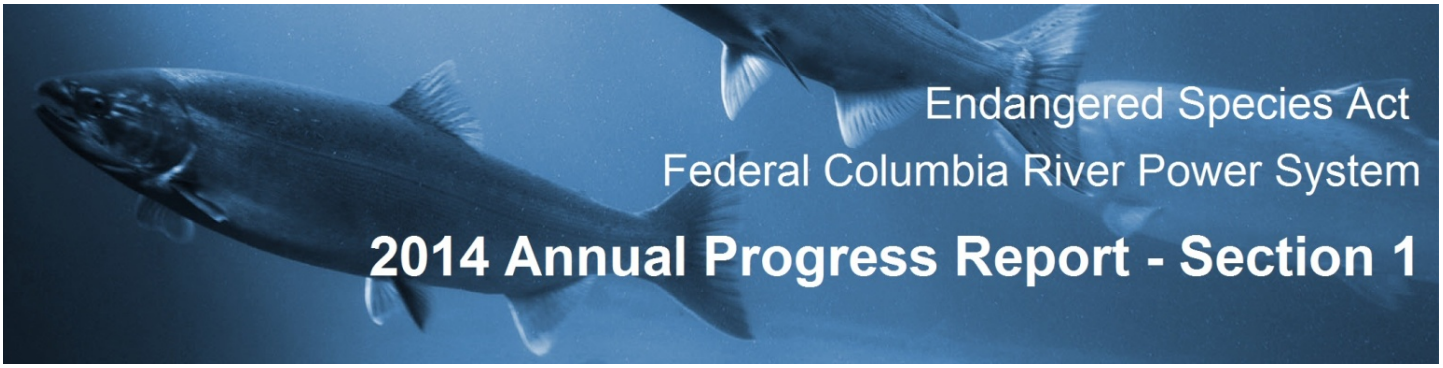

Endangered Species Act
Federal Columbia River Power System
2014 Annual Progress Report - Section 1

SEPTEMBER 2015

Throughout the Columbia River Basin, tribal, state, local, and federal entities are working in partnership to protect and restore stocks of salmon and steelhead. Thirteen 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) (see Figure 1). As called for by the BiOp, this report summarizes the actions implemented by the Action Agencies in 2014 to

continued on page 2

In May 2008, the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (also known as NOAA Fisheries or NMFS) issued a Biological Opinion 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 2014 FCRPS Supplemental Biological Opinion (2014 BiOp)[1] 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 scientific analysis that NOAA Fisheries concluded would avoid the likelihood of jeopardizing the listed species or adversely modifying their critical habitat. In 2010 and again in 2014, NOAA Fisheries reviewed and updated the FCRPS BiOp in Supplemental BiOps, which can be found at:

http://www.westcoast.fisheries.noaa.gov/fish_passage/fcrps_opinion/federal_columbia_river_power_system.html

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

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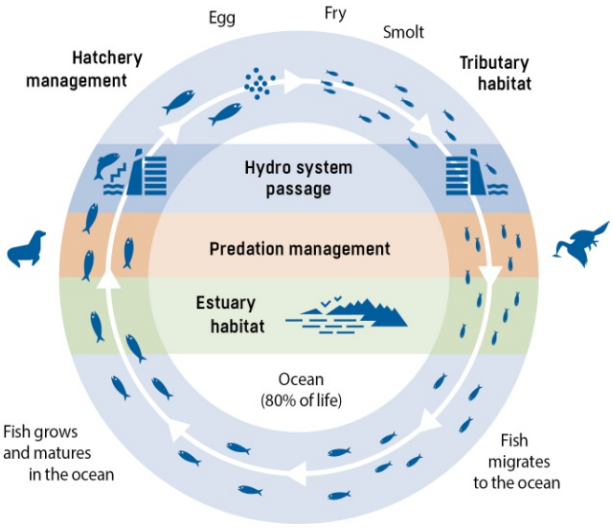

All-H Problems – All-H Solutions

[1] *The NOAA Fisheries 2014 FCRPS Supplemental Biological Opinion incorporates, in whole, the NOAA Fisheries 2008 Biological Opinion, the 2009 FCRPS Adaptive Management Implementation Plan, and the 2010 Supplemental Biological Opinion*

Contents

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continued from page 1

protect ESA-listed salmon and steelhead affected by the operation of the FCRPS[2]. These include actions to implement improvements at dams to increase fish survival, protect and enhance important habitats, improve hatchery and harvest practices, manage and reduce predation, and enhance river conditions for migrating fish. The actions are focused on achieving biological performance standards, achieving programmatic performance targets, and addressing limiting factors for listed salmon and steelhead. The Action Agencies, in coordination with NOAA Fisheries, and as provided for in the 2008 FCRPS BiOp RPA, use adaptive management to improve action effectiveness and efficiency based upon current scientific information.

[2] *The FCRPS includes 14 federal projects in the Columbia and Snake basin. These projects are operated as a coordinated system (including coordination with Canada) to meet multiple purposes as authorized by Congress.*

continued from page 1

The Action Agencies are responsible for providing annual progress reports detailing the implementation and progress of the RPA actions. This report describes implementation progress by the Action Agencies during the period of January 1 through December 31, 2014.

This report is organized into three sections: Implementation highlights and accomplishments are presented in Section 1; these will inform future RPA action implementation. Section 2 provides 2014 accomplishments on RPA implementation by action, and Section 3 displays projects implemented in 2014.

This FCRPS 2014 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/BiologicalOpinions/FCRPSBiOp/ProgressReports.aspx.

Previous FCRPS annual progress reports and additional information on other salmon and steelhead protection efforts are also available at this website.

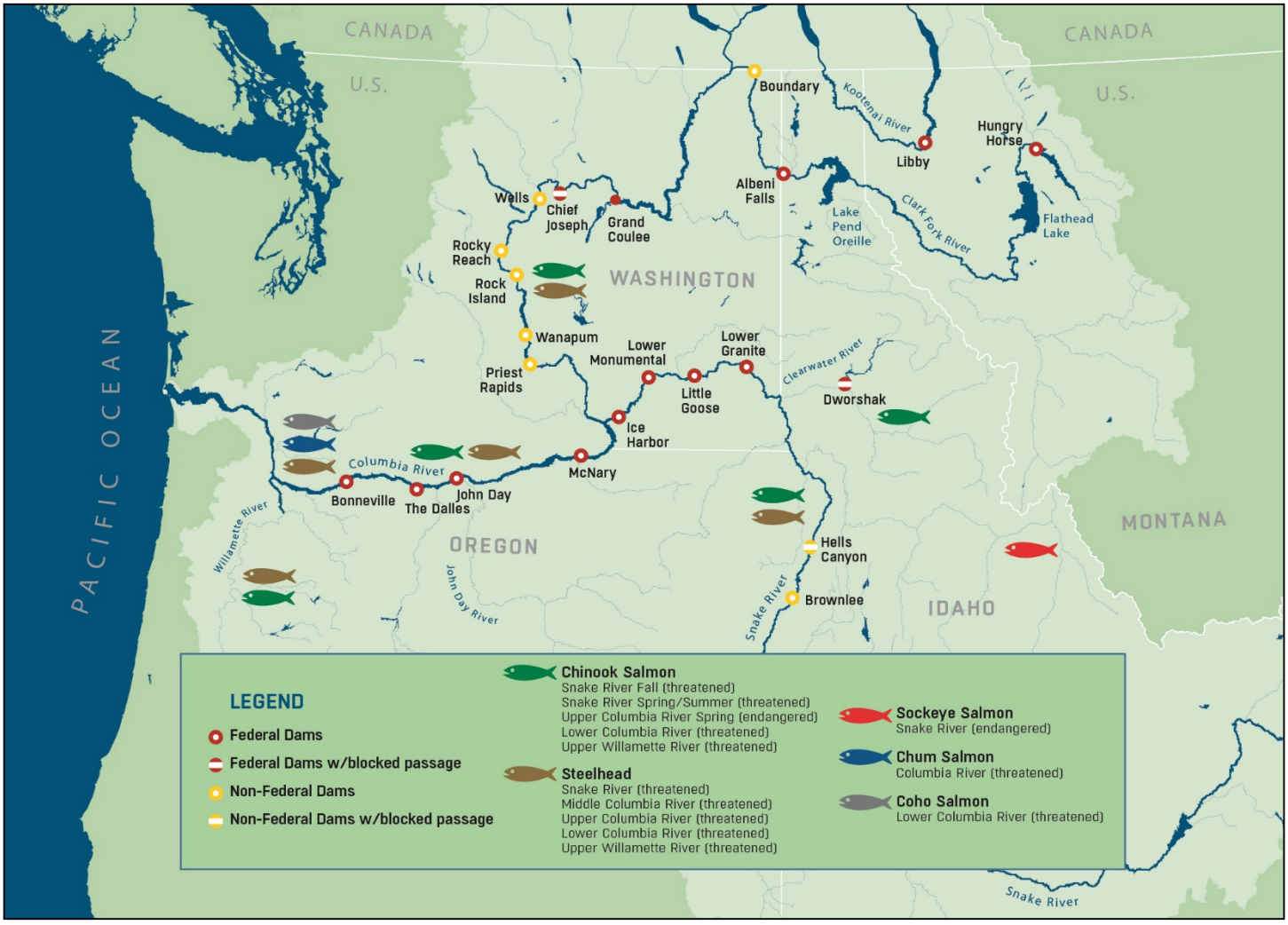

Figure 1. Map of the Columbia River Basin showing action areas, dams, and listed species.

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2014 Fish Status and Environmental Conditions

Fish Status

Columbia River Basin salmon and steelhead have been adversely affected by well over a century of human and environmental impacts. These impacts include urbanization, the introduction of non-native species, adverse ocean and climate conditions, overfishing, mining, predation, hatchery practices, and toxic pollutants, as well as the impacts from dams and water diversions. Steep declines in salmon and steelhead abundance in the early 1990s led to the first listings under the ESA.

In the Pacific Northwest, salmon and steelhead status is evaluated by tracking 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 2014, more than 2.57 million salmon and steelhead were counted as they passed Bonneville Dam, after ocean and lower river harvest. The total count includes both listed and non-listed salmon, hatchery and wild fish, and adults and approximately 200,000 jacks, which are young males that mature and return to spawning grounds earlier than others in the age class. The 2.57 million returning fish is the highest since counting began in 1938. In a typical year, an estimated 80 percent of all returning adult salmon are of hatchery origin, although the actual percentage varies by species and population; many of these hatchery fish are also part of listed ESUs/DPSs. The 2014 total count exceeds historical averages prior to 2000, and also exceeds the more recent 10-year average (Figure 2).

Counts in 2014 of adult salmon and steelhead passing Bonneville Dam varied by species. The returns of steelhead and of chum and pink salmon were somewhat below 10-year averages. All other species or runs exceeded their respective 10-year average (Table 1). Total counts in 2014 for Chinook, coho and sockeye were all the highest recorded for each species since counting begin in 1938, and the 2014 Fall Chinook run was only slightly smaller than the record-setting run in 2013.

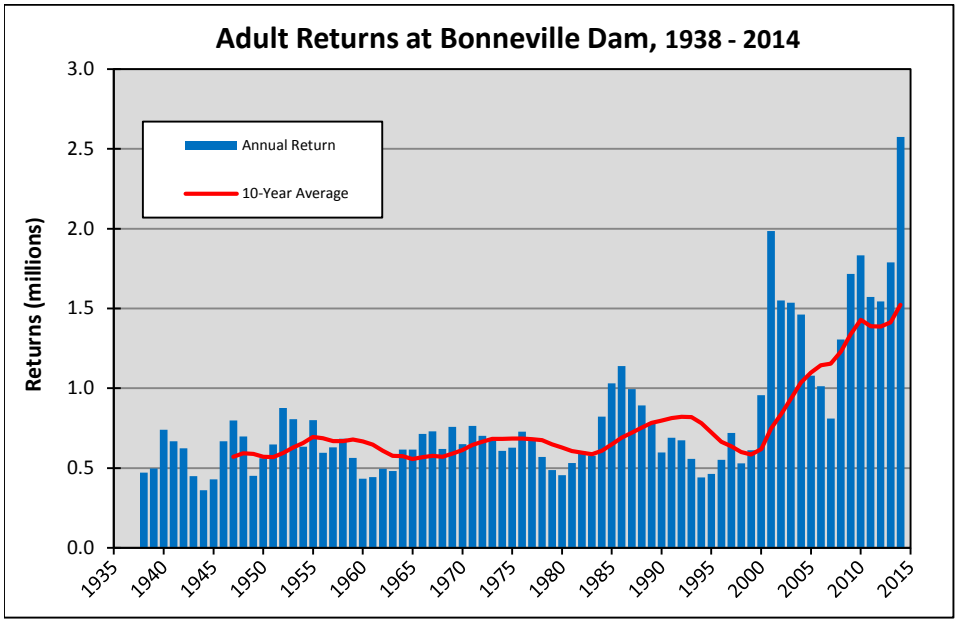


Figure 2. Salmon and steelhead returns at Bonneville Dam, 1938 to 2014. Values shown are for daytime counts, and include both hatchery and natural-origin fish, and both adults and jacks. Harvest levels below Bonneville Dam have varied over time. (Data from ACOE 2015.)

Species	2014 Returns	10-year average
Chinook – Total	1,339,659	791,331
Spring Chinook	214,177	155,742
Summer Chinook	135,076	107,758
Fall Chinook	990,406	527,830
Steelhead	326,001	352,454
Sockeye	614,179	241,352
Coho	294,534	137,914
Chum and Pink	123	571
TOTALS of all species	2,574,496	1,523,621

Period of 10-year average 2005–2014. Data are for daytime counts – 0400 to 2000 PST. All data are from ACOE 2015, Table 22b, *except* Chinook data are from monthly values in Table 23.
Chinook run dates used here are:
Spring = Jan 1–May 31; Summer = June 1–July 31;
Fall = Aug 1–Dec 31

Table 1. Adult salmon and steelhead returns at Bonneville Dam: 2014 returns and 10-year average. These numbers include hatchery and natural-origin fish. Chinook and Coho numbers include jacks.

Overview by Species

The following summaries describe abundance and abundance trends at the species or ESU/DPS level.

Species-level status is determined based on a "rolled up" review of population-level status and includes consideration of abundance, as well as the productivity, spatial structure, and diversity attributes of viable salmon and steelhead populations.

Species-level abundance is an important indicator under the ESA and the BiOp's contingency plans. The BiOp includes abundance and trend-based indicators intended to signal significant declines at the ESU/DPS level. A significant decline is judged to occur when the running four-year average of natural-origin adult abundance falls below a 10 percent likelihood of occurrence based on historical data. For this purpose, running four-year means are included in Figures 3 through 9 below. Such declines—in the unlikely event they occur—would trigger contingency actions. This contingency 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.

Figures 3 through 9 display natural-origin spawners only and do not include listed hatchery fish (with the exception of the Snake River Sockeye ESU, which is sustained through a captive broodstock program)[3]. It should be noted that natural annual variation in population abundance and productivity can be substantial, so longer term trends are more informative than shorter term indicators. Therefore, 10-year averages are also reported in the narrative for each species.

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. An estimated 85 percent of the ESU's historical spawning habitat was lost as a result of construction of the Hells Canyon Dam, which blocks all fish passage.

The most recent 10-year average return of natural-origin fish (through 2014) is estimated to be 8,736 adults. The most recent four-year average return is 14,218 adults (Figure 3). An analysis of adult returns from 1990–2014 indicates that the ESU-level trend in abundance was positive during this period. Neither the Early Warning Indicator nor the Significant Decline Trigger for this ESU were tripped in 2014.

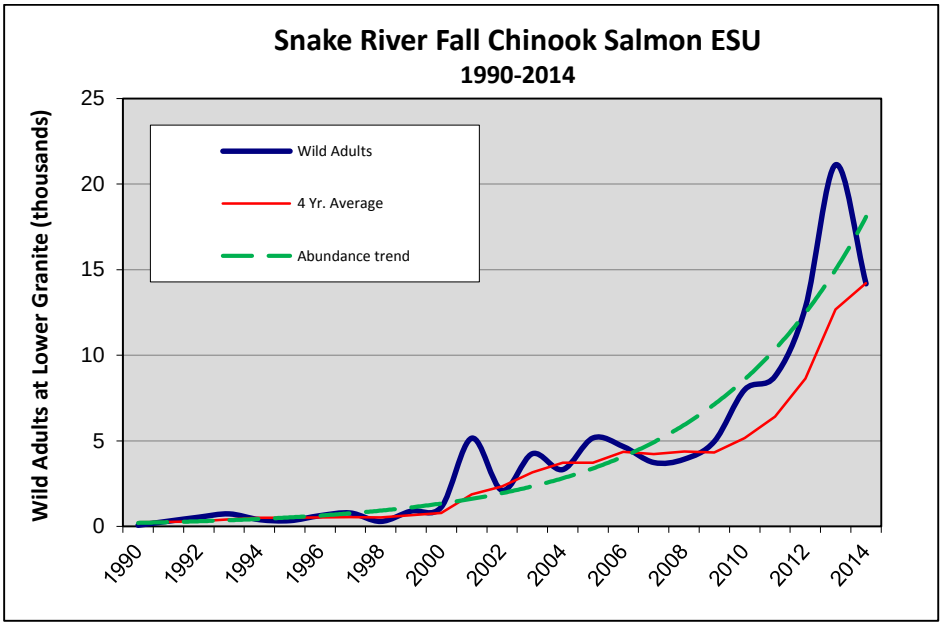


Figure 3. Returns of natural-origin adult Snake River Fall Chinook salmon at Lower Granite Dam, 1990–2014. The ESU-level trend in abundance was positive during this period.

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 major population groups (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

[3] 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, with the exception of the Yakima River MPG returns, which are taken from Columbia River 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).

