RIOG was established in 2008 to provide high-level policy review for the Columbia River Basin—to discuss and coordinate implementation of the FCRPS 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 (e.g., the Technical Management Team) to support regional review. In 2011, the RIOG met four times to discuss, review, and coordinate on a variety of topics including the Rapid Response/Long Term Contingency Plan, spring and summer hydrosystem operations, John Day Dam testing, the 2010 Annual Progress Report, the Early Warning Indicator Model, the Reintroduction Study, avian predation, and habitat improvement actions.

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## 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 action 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 2011, Tribal, State, and Federal partners implemented new projects and expanded existing projects under the Accords, and worked collaboratively to address operational issues related to substantially above-average flows in the Columbia River Basin.

Additionally, many projects are underway to protect and restore fish habitat in the tributaries and estuary. Examples of work completed in 2011 include the Bayhorse Creek Reconnection Project; the restoration projects to enhance and protect riparian habitat adjacent to the Entiat River; the rehabilitation of the stream channel and embankment on Wimpey Creek near the Lemhi River; and the Fort Columbia, Germany Creek, Mill Road, and Duncan Creek estuary projects to restore habitats, among others. Funding through the Accords continues to support hatchery supplementation programs in the Umatilla, Hood, Yakima, and upper Columbia River areas, the Snake River sockeye captive broodstock program, and various important RME programs throughout the basin.

## 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 NPCC’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 program includes independent science review processes that apply to BPA funded projects. The NPCC’s amended program (finalized in 2009) can be found at: <http://www.nwcouncil.org/library/2009/2009-09/Default.asp>.

## Regional Forum

The Regional Forum process was developed in 1995 and has been employed since by NMFS and regional sovereigns to implement ESA provisions for protection and recovery of listed salmon species. Members of the Regional Forum include: state and tribal sovereigns with management authority over fish and wildlife resources and water quality in the Columbia River Basin; and federal agencies with regulatory or action authority in the Columbia River, including NMFS, United States Fish and Wildlife Service (USFWS), BPA, Corps, Environmental Protection Agency, and Reclamation. Other agencies and regional interests, such as the Northwest Power and Conservation Council (NPCC), the Idaho Power Company and the Mid-Columbia Public Utility Districts, may also attend. The Regional Forum consists of several technical workgroups such as the Technical Management Team (TMT), the System Configuration Team (SCT), the Studies Review Work Group (SRWG), and the Fish Passage Operations and Maintenance (FPOM) workgroup. As used in this document, “the region” or “regional coordination” generally refers to the Regional Forum technical subgroup appropriate for the issue at hand.

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## Abbreviations and Acronyms

AMIP	Adaptive Management Implementation Plan
ASMS	Anadromous Salmonid Monitoring Strategy
AWS	Auxiliary Water Supply System
BiOp	Biological Opinion
BPA	Bonneville Power Administration
CEERP	Columbia Estuary Ecosystem Restoration Plan
CHaMP	Columbia Habitat Monitoring Program
COMPASS	Comprehensive Fish Passage
Corps	U.S. Army Corps of Engineers
CRE	Columbia River Estuary. Also refers to numeric designators for different restoration action types as assigned in NOAA's Estuary Recovery Module
CRITFC	Columbia River Inter-Tribal Fish Commission
DPS	distinct population segment
ERTG	Expert Regional Technical Group
ESA	Endangered Species Act
ESU	evolutionarily significant unit
FCRPS	Federal Columbia River Power System
HGMP	Hatchery and Genetic Management Plan
IMW	intensively monitored watershed
ISRP	Independent Scientific Review Panel
JBS	juvenile bypass system
KMP	Kelt Management Plan
LCRE	Lower Columbia River and Estuary
MBTA	Migratory Bird Treaty Act
MPG	major population group
NFH	National Fish Hatchery
NMFS	National Marine Fisheries Service (also known as NOAA-Fisheries)
NPMP	Northern Pikeminnow Management Program
NOAA	National Oceanic and Atmospheric Administration
NPCC	Northwest Power and Conservation Council
NWFSC	NOAA Fisheries Northwest Fisheries Science Center
PDO	Pacific Decadal Oscillation
PIT Tag	passive integrated transponder tag
PNAMP	Pacific Northwest Aquatic Monitoring Partnership
Reclamation	Bureau of Reclamation
RIOG	Regional Implementation Oversight Group
RME	research, monitoring and evaluation
RPA	Reasonable and Prudent Alternative
RRS	relative reproductive success
TDG	total dissolved gas
WMP	Water Management Plan

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## Endnotes

<sup>i</sup>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 coordination with Canada) to meet multiple purposes as authorized by Congress.

<sup>ii</sup>In-river consists of bypassed and detected fish.

<sup>iii</sup>For more information see the Pacific Northwest Climate Impacts Group website at <http://cses.washington.edu/cig/>.

<sup>iv</sup>Abundance charts in this report show ESU-level abundance from 1990 until the most recent available observation, consistent with the 2008 BiOp “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 and are taken from the U.S. v. Oregon Technical Advisory Committee Joint Staff Reports at [http://wdfw.wa.gov/fishing/crc/staff\\_reports.html](http://wdfw.wa.gov/fishing/crc/staff_reports.html), with the exception of the Yakima River MPG returns, which are taken from Columbia River DART (Data Access in Real Time) at <http://www.cbr.washington.edu/dart/>, and upper Columbia Steelhead numbers, which were supplied by NOAA Fisheries. Trend lines are shown where the 1990–present trend is statistically significant ( $p < 0.05$ ). The trend estimation method is taken from Good et al. (2005).

<sup>v</sup>Information taken from 2010 Pacific Coast Salmon Recovery Funds report to Congress.  
<http://www.nwr.noaa.gov/salmon-recovery-planning/pcsr/pcsr-documents.cfm>.

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Visit <https://www.salmonrecovery.gov/BiologicalOpinions/FCRPSBiOp/ProgressReports.aspx> for access to these documents.

## 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](http://www.rco.wa.gov/salmon_recovery/gsro.shtml)
- Idaho Office of Species Conservation: <http://www.species.idaho.gov>
- Federal Columbia River Power System 2009 Annual Report, website links, and more information on federal agency efforts for salmon and steelhead: <http://www.salmonrecovery.gov>