17,657 adults. The most recent four-year average return was 23,449 adults (Figure 4). An analysis of adult returns from 1990–2014 indicates that the ESU-level trend in abundance was positive during this period. Neither the Early Warning Indicator nor the Significant Decline Trigger for this ESU were tripped in 2014.

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 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. An average of 50 sockeye were counted at Lower Granite Dam from 2004 to 2007. The years 2008–11 saw improved counts of 907, 1,219, 2,406, and 1,502 fish, respectively, at Lower Granite Dam (Figure 5). These were the largest sockeye counts since fish counting began at Lower Granite Dam in 1975. Counts were lower in 2012 and 2013, increasing again in 2014; the most recent 10-year average was 1,030 adult fish and the most recent four year average return was 1,373 fish.

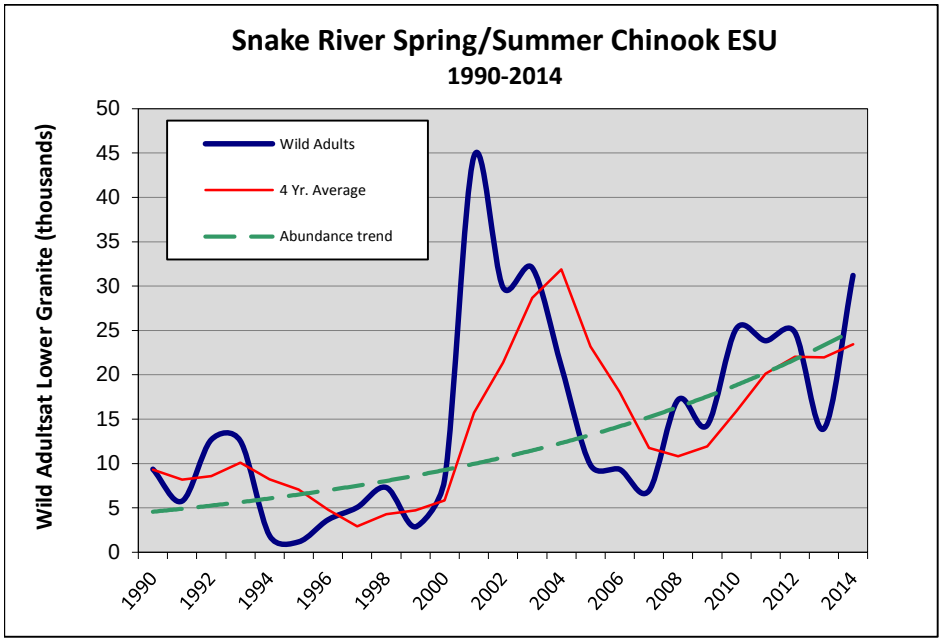


Figure 4. Returns of natural-origin adult Snake River spring/summer Chinook salmon at Lower Granite Dam, 1990–2014. The ESU-level trend in abundance was positive during this period.

Snake River Steelhead

The Snake River steelhead DPS was listed as threatened in 1997. The DPS is comprised of 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 Clearwater and Salmon rivers, while A-run steelhead occur throughout the Snake River Basin. NOAA Fisheries is currently undertaking an analysis to assess the importance of the distinctions.

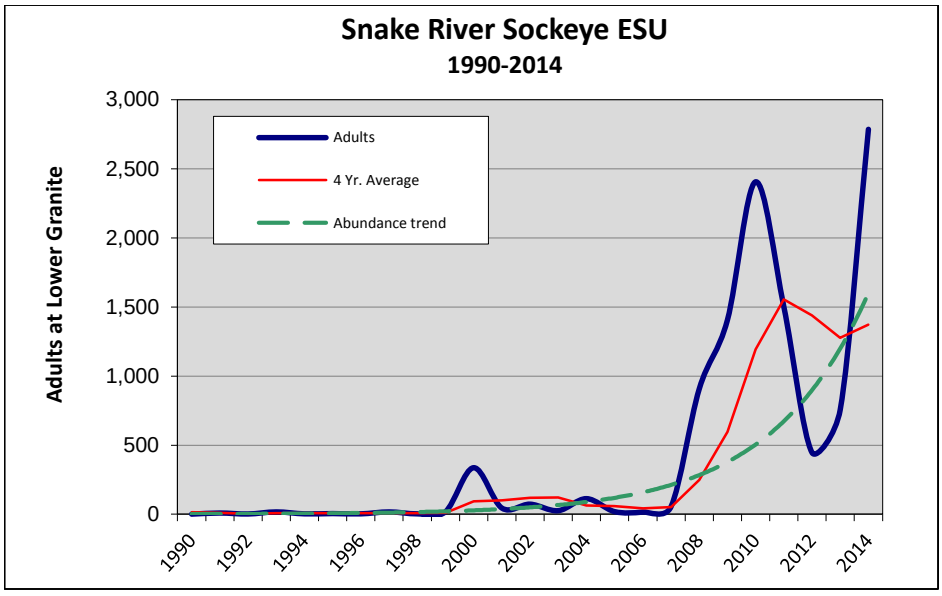


Figure 5. Returns of all Snake River sockeye salmon at Lower Granite Dam, 1990–2014. The ESU-level trend in abundance was positive during this period.

The most recent 10-year average return of natural-origin Snake River steelhead was 28,811 adults (2005–2014). The most recent four-year average return was 33,340 adults (Figure 6). An analysis of adult returns from 1990–2014 indicates that the DPS-level trend in abundance was positive during this period. Neither the Early Warning Indicator nor the Significant Decline Trigger for this DPS were tripped in 2014.

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 2,103 adults at Rock Island Dam (2005–2014). The most recent four-year average return was 2,896 adults (Figure 7). An analysis of adult returns from 1990–2014 indicates that there was no statistically significant ESU-level trend in abundance during this period. Neither the Early Warning Indicator nor the Significant Decline trigger for this ESU were tripped in 2014.

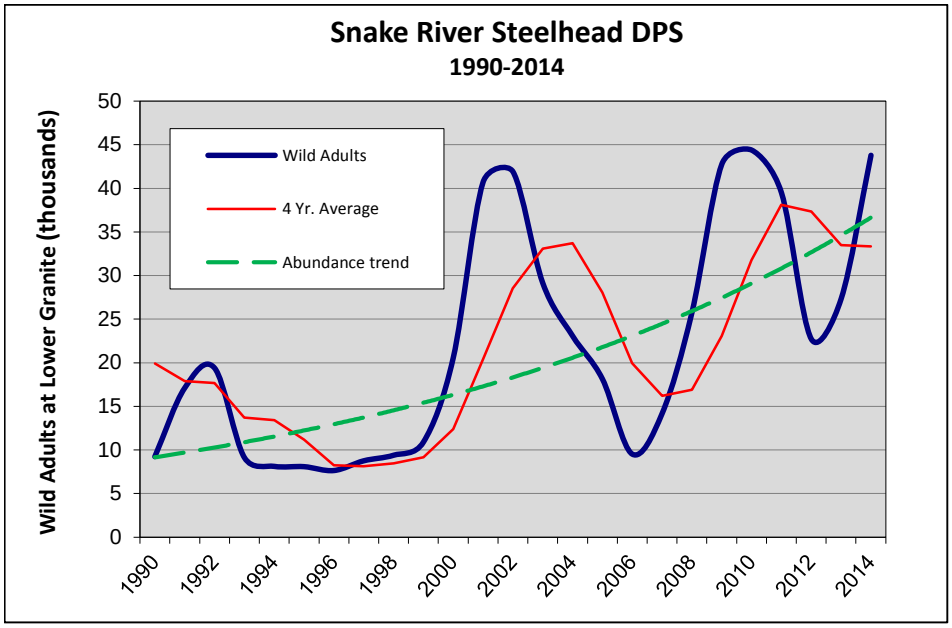


Figure 6. Returns of natural-origin adult Snake River steelhead at Lower Granite Dam, 1990–2014. The DPS-level trend in abundance was positive during this period.

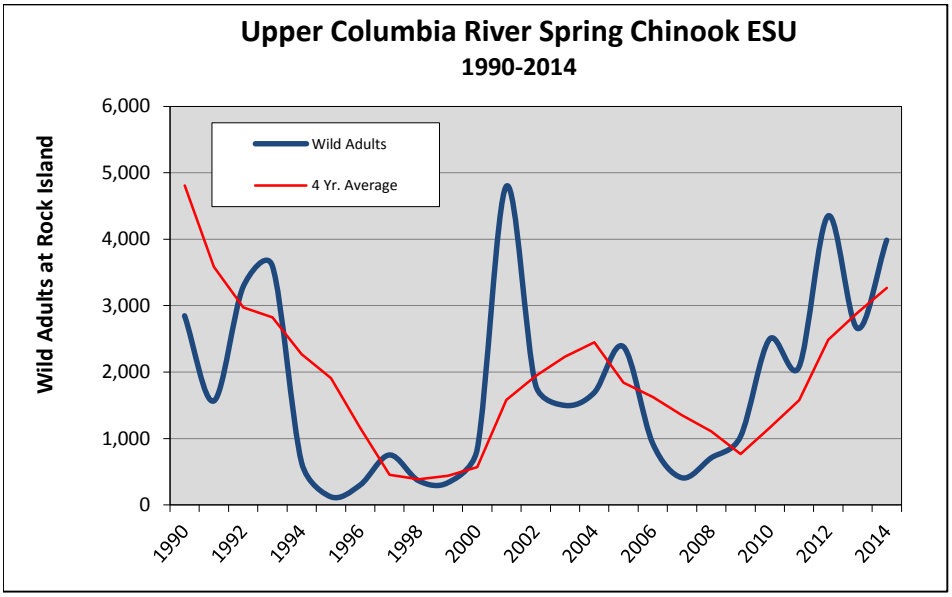


Figure 7. Returns of natural-origin adult Upper Columbia River spring Chinook salmon at Rock Island Dam, 1990–2014. An analysis of adult returns from 1990 to 2014 indicates that there was no statistically significant ESU-level trend in abundance during this period.

Upper Columbia River Steelhead

The Upper Columbia River steelhead DPS was listed as endangered in 1997 but was reclassified as a threatened species in 2009 consistent with a court ruling. 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 the Yakima River.

The most recent 10-year average return of natural-origin Upper Columbia River steelhead was 4,328 adults (2005–2014). The most recent four-year average return was 4,410 adults (Figure 8). An analysis of adult returns from 1990–2014 indicates that the DPS-level trend in abundance was positive during this period. Neither the Early Warning Indicator nor the Significant Decline Trigger for this DPS were tripped in 2014.

Middle Columbia River Steelhead

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

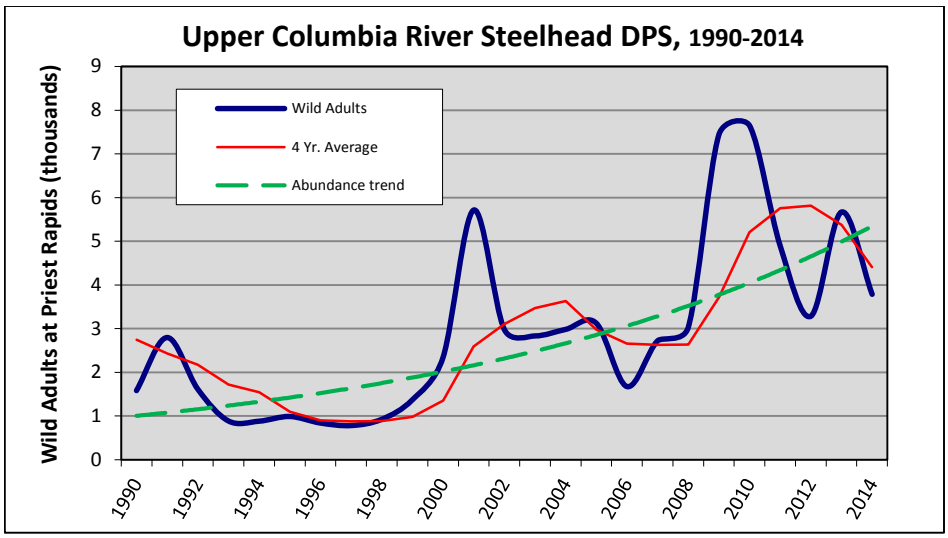


Figure 8. Returns of natural-origin adult upper Columbia River steelhead at Priest Rapids Dam, 1990–2014. The ESU-level trend in abundance was positive during this period.

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 BiOp relied 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 4,226 natural-origin adults (2005–2014). The most recent four-year average return was 5,246 natural-origin adults (Figure 9). The abundance trend for this MPG between 1990 and 2014 was positive. Neither the Early Warning Indicator nor the Significant Decline Trigger for this MPG were tripped in 2014.

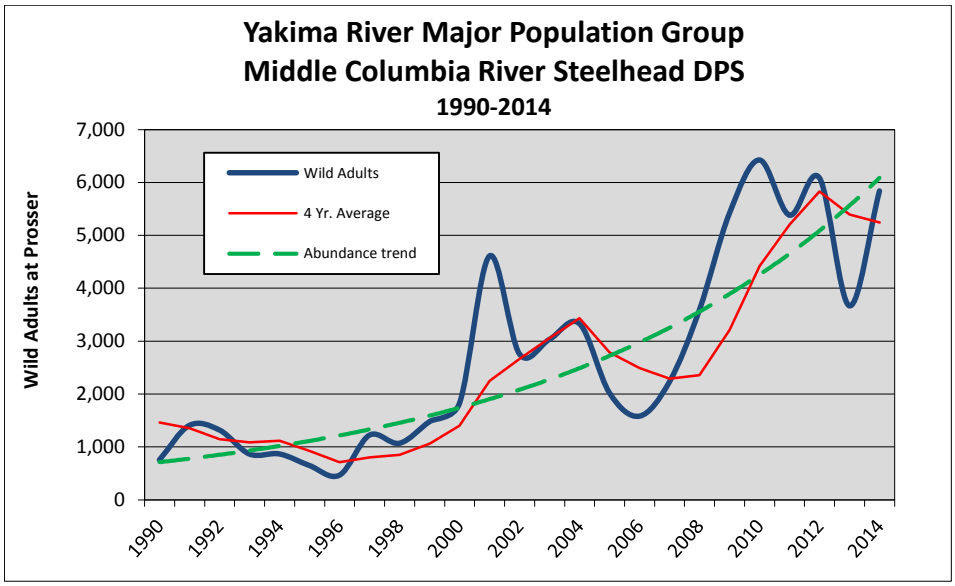


Figure 9. Returns of natural-origin adult Middle Columbia River steelhead (Yakima River MPG) at Prosser Dam, 1990–2014. The ESU-level trend in abundance was positive during this period.

Lower Columbia and Willamette River ESUs/DPSs

A total of six ESUs in the Willamette and lower Columbia rivers are listed under the ESA. The two listed species in the Willamette River are covered by a separate biological opinion for the Willamette Project. Quantitative status information is lacking for many of the populations in these ESUs/DPSs. For those populations for which data are available, the information indicates that abundance, while well below historic levels, is stable or increasing.[4] These species are currently threatened by a broad array of habitat and other environmental factors. For the most part, these ESUs/DPSs do not migrate through the Federal Columbia and lower Snake River dams; therefore the proposed operation of the Columbia/Snake projects of the FCRPS has less impact on these populations, with the exception of certain populations located in the Columbia River Gorge. The Action Agencies' estuary habitat program provides survival benefits for all populations in these ESUs and DPSs, including those that spawn below Bonneville Dam.

Environmental Conditions

Water Year and Streamflow Summary

The 2014 water year[5] started colder than normal and drier than average with slightly below average precipitation from October through December 2013, and much below average precipitation in January. There was a dramatic shift to a much

[4] *Information taken from 2010 Pacific Coast Salmon Recovery Funds report to Congress.* http://www.nwr.noaa.gov/salmon-recovery-planning/pcsrf/pcsrf-documents.cfm.

[5] *For hydropower system (hydro) operations, actions are reported by water year (October through September) and through calendar year 2014 because this is consistent with the actual approach for project operations.*

wetter period in February and March 2014. Heavy mountain snow accumulations, and well above average precipitation, with several daily rainfall records broken, dramatically increased the water supply outlook during February and March. April precipitation was near normal, with above normal temperatures in late April and early May. The peak runoff occurred in mid-May, then in early June flows leveled out. July was warm with a gradual recession of streamflow. The April through August water supply forecast was below average until March 2014, ranging from 83 percent of average in February to 111 percent of average in May 2014 at The Dalles. Flow on the mainstem Columbia River at McNary Dam generally followed recent historical averages as can be seen in Figure 10.

Ocean and Climate Conditions

Columbia River Basin salmon and steelhead abundance is strongly correlated with 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 11). 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. The PDO has been variable since about 1999, with conditions in 2010 through 2013 being favorable for salmon. The PDO index became unfavorable in 2014.

NOAA Fisheries' Northwest Fisheries Science Center (NWFSC) administers the Ocean Ecosystem Indicators Project to track specific physical 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. The PDO index discussed above is one of the indicators for physical conditions. Many of the ecosystem indicators for 2014 point towards it being a relatively poor year for juvenile salmon survival (Figure 12). The summer PDO values were strongly positive (warm), coinciding with a 'warm blob' of water centered in the Gulf of Alaska. El Niño conditions were 'neutral', sea surface temperatures were warmer than usual, and the upwelling season started very late and ended early. The biological indicators featured a high abundance of large, lipid-rich zooplankton, but a low abundance of winter fish larvae that develop into salmon prey in the spring, and moderate catches of juvenile spring Chinook salmon during the June survey off Washington and Oregon. Overall, juvenile salmon entering the ocean in 2014 encountered below average ocean conditions off Oregon and Washington (Peterson et al. 2014). This may result in lower returns of adult coho in 2015 and

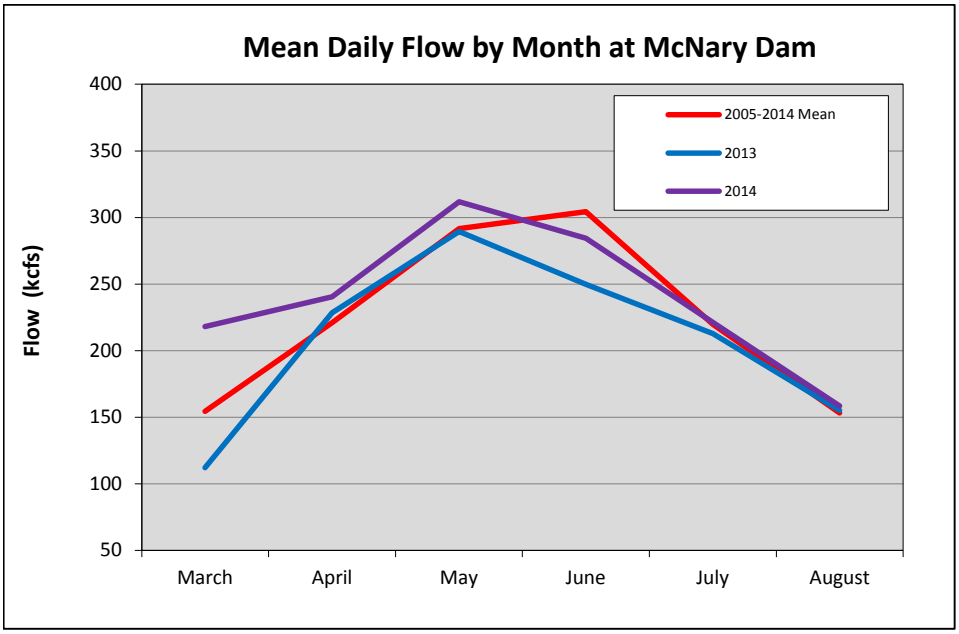


Figure 10. Mean daily flow shown by month at McNary Dam, 2013 through 2014, with the average value for the 2005–2014 period.

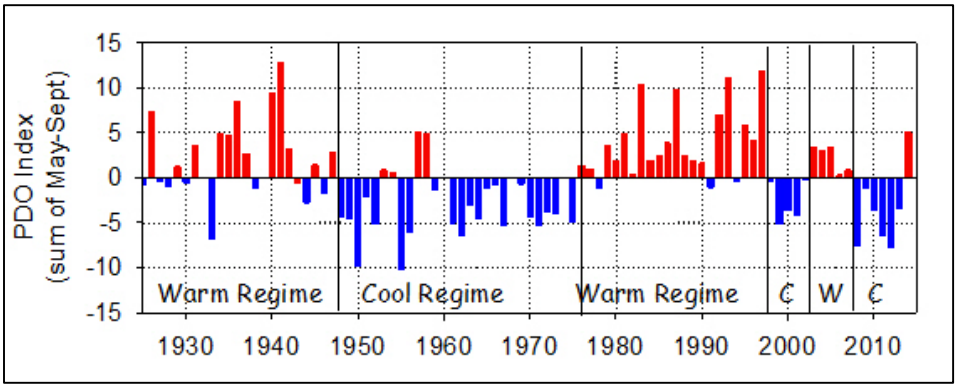


Figure 11. Time series of shifts in sign of the Pacific Decadal Oscillation, 1925 to 2014. Red bars indicate positive (warm) years; blue bars negative (cool) years. Cool PDO conditions are generally favorable for salmon and steelhead. From Peterson et al, 2014, and NOAA Fisheries website:
***http://www.nwfsc.noaa.gov/research/divisions/fed/oeip/ca-pdo.cfm*.**

adult Chinook salmon in 2016. However, adult Chinook returns in 2015 are expected to be good, based on good biological ocean conditions in 2013.

Climate Change

The Action Agencies support implementation of a substantial suite of habitat protection and restoration actions that can help to limit effects of increasing temperatures in the face of climate change, as confirmed by emerging science. These include creating riparian buffers, increasing tributary flows, and restoring and connecting wetlands and floodplains. The Action Agencies continue to support the River Management Joint Operating Committee Climate Change subgroup's climate research, modeling, and forecasting, and to collaborate with other climate research efforts in the region. One example, the Northwest Climate Science Center, compiles research findings that can then be incorporated into adaptive management of the hydrosystem.

Under the BiOp, the Action Agencies also receive an annual review of recent scientific literature from NOAA Fisheries' Northwest Fisheries Science Center (NWFSC) relating to potential long-term effects that climate change may have on Columbia River Basin salmon and steelhead. These reviews can be found at:

http://www.nwfsc.noaa.gov/trt/lcm/freshwater_habitat.cfm.

The 2014 report is also available in Section 2, Appendix A. Generally, the NWFSC 2014 literature review is consistent with past reviews in its forecasts for the impacts of climate change.

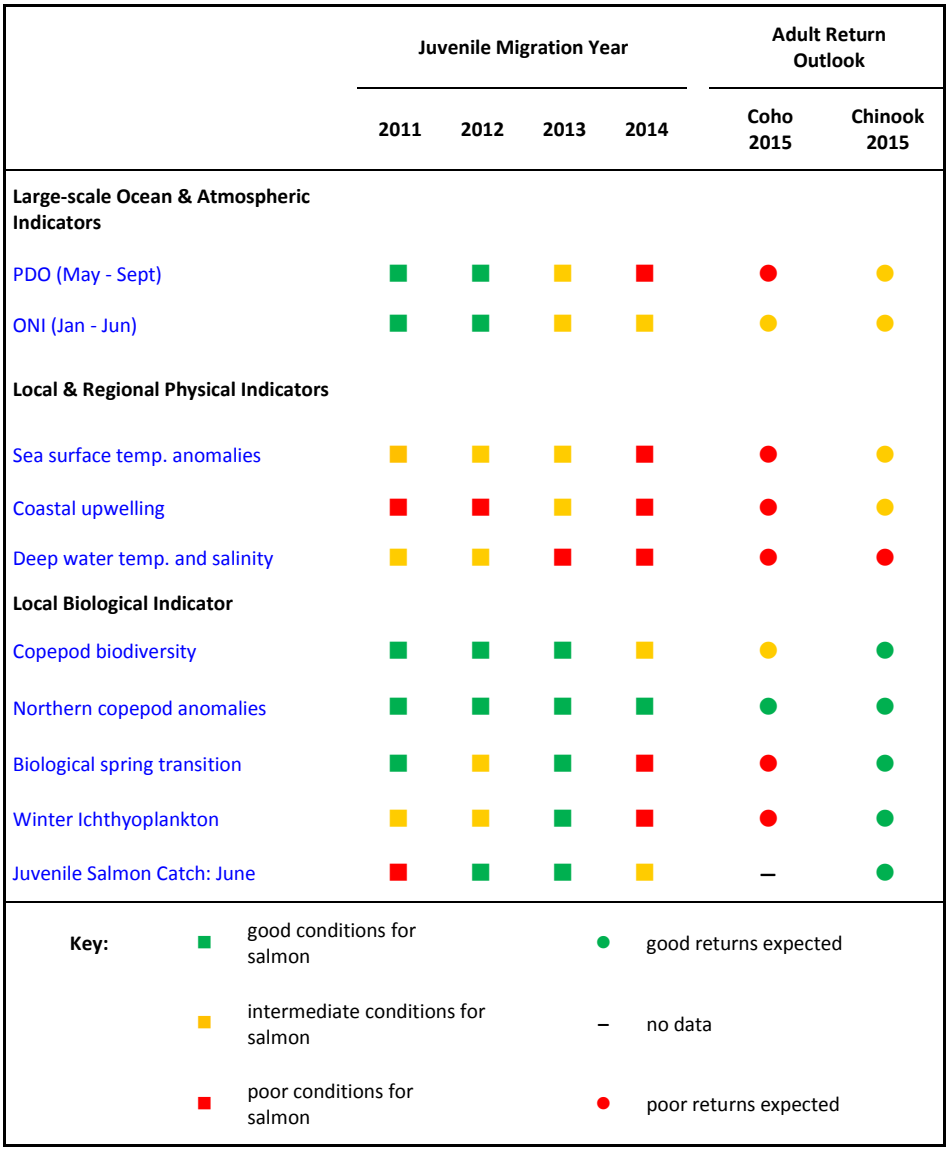


Figure 12. Ocean ecosystem indicators of the Northern California Current. Colored squares indicate positive (green), neutral (yellow), or negative (red) conditions for salmon entering the ocean each year. In the two columns to the far right, colored dots indicate the forecast of adult returns based on ocean conditions in 2014 (for coho) and 2013 (for Chinook). From Peterson et al, 2014. More information can be found on the NOAA website: *http://www.nwfsc.noaa.gov/research/divisions/fe/estuarine/oeip/ca-pdo.cfm.*

Implementation Overview

The Action Agencies have established implementation strategies and actions using the "All-H" approach—hydropower, habitat, hatchery, and harvest, plus predator management—to benefit salmon and steelhead in the Columbia River Basin. Accomplishments and implementation in 2014 are summarized below. Detailed descriptions can be found in Section 2 of this progress report.

Hydropower Actions

Developing and implementing actions to improve the survival of fish as they pass through the hydropower system is an integral component of the BiOp. The survival benefits to fish passing through the hydrosystem that these actions collectively provide are estimated using four different measures of fish survival. Juvenile fish dam passage survival performance standards document the survival improvements that specific configuration and operation actions implemented at each dam provide to juvenile fish as they pass individual dams. These performance standards are designed to ensure the implemented actions achieve a juvenile fish dam passage survival level of 96 percent for spring migrating fish (yearling Chinook and steelhead) and 93 percent for summer migrating fish (subyearling Chinook). The juvenile in-river survival performance metric estimates the survival of in-river migrating fish as they pass through the hydrosystem and compares those estimates with Comprehensive Fish Passage (COMPASS) model-generated survival estimates based on the river conditions experienced and the expected benefits of hydro actions that have been completed. Juvenile system survival performance targets estimate the expected increase in juvenile fish survival through the hydrosystem that are associated with proposed hydro actions and transport combined. Finally, adult performance standards track and confirm that the relatively high observed adult survival is maintained or increased. Generally, fish survival past the dams has improved substantially over the past decade as a result of dam configuration and operation improvements implemented to date. The following sections describe the 2014 progress in implementing those hydro actions identified in the BiOp.

Water Management and Flow Operations

In 2014, FCRPS storage reservoirs were managed to enhance flows and water quality to improve conditions for salmon and steelhead. The Action Agencies developed an annual Water Management Plan (WMP) to balance multiple purposes including providing flows for salmon, cooling water temperatures, protecting listed and unlisted resident fish, managing flood risks, and serving other authorized purposes consistent with RPA Action 4 specifications (BPA et al. 2013). The WMP was developed and implemented in coordination with federal agencies and regional states and tribes (i.e. regional sovereigns). Adjustments were made in-season to respond to changing environmental conditions with the help of the interagency Technical Management Team (TMT), a coordination group consisting of regional sovereign biologists and hydrologists.

Providing flows for fish is an important component of water management in the Columbia River Basin. In 2014, both the FCRPS storage projects (Libby, Hungry Horse, Albeni Falls, Grand Coulee, and Dworshak dams) 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 dams) were operated consistent with the WMP, in part, to aid juvenile fish passage. Winter drafts were limited so that there was a high probability that the storage reservoirs could be as full as possible (considering flood control requirements) by April 10. The storage projects also have summer refill and draft targets to provide flows for fish during the summer.

Columbia River flows are primarily driven by snowmelt with over 60 percent of the annual runoff occurring between April and June. Natural flows drop significantly by late July and into August. To enhance fish flows, BPA and the Corps negotiated an agreement with Canada through the Columbia River Treaty that allowed use of 1 million acre-feet (Maf) of water in Columbia River Treaty storage space for release during the spring and summer to support flows for fish downstream in the United States. Including the 1 Maf from Canada, a total of about 5 Maf of stored water—about one-sixth of the approximately 32 Maf of storage available in U.S. and Canadian storage reservoirs—was used in 2014 to augment Columbia River flows in spring and summer.

In 2014, Reclamation provided 487,000 acre-feet of flow augmentation water (Reclamation 2014) under the NOAA Fisheries 2008 Biological Opinion for Operations and Maintenance of Bureau of Reclamation Projects in the Snake River Basin above Brownlee Reservoir.

Water Quality

In July 2014, the Corps, in a collaborative effort with regional sovereign partners, finalized the Water Quality Plan for the Columbia River Basin in accordance with RPA Action 15. Operational measures identified in the plan were implemented throughout 2014.

Fish passage spill operations often 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 standard. The states of Washington and Oregon provide limited exceptions to the standard for juvenile fish passage spill. In 2014, the Corps provided fish passage spill consistent with the BiOp and monitored TDG levels in the river throughout the fish passage season. Spill patterns and spill levels were adjusted to manage TDG consistent with the applicable water quality standard to the extent practicable.

Spill at run-of-river projects also occurs when high flows exceed the turbine capacity at any dam or when demand is low for hydroelectric generation. Because these dams aren't designed to store water, high river flow combined with low electricity demand can sometimes lead to spill that exceeds the applicable TDG limits. In 2014, this situation occurred within a 3-week period in late May and early June.

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. In 2014, water temperature at the tailwater temperature gauge for Lower Granite Dam exceeded 68 degrees Fahrenheit on 8 days in August. Due to the very warm conditions in the summer of 2014, all Dworshak water available for temperature management was exhausted by September 24, with the reservoir drafted to the BiOp target of 1520 feet. The maximum hourly temperature at the Lower Granite Dam tailwater gauge was 68.97 degrees Fahrenheit on August 24.

For a more thorough discussion of how the system was operated in 2014, see the 2014 Total Dissolved Gas Report (ACOE 2014).

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. The BiOp's hydropower strategy addresses both juvenile and adult migration through the system as described below.

Adult Passage Improvements

The BiOp recognizes the importance of continued improvements in adult passage in the system. In 2014, the Corps completed a design report and started the plans and specifications for improvements to the east ladder auxiliary water supply at The Dalles Dam.

Adult passage can be adversely affected (i.e. delay, fallback) by the amount, location, and duration of spill for juvenile passage, requiring a balance at each dam. At Little Goose Dam, it appears that installation and operation of a spillway weir which aids downstream passage of juveniles can, under certain spill conditions, hinder the upstream passage of adults. Beginning in 2011 a new spill pattern was implemented to reduce adult passage delay, which the Corps continued to use through 2014. The Corps also initiated design of a new adjustable spillway weir to allow rapid closure of the weir and provide more flexibility in meeting passage goals for adult and juvenile fish. The Corps also completed the second year of a two-year study of the north ladder at The Dalles Dam to assess whether the spill pattern resulting from construction of the spillwall in 2010 has caused migration delays for adults attempting to use that ladder.

At Lower Granite Dam warm river surface temperatures in the forebay during late summer can create a temperature difference between the adult ladder exit and the entrance causing delays in adult passage. In 2013 and 2014, the Corps used temporary pumps to add cool water to the fish ladder, which reduced the temperature difference and minimized the delays. In addition, the Corps continued working on designing a permanent solution to the Lower Granite ladder temperature issue.

Juvenile Passage Improvements

Juvenile fish pass dams by many routes: through spillways and surface passage routes, through juvenile bypass systems (JBS), through turbines, or by collection and transport in barges or trucks downstream. Operations and structural improvements, such as juvenile bypass systems, spill, and surface passage routes, have been tailored to the specific conditions and structure of each dam to reduce the proportion of juvenile fish that pass through turbines, reduce forebay delay, and improve overall dam survival. Depending on location, time of year, and species, approximately 76 to 99 percent of the juvenile fish use these non-turbine routes.

In 2014, the Corps continued field investigations and design of fish survival upgrades to Bonneville's Powerhouse II JBS. Previous modifications to that system resulted in improved guidance efficiency but also increased the incidence of injury to juvenile fish, particularly to smaller juveniles when the turbines are operated at the upper end of the ±1 percent peak efficiency range. In 2014, the Corps continued to work with the region to identify a long term solution. As an interim measure, the Corps operated Powerhouse II turbines at the lower end of the ±1 percent peak efficiency range, reducing flow into the gatewells that reduced the injury to fish passing into the juvenile bypass system.

In 2014, manufacturing continued on an Ice Harbor Dam fixed blade turbine runner, the revolving component in a turbine. The contractor also began procuring materials for manufacture of the first of two adjustable blade runners. Based on computer and physical models, the new runners are expected to improve survival of turbine-passed fish by reducing the magnitude of pressure change, the probability of blade strike, and turbulence within the turbine passageways. Installation of the fixed blade runner is scheduled for 2016 and 2017, while installation of the two adjustable blade runners is scheduled for 2017 through 2019. Modification of the spillway chute and deflector for the spillway weir at Ice Harbor also began in late 2014. This is expected to improve juvenile passage survival and may reduce TDG.

Also in 2014, the Corps continued to work with the region on structural improvements to the JBS at Lower Granite Dam. The Corps completed design for structural improvements to the upper components of the JBS, which includes enlarging orifices, widening the juvenile collection channel, new dewatering structures, new automated cleaning systems, ability to direct additional water to the adult fish trap and auxiliary water supply pump chambers, and a new elevated flume structure with tie-in to the existing Juvenile Fish Facility. A construction contract for these components was awarded in September 2014 with initiation of construction activities in late 2014. Additional components continued to be designed including a new primary outfall. The bypass system upgrades are expected to increase juvenile fish survival by providing more efficient control of flow, improving the removal and passage of debris, increasing attraction flow for juvenile fish, and reducing risk of predation at the outfall release point.

Adult Fish Survival

Annual survival rates of listed adult salmon and steelhead through defined hydrosystem reaches are estimated based on detections of fish tagged with passive integrated transponder (PIT) tags at Bonneville, McNary, and Lower Granite dams, with adjustments 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 middle Columbia steelhead.

For 2014, the 5-year rolling averages (2010–2014) and 2014 results for Snake River fall Chinook, Upper Columbia River spring Chinook and Upper Columbia steelhead surpassed the BiOp performance standard. However, the 5-year rolling averages and 2014 results for the Snake River spring/summer Chinook salmon ESU and the Snake River steelhead DPS were below adult performance standards (Figure 13).

The adult fish performance standards are survival estimates of PIT tagged adult fish migrating between Bonneville and McNary dams (upper and middle Columbia ESUs) and Bonneville and Lower Granite dams (Snake River ESUs). The method to calculate these survival estimates attempts to isolate the effects of dam passage from other mortality sources by adjusting Bonneville to McNary or Lower Granite survival rates with estimates of harvest and straying. Nevertheless, the adult performance estimates are influenced by effects of dam passage as well as unreported harvest and other sources of adult fish mortality such as sea lion predation and high river temperatures. Also, high flows and high spill levels at dams can affect the estimates because they are known to increase fallback and delay of adults. Increased fallback and delay at dams can result in increased losses (Keefer et al. 2005). These potential factors are being assessed through BiOp Research, Monitoring & Evaluation (RME) actions and are described under Hydro RME.

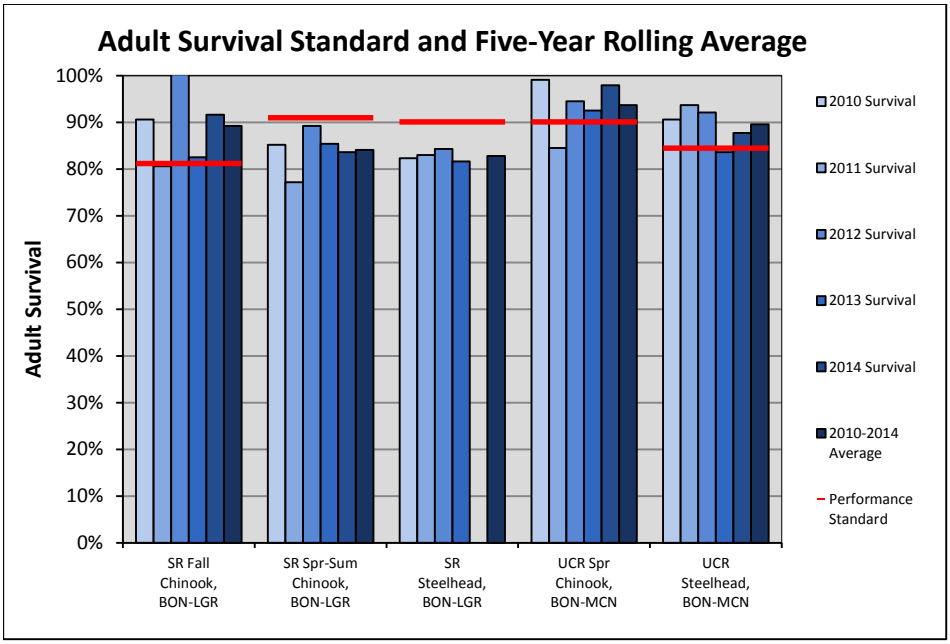


Figure 13. 2008 FCRPS BiOp adult survival standard and five-year rolling average survival of adults that migrated in-river as juveniles, based on PIT tag conversion rates of Snake River (SR) and Upper Columbia River (UCR) ESUs. (BON = Bonneville, MCN = McNary, LGR = Lower Granite). Data from NOAA Fisheries.

In 2014, the Corps completed the second year of a two-year adult passage study to better understand and quantify higher-than-expected losses of adults within certain reaches of the lower Columbia River. Preliminary results suggest that loss rates in lower Columbia River dam-to-dam reaches were highest between Bonneville and The Dalles dams, and were higher for larger fish, for fish that fell back at dams, and for fish that encountered warm water (Keefer et al. 2015). The parties in *United States v. Oregon* are also researching these higher-than-expected losses. As part of this research, the *United States v. Oregon* technical advisory committee and NOAA Fisheries' NWFSC are reviewing PIT tag data to evaluate potential causes.

Juvenile Dam Passage Survival

Under the BiOp, juvenile dam passage performance standards were established based on dam passage survival through all passage routes, with a benchmark of 96 percent average dam passage survival for migrating spring fish (yearling Chinook and steelhead) and 93 percent for migrating summer fish (subyearling fall Chinook). Juvenile passage improvements to provide surface passage routes (e.g. spillway weirs and sluiceways) have been completed at all eight federal dams on the lower Columbia and lower Snake rivers in order to provide more effective passage conditions to achieve the dam passage standards and encourage faster fish travel times through the hydrosystem. Other forms of passage improvements (such as spill walls, and improvements to juvenile bypass outfall locations) to achieve dam passage survival performance standards, have been identified and prioritized in coordination with the region, and have largely been completed at seven of eight Snake and lower Columbia River dams. (Construction at Lower Granite Dam is pending, based on plans and specifications for major design modifications to the juvenile bypass system that were completed in 2014.) To achieve the juvenile dam passage survival performance standards at any given dam, two years of testing must occur with survival either meeting or exceeding the performance standard each year.

In 2014, a second year of performance standard testing was conducted at McNary Dam for yearling Chinook, steelhead, and subyearling Chinook and at John Day Dam for subyearling Chinook. This second year of testing followed successful studies (all results were greater than the applicable 96% and 93% standard) in 2012. In 2014, spring migrating yearling Chinook and steelhead dam passage survival at McNary Dam surpassed the performance standard of 96 percent (Table 2). Unlike the first year test results from 2012, which had the same targeted spill operations, the 2014 estimates of subyearling Chinook dam passage survival at both McNary and John Day dams fell below the BiOp standard of 93% and were 92.4 and 91.7 percent, respectively (Table 2). The Corps, in coordination with NOAA Fisheries and the other Action Agencies, are reviewing the 2014 summer test results to assess the potential cause of lower than expected survival for subyearling Chinook, and determine the next steps to satisfy the juvenile dam passage survival performance standards for summer migrants at John Day and McNary dams. Additional data on test results and John Day and McNary dams is available in Table 6 and Table 7 in Section 2 of this report.

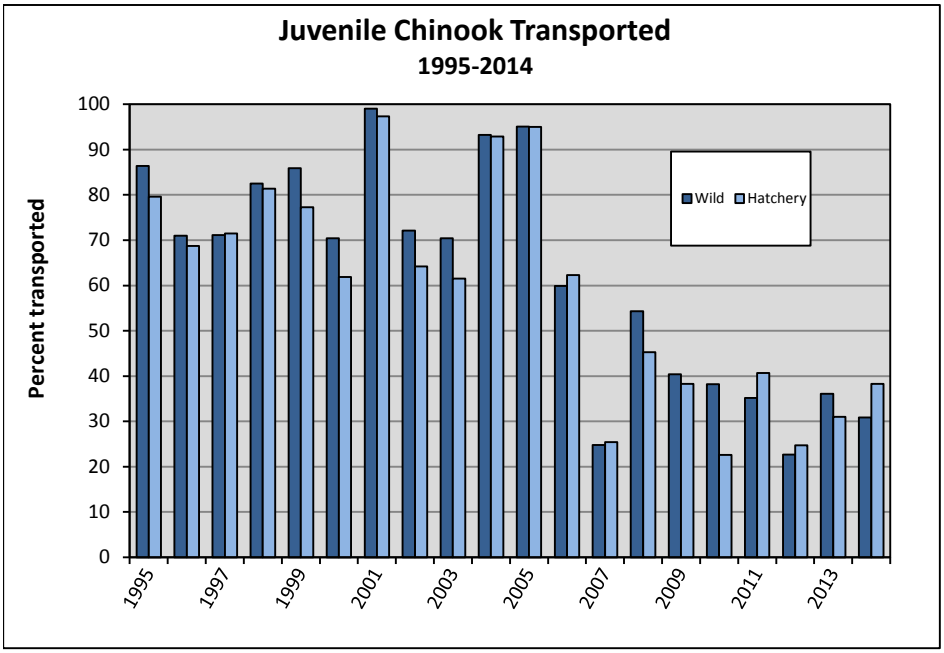
Species	Dam Passage Survival (percent)	Median Forebay Passage Time (hours)	Spill Passage Efficiency (percent)	Spill Operation (target / actual)
McNary Dam 2014				
Yearling Chinook	96.1 (1.3)	1.7	71.4	40% 52.6%
Juvenile Steelhead	97.0 (1.4)	2.6	84.3	40% 52.6%
Subyearling Chinook	92.4 (1.8)	2.2	53.8	50% 48.8%
John Day Dam 2014, 30% Spill				
Subyearling Chinook	92.0 (0.6)	2.3	55.5	30% 30%
John Day Dam 2014, 40% Spill				
Subyearling Chinook	91.3 (0.8)	1.9	71.3	40% 40%
John Day Dam 2014, Season-wide				
Subyearling Chinook	91.7 (0.6)	2.1	63.7	35% 35%

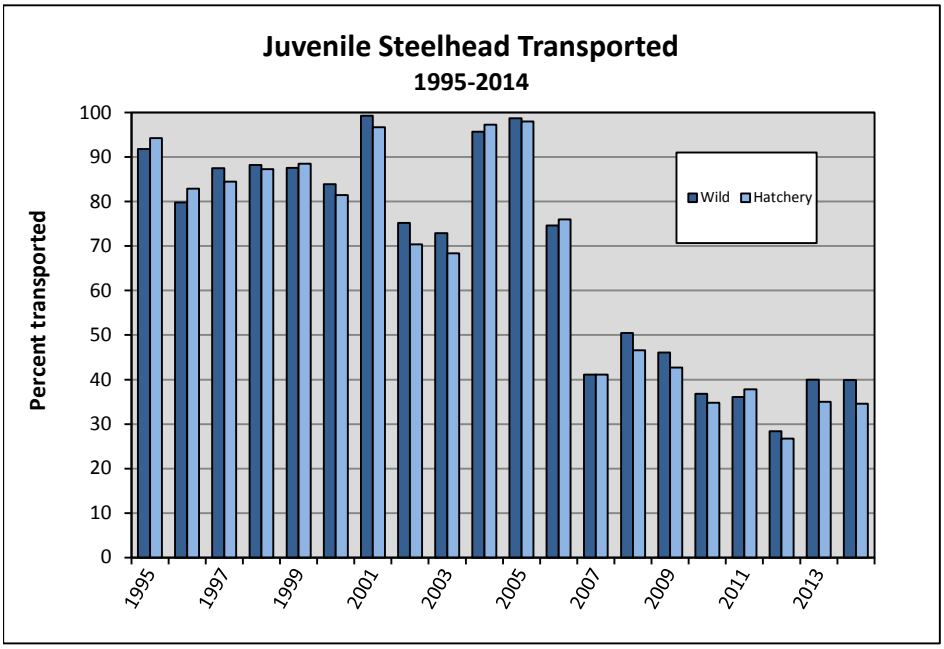
Table 2. Juvenile dam passage survival estimates with standard errors (in parentheses), passage times, and spill passage efficiency for yearling Chinook, juvenile steehead, and subyearling Chinook salmon derived from performance standard tests at McNary Dam and John Day Dam in 2014. Spill passage efficiency is the percent of all downstream migrating juvenile salmon and steelhead that pass a dam through the spillway and other surface passage routes. (Skalski et al. 2015a, Skalski et al. 2015b).

Fish Transportation and Barging

Hatchery and wild juvenile salmon and steelhead that migrate through the Snake and Columbia rivers to the ocean can migrate "in river" or they can be collected and transported. Juvenile fish transportation is an ongoing program to collect fish from juvenile bypass facilities at Lower Granite, Little Goose, and Lower Monumental dams and transport them by either barge or truck to release sites below Bonneville Dam.

The FCRPS 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, research is showing that Chinook return at higher rates when migrating in-river in early April, but return at higher rates when transported beginning in late April or early May. Also, steelhead generally exhibit higher survival when transported during the spring migration.





Figures 14 and 15. Estimated percent of yearling Chinook salmon and steelhead, respectively, transported to below Bonneville Dam, by year (1995–2014) (data from Faulkner et al. 2015).

In 2014, after coordination with the Technical Management Team, collection for transport began on May 1 at Lower Granite Dam, Little Goose Dam, and Lower Monumental Dam. Prior to May 1, juveniles collected at Snake River dams were bypassed back to the river. Estimated percentages of non-tagged spring/summer Chinook salmon juveniles that were transported during the entire 2014 season were 30.9 percent for wild fish and 38.3 percent for hatchery fish. For non-tagged steelhead, estimated percentages transported were 39.9 percent for wild fish and 34.6 percent for hatchery juveniles (Figures 14 and 15). Of the fish transported, 99.7 percent were barged, and the balance transported by truck.

These percentages are substantially lower than those for years prior to 2007. However, for yearling Chinook salmon and steelhead the estimated percentages are slightly higher than the record low estimated percentages for 2012.

Juvenile In-river and Total System Survival

Juvenile salmon and steelhead that are not transported are considered to have migrated "in river." Empirical data are used to track the percent of fish that return as adults among those transported and those left in-river to migrate. Generally, fish are transported during periods when both Chinook and steelhead show increased adult returns compared to in-river migrants. In-river survival of

migrating fish has improved significantly over time as a result of operation and passage improvements at the FCRPS dams. Figure 16 shows the trend of these improvements, including 2014 survival. To put these results in perspective, while study methods have changed, estimated juvenile survival in recent years with improved fish passage through eight dams is now roughly comparable to what it was in the 1960s when fish passed fewer dams.

In 2014, steelhead in-river survival was much higher than observed in previous years. It is likely that steelhead survival estimates in the lower Columbia River reaches were biased high in 2014 due to low detection probabilities at lower river sites and resulting violations of model assumptions (Faulkner et al. 2015).

In 2014, less than 40 percent of the Snake River steelhead and Chinook were estimated to be transported. Based upon recent analysis, ninety-eight percent of the transported juveniles are 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 from Lower Granite Dam to the Bonneville tailrace (survival of in-river and transported groups combined) was about 54 percent for wild Chinook, 70 percent for combined wild and hatchery Chinook, 78 percent for wild steelhead, and 84 percent for combined wild and hatchery steelhead. Because juvenile upper Columbia Chinook and steelhead are left to migrate in-river, in-river survival rates are equivalent to total system survival rates for those species. For steelhead, the estimates may also have been affected by the issues with steelhead in-river survival estimates described above.

Travel time through the hydropower system during 2014 was faster than the long-term average for most of the migration season (Figures 17 and 18). As in 2013, the difference between the long-term average and 2014 travel time was greater for steelhead than for yearling Chinook. This may indicate that juvenile steelhead, being more surface oriented, are receiving a greater benefit from surface passage structures than are yearling juvenile Chinook. In general, travel times seem to be improved through the reduced delay seen from the combination of spill and surface weirs and other surface passage routes.

The BiOp included a metric to estimate in-river survival performance for Snake River and upper Columbia River Chinook and steelhead. The Action

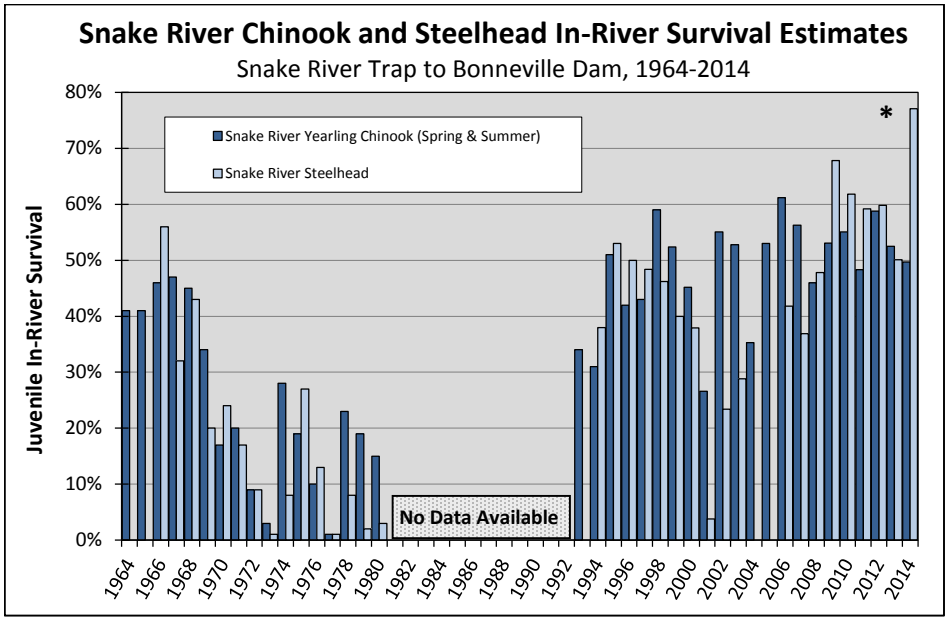
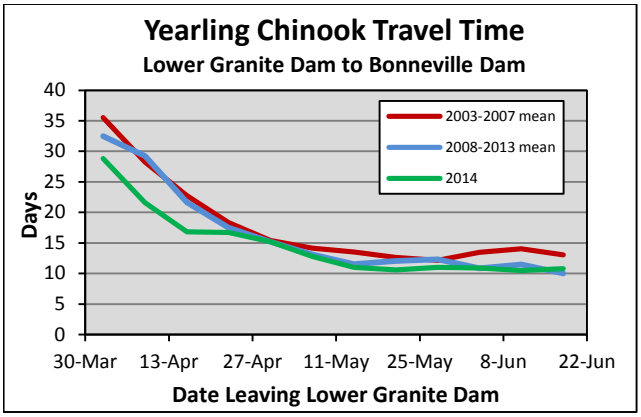
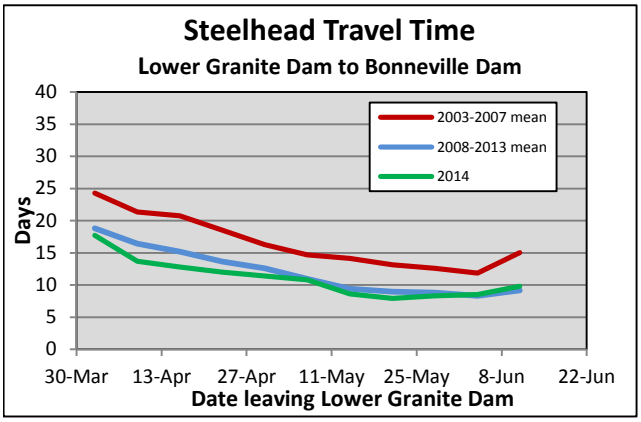
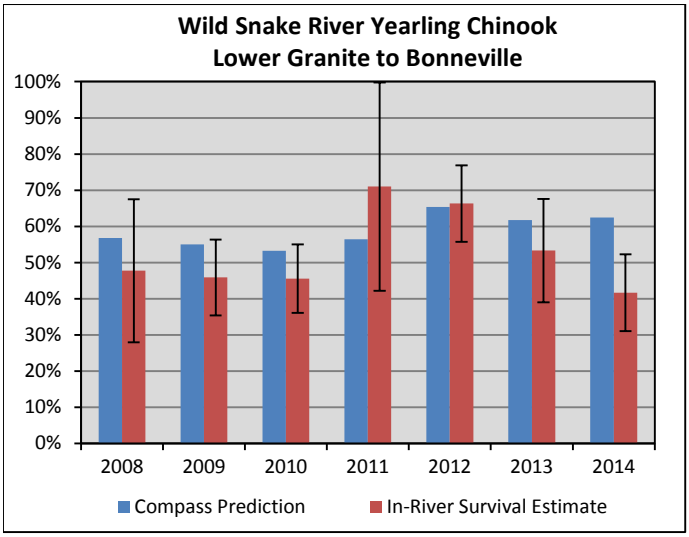


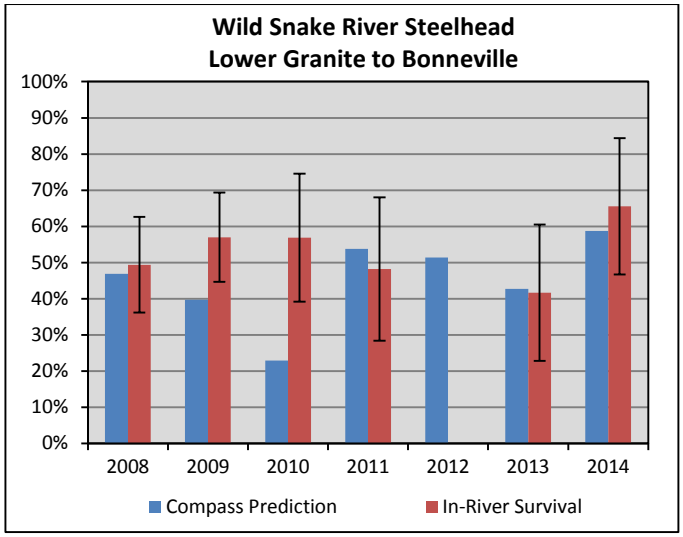
Figure 16. In-river survival estimates (hatchery and wild fish combined) for Snake River Chinook and steelhead, from the trap above Lower Granite Dam to Bonneville Dam. Steelhead estimates for 2004 and 2005 are unavailable due to low PIT tag detection efficiency at Bonneville Dam. Survival estimates are not available for 1981 through 1992. * See the text regarding the steelhead value for 2014 (2014 data from Faulkner et al. 2015.)

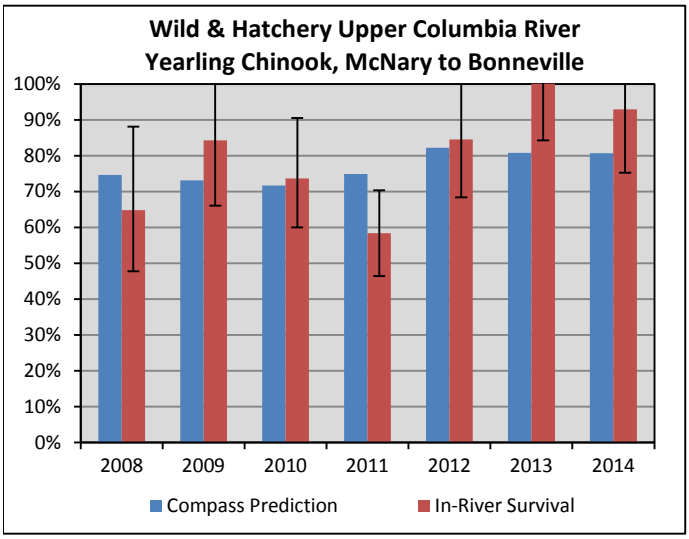


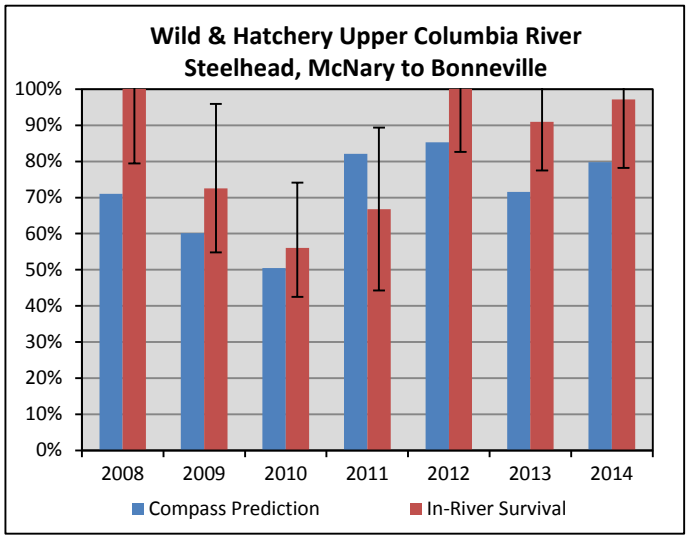


Figures 17 and 18. Median travel time from Lower Granite Dam to Bonneville Dam for weekly release groups of Snake River yearling Chinook salmon (Figure 17) and steelhead (Figure 18). (Data from Faulkner et al. 2015)









Figures 19, 20, 21, and 22. 2008–2013 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. PIT estimate not available for wild Snake River steelhead for 2012. (BON = Bonneville, MCN = McNary, LGR = Lower Granite)

Agencies empirically estimated in-river survival for 2014 (Lower Granite to Bonneville and McNary to Bonneville) and compared that with the survival estimates derived from COMPASS modeling. For this comparison, the COMPASS model was run with survival estimates for the actions implemented at the start of the 2014 migration season using 2014 river conditions, fish migration patterns, and dam and transport operations. Figures 19–22 show the results of these comparisons. In 2014, the PIT tag in-river juvenile survival estimate for natural origin Snake River yearling Chinook was lower than the mean COMPASS estimate. The PIT tag estimates for natural origin Snake River steelhead, upper Columbia River yearling Chinook and upper Columbia River steelhead were higher than the COMPASS estimates. Results presented in Figures 19-22 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.

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. Kelt reconditioning is the process of collecting steelhead during their seaward migration, containing them in a hatchery setting, and rehabilitating the fish through special diets and treatment of pathogens. Fish are then released back into the collection stream(s) to spawn again.

In order to implement the kelt objectives in the BiOp, BPA and the Corps completed the 2014 Kelt Management Plan (KMP) annual supplement (BPA and ACOE 2014a). The 2014 version of the KMP built upon the framework of previous plans, and also identified future direction through the remainder of the BiOp. The report can be found at:

http://www.salmonrecovery.gov/Hatchery/KeltReconditioning.aspx.

In 2014, reconditioning of Snake River B-run kelts occurred at Dworshak National Fish Hatchery. The 2014 release consisted of 34 fish from the Snake River reconditioning program, which included fish collected both at Lower Granite Dam and at the Fish Creek weir.

Photo of reconditioned Snake River B-run kelt at Dworshak Hatchery in 2014

The 2014 KMP also includes a summary of information from the in-river kelt migration studies performed during 2012 and 2013. Colotelo et al. (2014) showed higher adult survival during the high flow year of 2012 than during the lower flow year of 2013 and also discusses potential causative mechanisms of kelt migrating behaviors that may have influenced route preference between years and flow conditions.

No transportation of kelts occurred in 2014. The Action Agencies and relevant coordinating entities will reconsider the transport strategy when the number of collected kelts exceeds the capacity of reconditioning programs.

Habitat Protection and Improvement Actions

Productive habitat in the Columbia River estuary and tributaries is critical to the life cycle of salmon and steelhead. Each year, the Action Agencies spend tens of millions of dollars under the BiOp and the Columbia Basin Fish Accords to 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 "off-site mitigation" for impacts of the hydropower system.

Tributary Habitat Actions

The hundreds of tributary habitat improvement actions implemented or in various stages of development represent a mature habitat program that is progressing toward BiOp targets that the Action Agencies expect to achieve by 2018. A growing list of habitat improvement actions implemented includes flow acquisition, riparian enhancement, improved instream complexity, removal of passage barriers, and improved access to stream habitat. Improved planning and evaluation of current conditions has resulted in a strategy focused on ecological concerns/limiting factors and the needs of fish that are being addressed with projects of increasing size and complexity.

In implementing the tributary habitat program, the Action Agencies consult with local technical teams on the current conditions of habitat and on design details of actions intended to improve conditions for fish. Improvements to limiting factors expected to result from these actions are estimated by expert panels. Based on the expert panels' estimates of changes to habitat functions, the Action Agencies calculate habitat quality improvements (HQIs), which correspond to survival improvements, expected to result from implementation. The process uses the Collaboration Habitat Workgroup Method that was developed during the remand collaboration informing the 2008 BiOp (see: *http://www.usbr.gov/pn/fcrps/habitat/panels/index.html*). Research and monitoring to date is pointing toward the biological value and importance of the tributary habitat program (i.e., that habitat actions improve conditions for salmon and steelhead) (BPA 2014).

Research and monitoring are also illustrating how in several watersheds and for many populations density dependence [6] may limit fish numbers and survival. In other words, carrying capacity of some habitats can be limiting.

Summary of Tributary Habitat Accomplishments

Accomplishments for 2014 are presented and summarized below. Flow protection, barrier removal, and habitat enhancement are just some of the tributary habitat improvements delivering benefits to listed salmon and steelhead. A complete list of actions and metrics by population is included in Sections 2 and 3. Below are some examples of improvements and the cumulative habitat metrics that have been delivered over time.

Protecting and Improving Instream Flow

The Action Agencies support water transactions through a dedicated program of funding. See Figure 23 for annual and cumulative progress. This program has resulted in increased flows to streams historically impacted by water withdrawals. In 2014, in Poison Creek, a tributary to the Salmon River mainstem below Redfish Lake, three points of diversion were consolidated and 9.2 cubic feet per second (cfs) of flow was restored to the creek, connecting it year round to the Salmon River. Prior to

[6] *Density dependent effects have been identified and evaluated by NOAA in the 2014 BiOp and assessed by the Independent Scientific Advisory Board.*

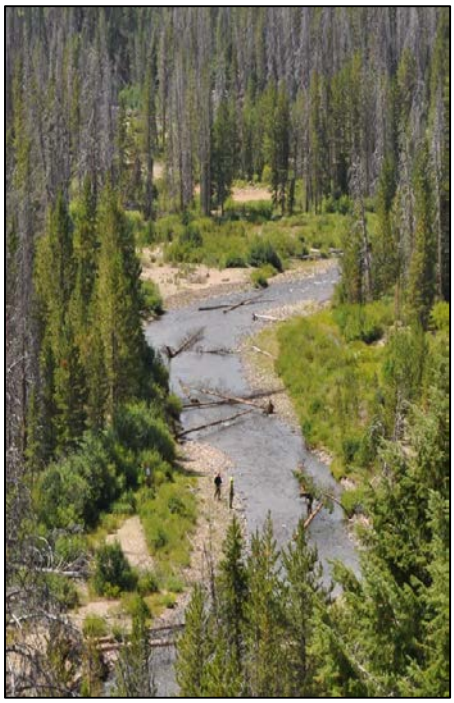


Figure 24. Yankee Fork large wood restoration. Phase I included placement of over 300 pieces of large wood along three miles of the channel.

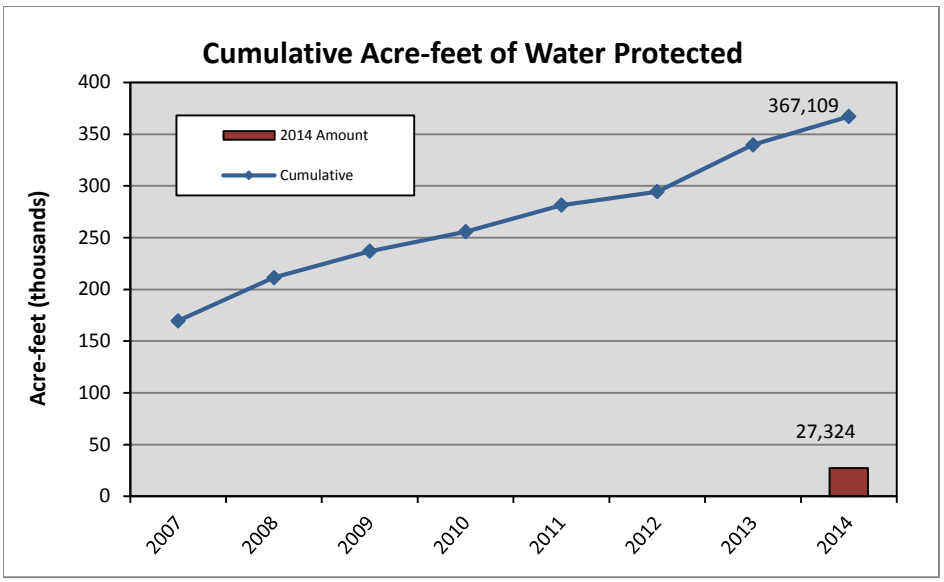


Figure 23. Water secured and protected, in acre-feet of instream flow, 2007–2014. Cumulative acre-feet/year can include annually renewed water leases.

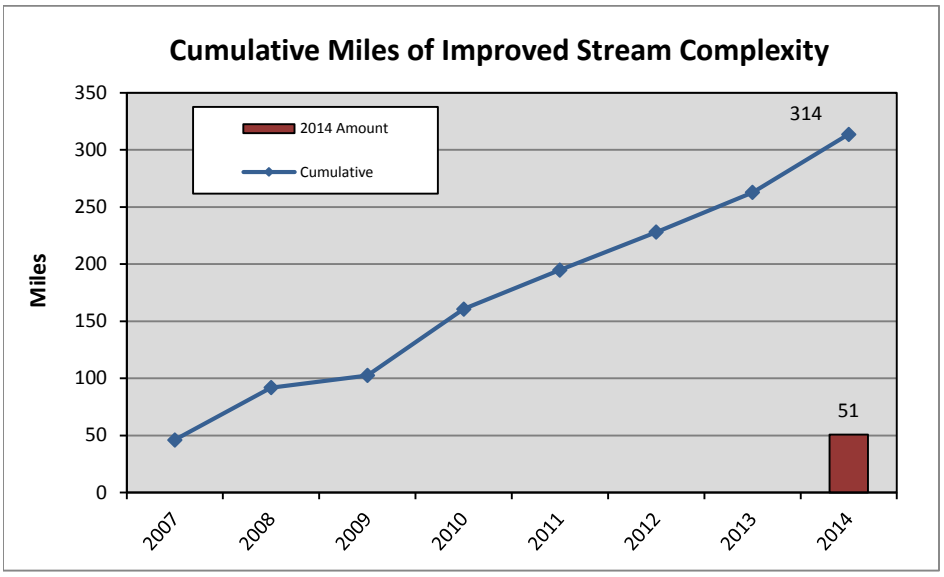


Figure 25. Cumulative miles of improved stream complexity, 2007–2014.

implementation of this action in 2014, all the flow in Poison Creek was diverted for irrigation.

Additional transactions in 2014 included one action involving eight landowners in Roaring Creek, a tributary to the Entiat River, which permanently dedicates over 1.5 cfs to Roaring Creek. It is thought that 15 to 20 percent of steelhead redds in the Entiat sub-basin occur in Roaring Creek. Other transactions in 2014 secured a 20 year lease for 9.3 cfs in Beaver Creek, a previously dewatered tributary of the Salmon River in Idaho, and 6 cfs in the upper Grande Ronde River in Oregon that will benefit Snake River Spring/Summer Chinook and steelhead.

Improving Habitat Complexity

Instream habitat actions that improve complexity have benefitted a number of salmon and steelhead populations with specific focus on BiOp priority populations. Where habitat complexity is improved, we have routinely seen increased fish use almost immediately. Several extensive actions in 2014 included floodplain and riparian enhancement and placement of large wood to create more fish habitat. One action to improve habitat for fish involved placement of large wood in the upper Yankee Fork over 3 miles of stream (Figure 24). The 2014 action was the first of a series of treatments that are planned for the Yankee Fork, which has been subject to severe impact as the result of historical mining and logging. The Yankee Fork series of treatments are intended to mimic natural circumstances that occur, in some cases, at a landscape scale. Two of the 2014 treatments were intended to mimic conditions that would result as a consequence of a natural land slide. Video footage of the upper Yankee Fork treatment is available at:

https://www.youtube.com/watch?v=jHjPSBXhYfE.

This and other actions contributed to progress in this area as shown in Figure 25 displaying annual and cumulative metrics.

Figure 26. Tucannon River large wood enhancements have addressed 9.72 miles with 1,891 pieces since 2010.

In 2014, in the Tucannon River, a series of large wood projects intended to restore floodplain connectivity and complexity were implemented by the Action Agencies in partnership with the Lower Snake Salmon Recovery Board and the Washington Department of Fish and Wildlife (WDFW) (Figure 26). Post implementation action effectiveness monitoring by the project partners as well as monitoring by the Columbia Habitat Monitoring Program (CHaMP) in 2014 continued to document fish use, changes in channel complexity, and restored floodplain connectivity. River gauge data (from stations at Marengo and Starbuck) has also shown improved temperature and instream flow in the Tucannon River.

Riparian Area Improvement and Protection

Unlike flow restoration or barrier removal, which deliver immediate benefits to fish, improvements from riparian revegetation generally accrue over time (Roni et al. 2014). As the features of habitat mature and improve so will conditions for fish. In addition to improving physical habitat, these actions also improve water quality and enhance forage resources. See Figure 27 for annual and cumulative acres of habitat improved.

Figure 28. Methow River M2-3R project showing riparian habitat enhancement.

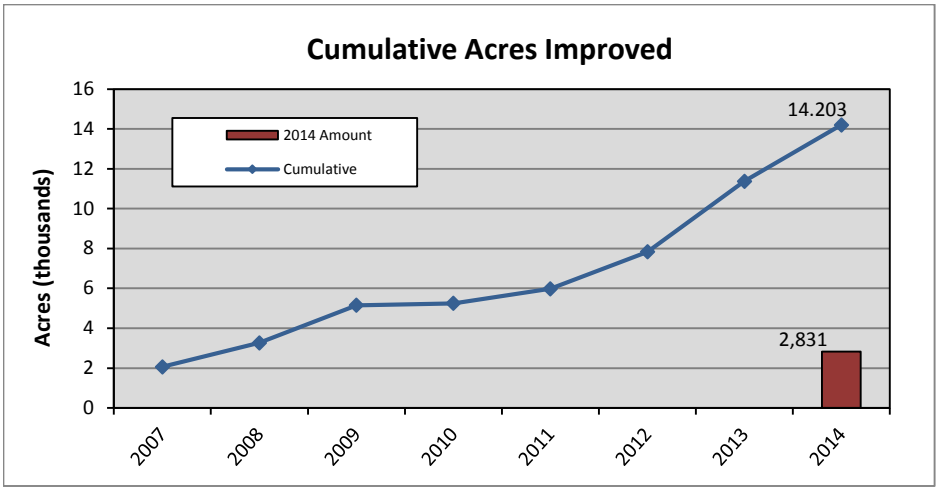


Figure 27. Cumulative Acres of riparian habitat improved, 2007–2014.

Figure 28 illustrates riparian planting to increase the recovery rate of woody species in the Methow M2 reach, which is critical for juvenile salmon rearing. The fencing is to protect young plants from browsing by deer. Another riparian enhancement project implemented by the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) and others in Catherine Creek involved acquisition of the 545-acre Southern Cross Ranch. The project eliminated grazing impacts on 4 acres of riparian and wetland habitat and along a 0.75 mile reach of Catherine Creek. In 2014, the CTUIR also acquired a 15 year conservation easement establishing a 450-acre riparian buffer along 15 miles of Rock Creek, a tributary to the upper Grande Ronde River.

Reducing Fish Entrainment Irrigation Diversions at

The Action Agencies continue to support the improvement and replacement of screens to prevent fish from being drawn into irrigation diversions. In 2014, the Action Agencies funded programs in Oregon and Idaho that fabricate screens; sixty-three screens were installed or improved (see Figure 29). The screen shop crews are involved in the installation of updated screens and in coordinating what is necessary for maintenance with

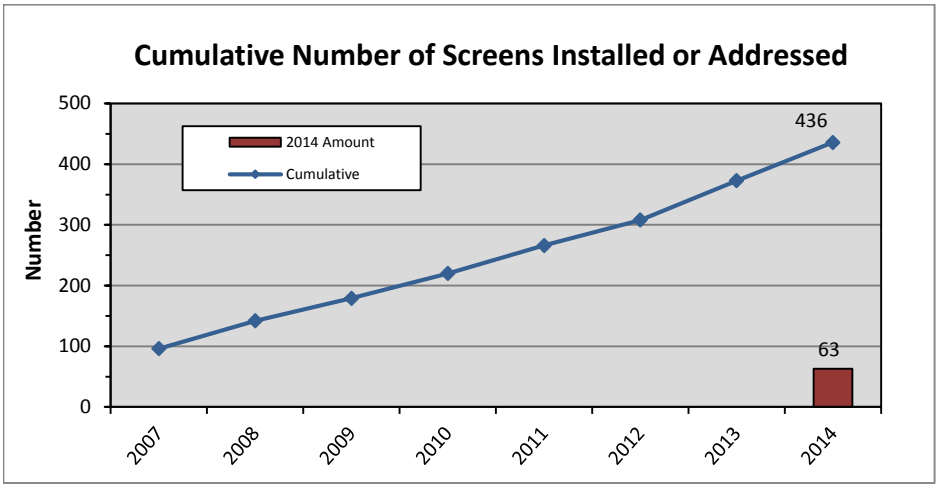


Figure 29. Cumulative number of fish screens installed or improved, 2007–2014.

private landowners. The working relationships that are established through these efforts are reflective of long term stakeholder engagement. Figure 30 illustrates a project on Poison Creek, a tributary of the upper Salmon River, that consolidated three existing unscreened points of diversion that were in disrepair, and installed a new screened diversion and an auxiliary screen intended to prevent fish from being drawn into the consolidated diversion.

Improving Access to Spawning and Rearing Habitat

The Action Agencies continue to work with partners to replace culverts and irrigation diversions that block or impede fish passage (Figure 31). Culvert replacement and barrier removal have some of the most immediate benefits to fish because they quickly reopen habitat. Figures 32 and 33 illustrate a project constructed in 2014 on Garden Creek in the Upper Salmon where 1.4 miles of habitat was made accessible by the removal of an old check dam that was used to maintain the city water supply. The project also restored 1.58 cfs of surface flow to the Salmon River. The City of Challis converted to a well to supply city water demands and now minimally diverts surface water and only in times of emergency (e.g., fire) or extreme need.

Figure 30. Poison Creek consolidated point of diversion after implementation.

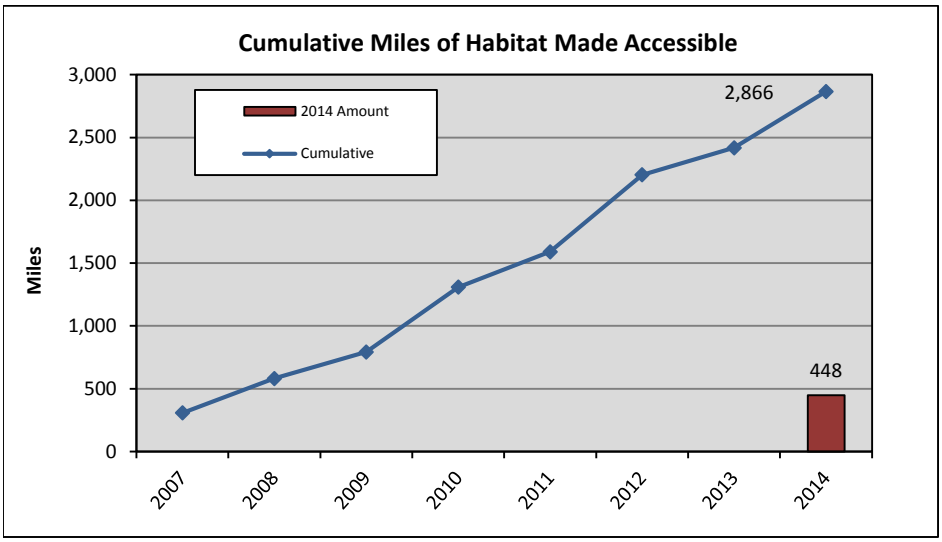


Figure 31. Cumulative miles of habitat made accessible, 2007–2014.

Figures 32 and 33. City of Challis diversion dam removal on Garden Creek before and after implementation.

Tributary Habitat Improvement Metrics by ESU/DPS

Actions that improve stream conditions for the freshwater life-stages of salmon and steelhead are categorized and tracked through metrics. These metrics are summarized for 2014 in Table 3 by ESU/DPS and are displayed in the metrics charts above (Figures 23, 24, 27, 29, 31). More details for specific populations can be found in Section 3.[7]

Estuary Habitat Actions

The estuary's diverse habitats provide food and refuge for rearing and migrating juvenile salmon as they make their critical transition from fresh water to productive marine feeding grounds, where they grow at higher rates than are obtainable in freshwater systems. Research continues to demonstrate the importance of estuary habitat rich in food resources in giving juvenile salmon and steelhead an opportunity to feed and gain strength before entering the ocean (Diefenderfer et al. 2011, Diefenderfer et al. 2012).The Action Agencies' projects in the estuary are focused on restoring this critical estuarine habitat for the benefit of listed juvenile salmon and steelhead.

Implementation of the habitat program in the lower Columbia River and estuary continues to improve over the course of the BiOp period. Efforts in 2014 netted a total of 3.1 Ocean Survival Benefit Units (SBUs) and 1.2 Stream SBUs. This demonstrates the Action Agencies' progress toward their BiOp targets. In 2014 the Action Agencies continued to implement the strategies outlined in the Columbia Estuary Ecosystem Restoration Plan (CEERP) documents (BPA and ACOE 2014b, Johnson et al. 2014). Below are examples of three of the most significant habitat improvements in the estuary in 2014.

Sauvie Island - North Unit Access and Habitat Diversity Project

The Columbia River Estuary Study Taskforce (CREST), a partner organization in the estuary, implemented the second phase of a three-phase project intended to restore fish habitat and natural hydrology in the North Unit of the Sauvie Island Wildlife Area, northwest of Portland, Oregon. Restoration objectives aim to create an accessible mosaic of sloughs, wetlands, and back swamps that invite and support juvenile salmonid use within the North Unit. Phase Two included the removal of water control structures in two back swamp wetland complexes: Millionaire Lake and Deep Lake / Widgeon Lake (Figures 34 and 35). Removal of the two barriers will return approximately 138 acres of historical juvenile salmonid habitat to current fish use. As with Phase One, where more than 123 acres were reopened in Ruby Lake, CREST excavated marsh plain surfaces to lower elevations, thereby increasing the frequency of water inundation. This lowering of the marsh plain, along with native plantings, increases survival for wetland plants and provides better fish access at the site.

Figure 34. Aerial view of Millionaire Lake (in the middle of the photo), at the north end of Sauvie Island, after the removal of water control structures. In total, Phase II restored access to approximately 138 acres of historical juvenile salmonid habitat.

Table 3. 2014 Tributary Habitat Improvement Metrics by ESU/DPS. *

Habitat Improvement Metric	Snake River Spring/ Summer Chinook	Snake River Steelhead	Upper Columbia River Spring Chinook	Upper Columbia River Spring Steelhead	Middle Columbia River Steelhead
Acre-feet/year of water protected	3654	3654	78	798	8672
Acres protected	138	178	10	10	1663
Acres treated	443	544	234	382	1889
Miles of enhanced or newly accessible habitat	312	312	11	47	69
Miles of improved stream complexity	33	33	5	5	7
Miles protected	9	11	0	0	86
Screens installed or addressed	8	8	1	31	24

* Note: Some projects benefit multiple species. In those instances, therefore, metrics by species shown above include numbers for both steelhead and Chinook ESUs/DPSs present in the same watershed.

[7] *The Action Agencies identify actions and the extent of treatment in terms of number of acres restored, riparian miles restored, amount of flow restored, etc. Expert panels estimate how implementation of these actions will change the function of limiting factors, and this change in habitat function is then converted, by the Action Agencies (using the method developed by the Collaboration Habitat Workgroup), into an overall change in habitat quality and associated survival improvement.*

Karlson Island Hydraulic Reconnection & Access Project

The Karlson Island project, also implemented by CREST, restored functional hydrology and fish access to 320 acres of tidal marsh habitat in Cathlamet Bay, Oregon (Figure 36). Restoration objectives included maximizing access to emergent marsh habitat for juvenile salmonid species, improving hydrologic exchanges to more closely resemble natural conditions, improving hydraulics and flow patterns in the existing channels, and enhancing food web connectivity between the marsh floodplain and surrounding riverine system. Objectives were met by removing over 2,050 feet of levee creating a new channel footprint, replanting with native vegetation, treating for invasive plant species, and installing large woody debris.

Steamboat Slough Restoration Project

The Corps implemented the Steamboat Slough restoration project in order to restore floodplain connection, wetland function and juvenile salmonid access to the 67 acre site located on the Julia Butler Hansen Wildlife Refuge in Washington (Figure 37). Improving floodplain connection and restoring tidal influence allowed for renewed access to preferred off-channel habitat for threatened and endangered species of salmon. The habitat quality was also improved as the site was returned back to historical wetland conditions. Restoration actions included removing sections of levee, excavating a tidal channel network for off channel habitat, and reshaping excavated materials into terraces and hummocks to create topographic diversity. A setback levee was also constructed around the site, protecting adjacent lands from flood waters. Other restoration actions included installing large woody debris, performing invasive plant removal, and revegetating disturbed areas with native wetland plants.

2014 Implementation

In 2014, the Action Agencies completed on-the-ground habitat actions for eight projects in the estuary and continued planning and development of additional projects for future implementation. (See Section 3, Attachment 4 for status of projects.) These projects yielded 3.1 Ocean SBUs and 1.2 Stream SBUs by restoring a total of nearly 1,183 acres throughout the Columbia River estuary (Table 4). In addition to restoration actions, protecting land under permanent conservation easements further supports habitat and fish conservation in the short and long term, both by enabling future active restoration and by allowing landscape processes to passively restore the site.

As shown in Figures 38 and 39, the nearly 1183 acres protected and restored in 2014 brings the BiOp period cumulative total to over 6000 acres. Projects with full hydrologic reconnection (CRE 10.1), allowing increased inundation and more wetland habitat, made up the largest proportion of the actively restored acres. The Action Agency restoration strategy has given priority to full hydraulic reconnection given the high biological benefits associated with these types of projects. The other types of restoration described in Table 4 continue to be useful when developing a comprehensive suite of actions at a site and when full reconnection is not possible for social or technical reasons.

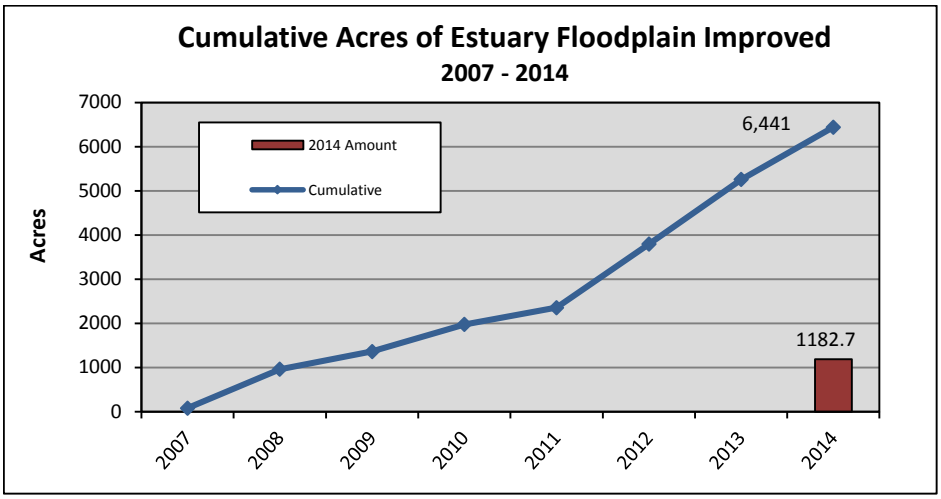
Figure 35. An example of a water control structure removed during Phase II. The undersized and perched fish egress pipe in the foreground was an impassable barrier preventing fish use of the habitat.

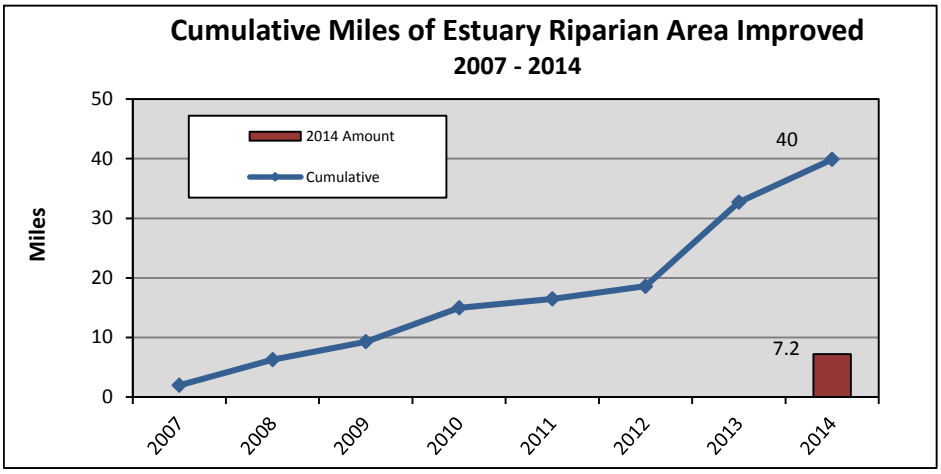
Figure 36. Aerial views of Karlson Island after restoring fish access and hydrological function to 320 acres of tidal marsh in Cathlamet Bay, Oregon.

Figure 37. Aerial view of Steamboat Slough after restoring wetland function and juvenile salmonid access to 67 acres of the Julia Butler Hansen National Wildlife Refuge near Cathlamet, Washington.

Table 4. Summary of estuary habitat restoration metrics, 2014. "CRE" refers to an action type described in NOAA Fisheries' "*Columbia River estuary ESA recovery plan module for salmon and steelhead*" (NMFS 2011).

Action	Acres
Protect riparian areas (CRE 1.3)	0
Restore off-channel habitat (CRE 9.4)	59
Restore full hydrology/access (CRE 10.1)	597
Improve hydrology/access (CRE 10.2)	0
Improve access (CRE 10.3)	333
Reduce invasive plants (CRE 15.3)	171.7
Use dredged materials beneficially (CRE 6.3)	0
Land Acquisition (CRE 9.3)	22
Total	**1182.7**





Figures 38 and 39. Cumulative acres of estuary floodplain improved; and cumulative miles of estuary riparian areas improved, respectively.

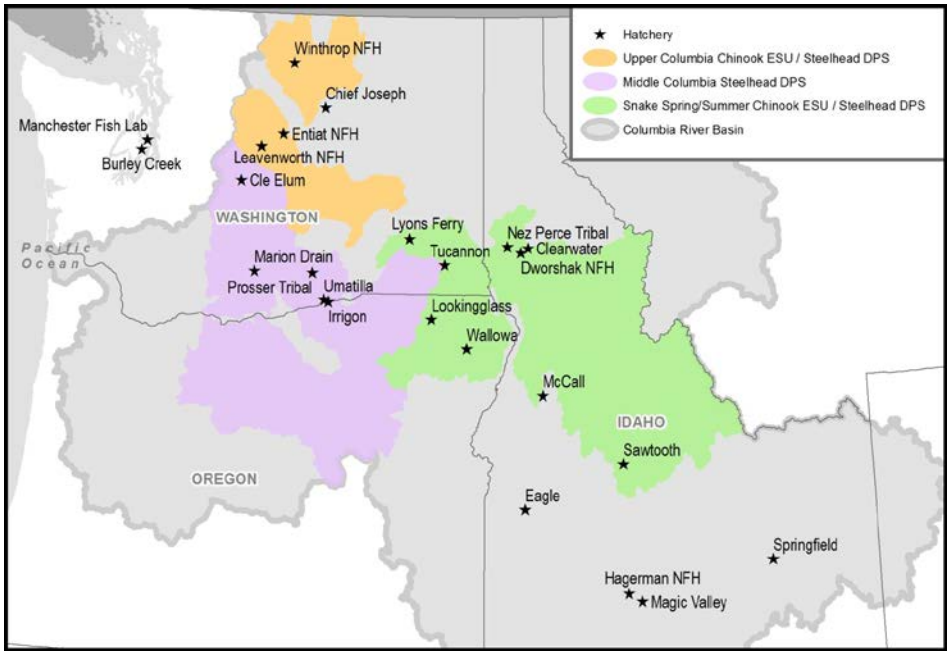


Figure 40. Action Agency-funded anadromous fish hatcheries with hatchery programs requiring an updated HGMP and ESA consultation under BiOp RPA Action 39.

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-listed salmon and steelhead, the Action Agencies worked with hatchery operators to prepare updated hatchery and genetic management plans (HGMPs) (Figure 40). 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 2013, the Action Agencies had reviewed and commented on draft HGMPs for all of the 44 Action Agency-funded hatchery programs, a total of 28 HGMPs had been determined by NOAA Fisheries to be sufficient for formal ESA consultation, and 9 site-specific biological opinions had been completed. No further changes occurred in 2014.

Conservation and Safety Net Programs

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 2014, BPA continued to fund projects reconditioning upper and middle Columbia River and steelhead kelts. 2014 progress for reconditioning includes:

- Expanded collection opportunities to known B-Run steelhead tributaries (e.g. Fish Creek); and
- Continued reconditioning research including: assessments of fish culture techniques such as diet

composition; monitoring of ocean return rates of kelts released from different reconditioning programs, experimental treatments, and stock origins; and estimation of reproductive success rates including long-term reconditioned kelts which did not undergo a repeat ocean migration.

BPA also continued to fund and support supplementation programs using local origin broodstock such as Snake River and upper and middle Columbia River Chinook and steelhead as well as Snake River Spring/Summer Chinook Salmon. In addition, construction of the Chief Joseph Hatchery was completed in 2013 with its first upper Columbia summer Chinook sub-yearling release in 2014. In 2014, the Chief Joseph Hatchery also received the first ESA-listed Upper Columbia River spring Chinook for reintroduction in the Okanogan Basin.

Reclamation continued funding collection of local broodstock and managing returning adult steelhead for the Methow Upper Columbia steelhead program. Sufficient natural-origin local broodstock were collected to produce an anticipated release of 135,000 smolts in 2016 after a two-year rearing program. The hatchery operator also continued efforts to remove hatchery-produced adult steelhead from the spawning grounds.

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 juveniles 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, 6,219 adults from the program have returned to Idaho's Redfish Lake or to the Sawtooth Hatchery weir on the upper Salmon River (Figure 41). In 2014, 1,408 adults returned to these two locations. Of these, 452 were natural-origin (i.e., non-hatchery) fish. The Action Agencies, along with NOAA Fisheries, have continued to work with the region to investigate factors contributing to the loss of adult sockeye between Lower Granite Dam and the Redfish Lake/Sawtooth Hatchery weir, and a report evaluating those factors was finalized in 2014 (Crozier et al. 2014).

The BiOp calls for the Action Agencies to expand the Snake River sockeye program to produce between 500,000 and 1 million juveniles 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. Construction of the Springfield Hatchery facility in southeastern Idaho was completed in 2013 and in 2014 the hatchery reared two brood years of Snake River sockeye.

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 biological opinions. 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 2014, the Action Agencies continued funding the implementation and evaluation of live-capture fishing gear that can be used to selectively harvest marked hatchery fish while allowing ESA-listed natural-origin fish to escape unharmed. Terminal area fishing was also supported through BPA funded Select Area Fisheries Enhancement Program. In addition, the Action Agencies continued to fund research into harvest managers'

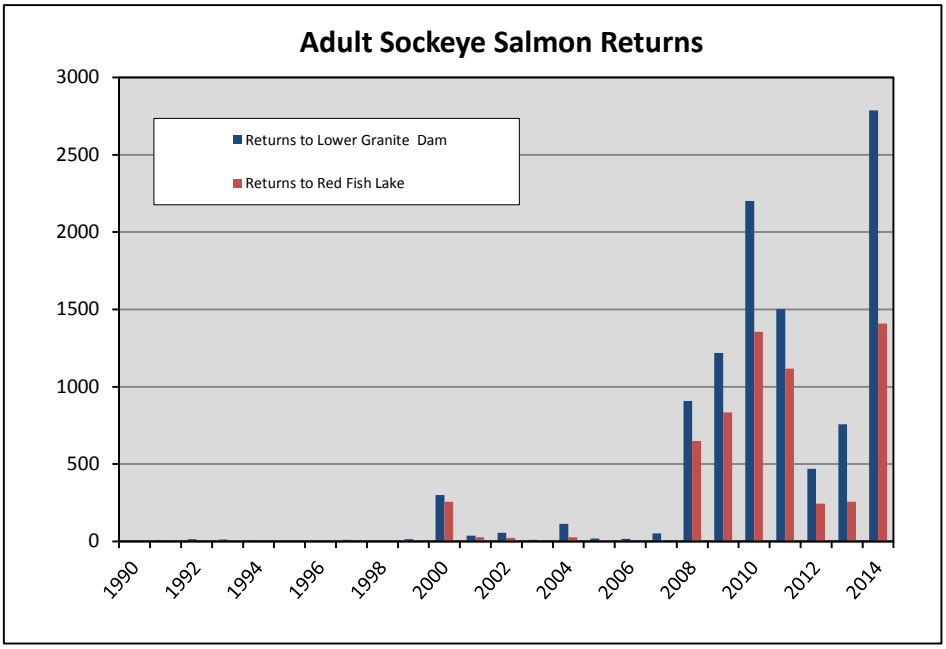


Figure 41. Adult sockeye salmon returns to Lower Granite and to Redfish Lake/Sawtooth Hatchery weir on the upper Salmon River, Idaho, 1991–2014.

sampling regime and estimation model to assess whether improved methodologies could provide more precise estimates, especially with the use of PIT technology.

Predator Management

Five 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 middle Columbia region, but at lower numbers. Both Caspian terns and double-crested cormorants are protected under the Migratory Bird Treaty Act of 1918; which requires additional processes to reduce the impacts of these birds on the ESA-listed salmon and steelhead.

Among fish, northern pikeminnow are 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 Fisheries 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 of salmon and steelhead. Programs to redistribute Caspian terns currently nesting in the estuary and the Columbia Basin, 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 2014, the Action Agencies continued these efforts to control specific predators and improve survival of juvenile fish.

Avian Predation

Caspian Terns in the Estuary

Under the BiOp, the Action Agencies have created Caspian tern nesting habitat outside of the Columbia Basin to allow reduction of nesting habitat on East Sand Island in the estuary. In 2014, a total of 6.8 acres was available to terns nesting at seven created sites in southern Oregon and northern California. These sites are listed in Table 5 below. A combined total of 786 breeding pairs of Caspian terns attempted to nest at five of these Corps-constructed islands in 2014, a decrease from the number of breeding pairs nesting on these islands in 2013 but an increase over the average period of record (approximately 600 breeding pairs).

Due to the number of alternative nest sites made available in interior Oregon and northern California, the area made available for tern nesting at East Sand Island was limited to 1.55 acres, slightly less than the 1.58 acres made available 2012 and 2013.

In 2014, the Corps and also started construction of additional tern nesting habitat in the Don Edwards National Wildlife Refuge in South San Francisco Bay. This additional habitat (which is also part of the Inland Avian Predation Management Plan described below) will allow the Corps to reduce the area available for tern nesting at East Sand Island to a minimum of 1.0 acre.

The Caspian tern colony on East Sand Island in the Columbia River estuary consisted of about 6,270 breeding pairs in 2014. This is a decrease from the estimate of 7,400 pairs in 2013, and is the smallest colony size recorded at East Sand Island since the initiation of reductions in tern nesting habitat on the island in 2008, when the colony numbered over 10,000 breeding pairs (Figure 42). However, this colony size remains above the target colony size of 3,125–4,375 breeding pairs set forth in the Tern Environmental Impact Statement and Record of Decision. Average nesting

Location	Acres Available in 2014	Completion Date	Social Attraction	Watered
Fern Ridge Reservoir (OR)	1.0	Feb 2008	No	Yes
Crump Lake (OR)	1.0	Mar 2008	No	Yes
East Link Unit, Summer Lake Wildlife Area (OR)	0.5	Dec 2008	Yes	Yes
Dutchy Lake, Summer Lake Wildlife Area (OR)*	0.0	Feb 2009	NA	NA
Sump 1B, Tule Lake NWR (CA)	2.0	Aug 2009	Yes	Yes
Gold Dike Unit, Summer Lake Wildlife Area (OR)	0.5	Sep 2009	Yes	Yes
Orems Unit, Lower Klamath NWR (CA)	0.0	Sep 2009	No	No
Sheepy Lake, Lower Klamath NWR, (CA)	0.8	Feb 2010	Yes	Yes
Malheur Lake, NWR (OR)	1.0	Feb 2012	Yes	Yes
*Island removed in 2012. No management or monitoring in 2014.				

Table 5. Status of Caspian Tern Nesting Islands for the 2014 Breeding Season.

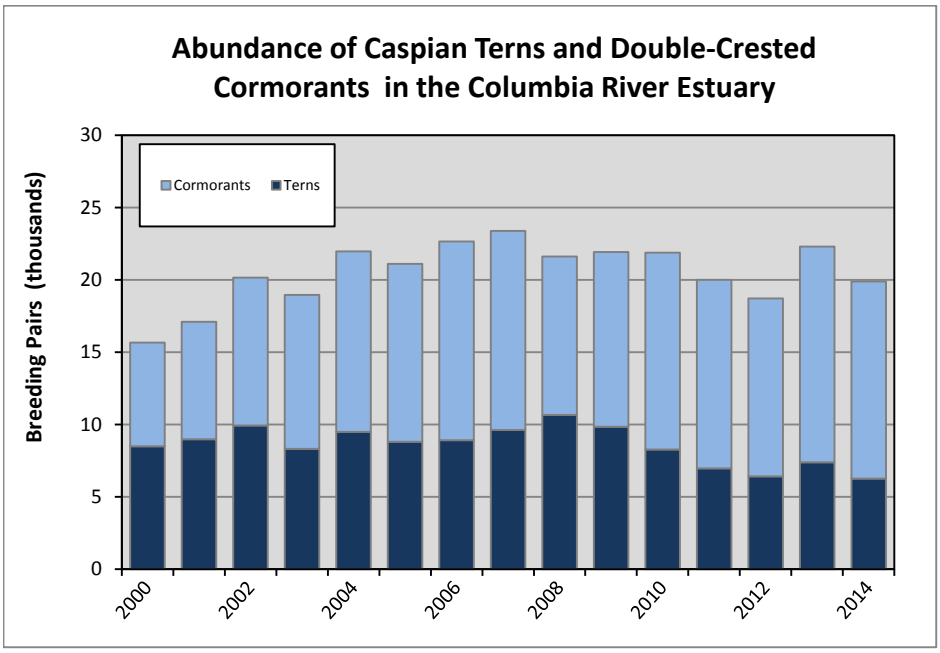
density in 2014 was 1.06 nests/m^2, a decrease from the 1.17 nests/m^2 seen in 2013 but well above the average nesting density of 0.71 nests/m^2. The Caspian tern colony on East Sand Island produced roughly 1,700 fledglings in 2014 (average of about 0.28 young raised/breeding pair), an increase compared to 2010–2012 when productivity averaged 0–0.06 young raised/breeding pair, but still lower than the average during the previous decade (2000–2009).

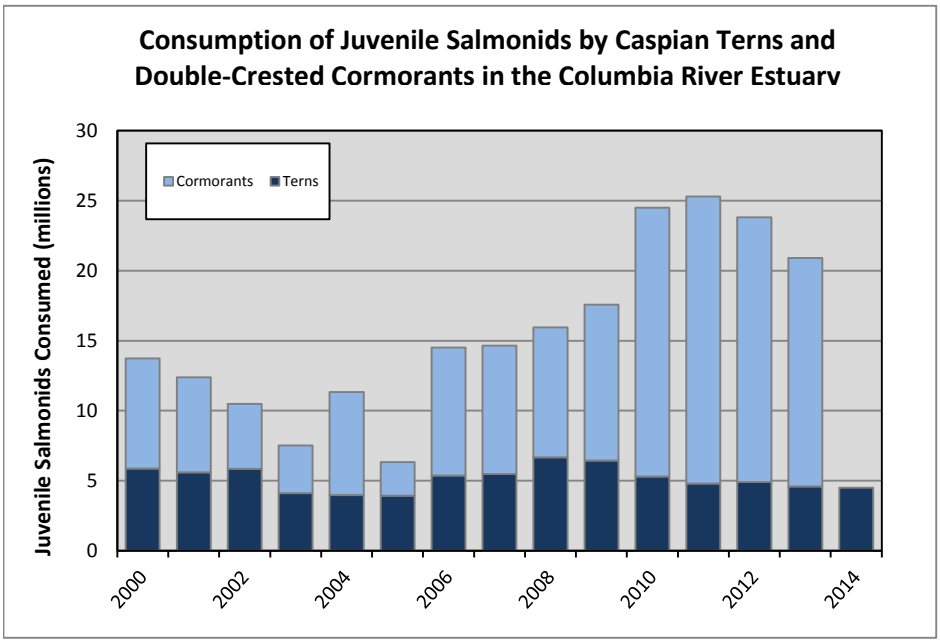
The average proportion of juvenile salmon and steelhead in the diet of Caspian terns during the 2014 nesting season was 33 percent, similar to the average observed over the previous eight nesting seasons. The estimated total smolt consumption by Caspian terns nesting at East Sand Island in 2014 was 4.5 million (95 percent c.i. = 3.9–5.1 million), not significantly different from total annual smolt consumption during 2011, 2012, and 2013 (Figure 43). Predation rates on specific populations of salmonids (ESUs/DPSs) by Caspian terns in 2014 were similar to those observed during 2011–2013, but were generally lower than those observed during the period 2007–2010. Similar to previous years, Caspian tern predation rates were 5–10 times higher on populations of steelhead smolts (8.6–11.4 percent, depending on DPS) compared with populations of salmon (0.9–1.6 percent depending on ESU).

Cormorants in the Estuary

In 2014, the Action Agencies continued to evaluate potential management techniques to reduce losses of juvenile salmon and steelhead due to double-crested cormorant predation in the Columbia River estuary. All of East Sand Island was made available for double-crested cormorant nesting in 2014.

In 2014, the colony consisted of about 13,626 breeding pairs, down from the 14,916 pairs recorded in 2013 but higher than the average annual estimate of 10,776 for 1997–2013 (Figure 42). Predation rates in 2014 were higher than those observed in 2013 for all ESUs/DPSs evaluated. Predation rates on some salmon ESUs in 2014 were the highest recorded since the colony was first scanned for PIT tags in 1999. For example, the rate of predation by East Sand Island double-crested cormorants on Snake River spring Chinook salmon in 2014 (8.5 percent; 95 percent c.i. = 6.1–13.2 percent) was roughly 2–10 times higher than those recorded during 1999–2013 (ca. 0.9–6.8 percent). Predation rates by double-crested cormorants nesting on East Sand Island were generally higher on steelhead populations than on salmon populations; analysis





Figures 42 and 43. Abundance of colonial birds in the Columbia River Estuary and consumption of juvenile salmonids in the Columbia River Estuary, respectively. 2014 estimate of total cormorant consumption of juvenile salmonids was not available at time of writing. (Tern data and 2003–2013 cormorant data from Roby et al. 2015. Cormorant data 2000–2002 from K. Collis, pers. comm.)

suggests that double-crested cormorants consume juvenile salmonids in relative proportion to their availability on an annual basis.

On June 12, 2014, the Draft Environmental Impact Statement for Double-Crested Cormorant Management to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary was published in the Federal Register and offered for public comment. The Corps received a substantial number of comments, particularly regarding cumulative impacts to the western population of double-crested cormorants. The Corps continued to work toward completion and publication of the Final Environmental Impact Statement during the remainder of 2014.

Inland Avian Predation

In 2014, the Action Agencies finished development of the Inland Avian Predation Management Plan (IAPMP) with regional collaboration. The IAPMP is a 5-year, phased, habitat based management plan primarily addressing Caspian tern predation within the Columbia River Basin upstream of Bonneville Dam. Based on results of RME conducted as part of RPA Action 68, the Corps and Reclamation agreed to expand the scope of the plan to include Goose Island (Reclamation-owned lands in Potholes Reservoir near Othello, Washington), where a Caspian tern colony was preying heavily on Upper Columbia River steelhead. IAPMP implementation Phase I actions in 2014 by the Corps and Reclamation focused primarily on dissuading Caspian terns from Goose Island through use of rope, flagging, and active hazing, and developing Caspian tern nesting habitat at the U.S. Fish and Wildlife Service (USFWS) Don Edwards National Wildlife Refuge (San Francisco Bay, California) to enable subsequent implementation of IAPMP Phase II dissuasion actions in 2015 at Crescent Island in McNary Reservoir on the Columbia River.

Implementation of the IAPMP is already yielding encouraging results. Management efforts in 2014 reduced the Goose Island colony predation rate on Upper Columbia River steelhead from a 2007-2013 average of 15.7 percent to 2.9 percent in 2014, and the predation rate on listed Upper Columbia River Spring Chinook from a 2009-2013 average of 2.6 percent to 0.5 percent in 2014 (Roby et al. 2015).

The Corps' avian deterrent program at the 8 lower Columbia and lower Snake River hydroelectric facilities continued to be addressed through the Fish Passage Operations and Maintenance group and was included in the Fish Passage Plan as called for by the RPA.

Northern Pikeminnow

Large northern pikeminnow are predators 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 2014, the BPA monetary reward for the catch of this predator was sustained at a higher level than first 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 6,424 northern pikeminnow were caught at those locations in 2014.

In 2014, the exploitation rate on northern pikeminnow was 11.5 percent. This rate was based on a numerical catch of 170,482 from the sport reward and dam angling fisheries.

The NPMP has removed more than 4 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 3 to 5 million juvenile salmon annually that otherwise would have been eaten by this predator.

Sea Lions at Bonneville Dam

In recent years, California and Steller 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 on adult spring Chinook salmon, winter steelhead, Pacific lamprey, and white sturgeon. Initially, sea lions would arrive at Bonneville in middle to late February, and leave by the first week in June. However, in recent years some Steller sea lions have started to arrive during the fall months to prey upon adult fall Chinook and coho salmon, steelhead, and white sturgeon.

Corps biologists began gathering data on sea lion presence and predation at the dam in 2001. In 2014 the total number of pinnipeds at Bonneville Dam was essentially the same as in 2013, but the number of California sea lions increased by 15 from 2013, while the number of Steller sea lions dropped by an equal

Photo of sea lion with salmon

amount (Figure 44). The number of fish eaten by sea lions reached an initial peak in 2010 (Table 6). In 2014 estimated consumption was 4,314 (about 2.0 percent of all salmonids counted at Bonneville Dam from January 1 through May 31). Salmon and steelhead consumption by Steller sea lions has increased in the last several years, with Stellers responsible for approximately half of the total consumption in 2013. In 2014 the expanded estimate of salmonid consumption by Stellers was 1,699, or about 39 percent of the total.

As called for by RPA actions 49 and 69, the goals for the Corps' pinniped program are 1) annual installation of devices to keep sea lions out of fish ladder entrances; 2) providing hazing efforts; 3) monitoring the number of sea lions present and their consumption of salmon, steelhead and other fish; and 4) evaluating the effectiveness of hazing and other deterrent measures.

In 2014, the Corps again contracted with U.S. Department of Agriculture (USDA) Wildlife Services to harass sea lions away from fishways and other dam structures, as they have each year since 2006. Dam-based harassment began each year in March and was conducted daily through the end of May. Harassment involved a combination of acoustic, visual, and tactile non-lethal deterrents, including above-water pyrotechnics (cracker shells, screamer shells, or rockets), rubber bullets, rubber buckshot, and beanbags. Also since 2006, sea lion exclusion devices (SLEDs) have been installed annually at Bonneville Dam's 12 primary fishway entrances to prevent sea lions from entering the fishways. The SLEDs feature 15.38-inch (39.05-centimeter) gaps that are designed to allow fish passage. Floating orifice gates are also equipped with similar barriers.

In 2014, the Action Agencies again supported boat-based harassment conducted by the Columbia River Inter-Tribal Fish Commission

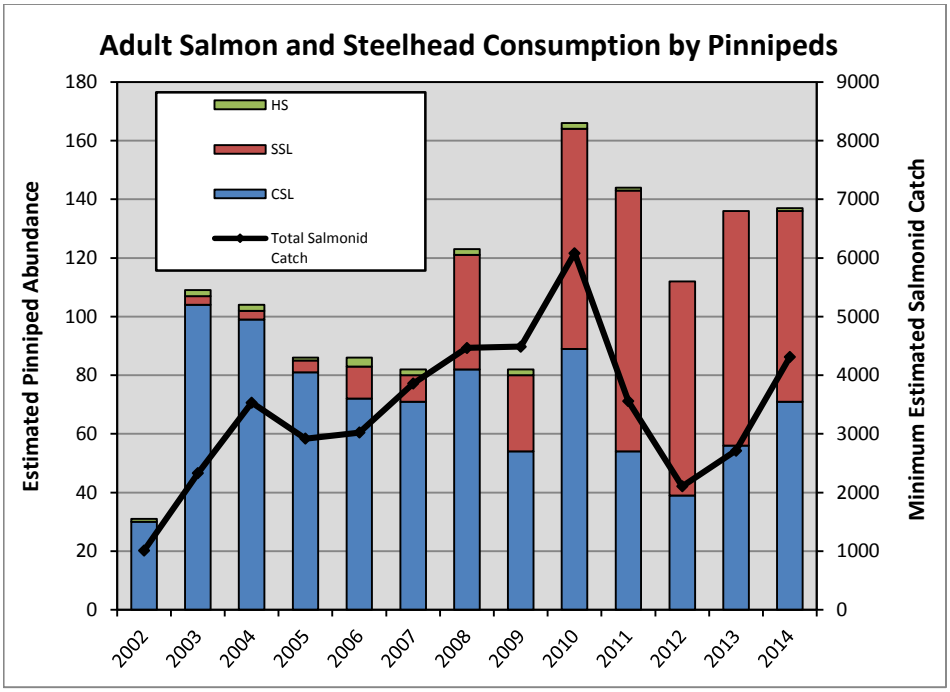


Figure 44. Estimated minimum number of adult salmon and steelheads consumed by pinnipeds and estimated total number of pinnipeds seen at Bonneville Dam January 1–May 31, from 2002 to 2014. In 2005, regular observations did not start until March 18. Pinnipeds observed included California sea lions, Steller sea lions, and harbor seals. Data from Stansell et al. 2014.

Year	Bonneville Dam salmon and steelhead passage (Jan. 1–May 31)	Expanded salmon and steelhead consumption estimate		Adjusted salmon and steelhead consumption estimate	
		Estimated consumption	Percent of run (Jan. 1–May 31)	Estimated consumption	Percent of run (Jan. 1–May 31)
2002	284,732	1,010	0.4	1,010	0.4
2003	217,934	2,329	1.1	2,329	1.1
2004	186,771	3,533	1.9	3,533	1.9
2005	81,252	2,920	3.6	2,920	3.4
2006	105,063	3,023	2.9	3,520	3.4
2007	88,474	3,859	4.4	4,507	5.1
2008	147,558	4,466	3.0	5,099	3.5
2009	186,056	4,489	2.4	5,134	2.8
2010	267,127	6,081	2.3	6,542	2.4
2011	223,380	3,557	1.6	3.970	1.8
2012	171,665	2,107	1.2	2,382	1.4
2013	120,619	2,714	2.3	2,954	2.4
2014	219,929	4,314	2.0	4,746	2.2

Table 6. Consumption of Salmon and Steelhead by California Sea Lions, Steller Sea Lions, and Harbor Seals at Bonneville Dam, from Surface Observations Conducted Between 2002 and 2014. Total salmon and steelhead passage counts include all adult salmon and steelhead 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. Data from Stansell et al. 2014.

(CRITFC). The Corps granted access to the Bonneville Dam boat restricted zone but, given concerns about human and fish safety, harassment was not allowed within 30 meters of dam structures or within 50 meters of fishway entrances. The use of "seal bomb" deterrents was prohibited within 100 meters of fishways, collection channels, or fish outfalls for the Powerhouse 2 corner collector and smolt monitoring facility. Boat crews ceased use of seal bombs inside the boat restricted zone after adult salmon and steelhead passage exceeded 1,000 fish per day. Corps biologists coordinated with USDA agents and boat-based crews from Oregon Department of Fish and Wildlife (ODFW), Washington Department of Fish and Wildlife (WDFW), and CRITFC on all sea lion harassment activities at Bonneville Dam to ensure safety and increase the effectiveness of harassment efforts.

In 2014, ODFW and WDFW operated four floating sea lion traps at Bonneville Dam at various locations across the season. All Stellers captured were released as soon as possible without further handling. A number of Californias, already branded, were recorded and released without further handling. Another 21 Californias were branded and released. The remaining 15 Californias, having been trapped in previous years and on the authorized list for permanent removal from the population, were euthanized by state entities.

Research, Monitoring, Evaluation, and Adaptive Management

The Action Agencies spend tens of millions of dollars each year on a robust Research, Monitoring, and Evaluation (RME) Program. This program generates data critical to improve action efficiency and effectiveness through adaptive management, and supports accountability for BiOp action implementation. The Action Agencies use the best available scientific information from this program to help ensure that actions meet the BiOp goals and performance standards.

RME is implemented through BPA's Fish and Wildlife Program, the Corps' Anadromous Fish Evaluation Program, and Reclamation's technical assistance activities. The Action Agencies coordinate with other state, federal, and tribal aquatic habitat and ESA-listed salmon and steelhead monitoring programs, and state and tribal constituents through the Pacific Northwest Aquatic Monitoring Partnership.

The Action Agencies carry out RME for fish population status, hydropower, tributary habitat, estuary/ocean, harvest, hatchery, predation, and regional coordination and data management. Work implemented and key lessons learned in 2014 are summarized below.

Refer to Section 2 of this APR for a complete list of Action Agency funded RME projects that are summarized in the significant results sections below. Additional project details, sponsor reports, and a PDF compilation of all 2014 RPA subaction reports can be found at:

http://www.cbfish.org/BiologicalOpinionAction.mvc/Index/2014/BiOpRpaStatus.

Fish Population Status Monitoring

The fish population status and trend monitoring program looks at 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 and species needed to assess progress on BiOp performance targets and contingency triggers. Fish population status is an important indicator in prioritizing and evaluating tributary and estuary restoration actions, hatchery management actions, predation management, and hydropower actions.

The fish population status and trends monitoring RPA actions primarily focus on natural-origin spawner abundance in spawning streams and tributaries ("fish-in"), juvenile fish abundance in spawning and rearing areas at various life stages ("fish-out"), and adult and juvenile salmon passage and survival through the hydro system.

Significant Results

- Natural Escapement: Since 2001, natural-origin adult escapement trend has increased for many species (see Figures 3–9) (BPA Project 1983-350-03).
- Fall Chinook: Snake River fall Chinook have exceeded NOAA's 10-year geometric mean viability abundance threshold of 3,000 natural spawners, with a 10-year geomean of 9,084 natural-origin spawners. In 2014, a total of 73,045 fall Chinook salmon were counted at Lower Granite Dam (LGR), including estimates of 17,858 natural-origin and 55,187 hatchery-origin fish. This is the second highest count since the construction of the Snake River dams (BPA Project 1983-350-03).
- Steelhead: For many populations there have been increases in natural production of out-migrating steelhead. The Hood River population has met or exceeded natural-origin fish objective 8 times since 1994 (BPA Project 1988-053-04).
- Carrying Capacity: Density dependence and limits to carrying capacity for species continue to be documented for many populations (BPA Projects 1990-055-00, 2003-017-00 & 1989-024-01). NOAA noted these effects in their analysis in

the 2014 Supplemental BiOp. Mapping the variations across systems may help prioritize habitat restoration opportunities where habitat form and function are limiting production.

- Stray Spawners: The proportion of hatchery-origin spawners straying into natural spawning areas for some populations remains high. For some, like the Asotin steelhead population, the proportion of out-of-basin strays make up the largest proportion of spawners (BPA Project 2002-053-00). This suggests that there may be room for adaptive management of fishing seasons or hatchery practices.
- OBMEP: The Okanogan Basin Monitoring and Evaluation Program (OBMEP) continues to provide adult spawning maps to guide restoration opportunities. Snorkel surveys are documenting that the majority of non-native piscivores are smallmouth bass (BPA Project 2003-022-00 OBMEP).
- Life-cycle Modeling: In the Yakima River, an increased proportion of PIT tag sampling compared to radio-tagged fish may be yielding more accurate spawner escapement estimates. The instream PIT tag arrays have allowed sponsors to collect demographic and life history data at the population scale, which is critical for estimating the productivity and diversity of Viable Salmonid Population (VSP) parameters. This type of data will not only improve our understanding of physical habitat and biological relationships needed for determining life-stage specific limiting factors, but also assist with life-cycle modeling efforts and prioritization of habitat restoration actions (BPA Project 2010-030-00).
- Fry Emergence: The USFWS and the U.S. Geological Survey (USGS) collaborated to monitor timing and abundance of early life stages of fall-run Chinook in the Snake River from 1992–2014. Fry emergence is relatively stable between years, but occurs earlier in the warmer upper reaches of the Snake than in the cooler lower reaches. Parr generally started appearing earlier in the year and mean parr weight decreased as overall fish densities increased from periods of lower abundance (1992–1999) to higher abundance (2000–2014), providing further evidence for density-dependent phenotypic changes to subyearlings (BPA Project 1991-029-00).

Hydro RME

RME actions are conducted in the FCRPS to evaluate compliance with survival and performance standards prescribed in the BiOp as well as to provide a record of status and trends for population level indices including, juvenile dam survival, smolt survival in-river and adult passage survival. RME also assess the effectiveness of management actions, such as transportation, surface passage operation and spill levels, as well as addressing critical uncertainties such as evolving life history strategies for fall Chinook and issues related to latent mortality.

Significant Results

- Mainstem Overwintering: Estimates indicate that 8–33 percent of all returning adult Snake River steelhead overwinter in the mainstem Snake and Columbia rivers. Late migrating steelhead have a higher probability of overwintering in the mainstem. Generally, mainstem overwintering appears to be most prevalent in Lower Granite, Little Goose, and McNary reservoirs. Results indicate that harvest of these fish is low and survival is estimated to be near 93 percent (Keefer et al. 2014).
- Spring Transportation and In-river Migration Comparison: The NOAA Fisheries NW Fisheries Science Center and the Comparative Survival Study (CSS) both updated their estimates of relative returns of adult spring migrating salmon and steelhead based on whether they were transported or left to migrate in-river. The CSS estimated smolt-to-adult return (SARs) rates for cohorts of wild Chinook and steelhead from 1994–2011 which were either transported from the lower Snake River, or migrated in-river. The ratio of survival rates for transported vs. in-river groups (TIR) shows that on average, wild Chinook benefit from transport when Lower Granite-to-Bonneville in-river survival rates are below 55 percent, and wild steelhead benefit when in-river survival is below 73 percent. Like the CSS results, NOAA Fisheries' data showed similar benefits but as discussed earlier in the hydro summary of this report separated those results into TIR ratios on a weekly basis rather than season wide averages like those produced by the CSS.
- Transportation of Snake River Fall Chinook: The effects of transportation on Snake River fall Chinook salmon are also being evaluated by the CSS and by NOAA Fisheries. Final analysis is still awaiting the return of all adult Chinook salmon that were tagged for the study as juveniles. Preliminary results from the 2014 CSS report show that the benefit to fall Chinook is variable between years, release location, and hatchery/wild status. NOAA analysis comparing SARs of Snake River fall Chinook that outmigrated through bypass systems at the dams to SARs of fish that were transported are showing that the timing of migration and transport is important. In general, the bypassed fish had higher survival relative to transporting juvenile fall Chinook salmon prior to June 15. However, after that

date the transport strategy produced higher SARs than fish which were collected and returned to the river (Smith et al. 2014).

- Delayed Mortality: The 2014 Comparative Survival Study considered the effects of spill above the current Washington and Oregon gas standards on returning adult salmon from the Snake River which was the basis for a high spill test proposed by the state of Oregon. The Independent Scientific Advisory Board (ISAB) reviewed the CSS information as well as other relevant considerations and did not recommend the study for implementation in 2014 (ISAB 2014). NOAA also considered this information from the CSS during the preparation of the 2014 Supplemental BiOp and like the ISAB, identified several technical and logistical issues that would need to be addressed prior to initiating a test, and did not recommend a test of spill levels above the current gas caps.
- Kelt Passage: In 2014, the Action Agencies continued to evaluate downstream survival of steelhead kelts. Balloon tag studies of adult steelhead at McNary Dam in 2014 indicate that surface weirs provide a safer passage route than turbines at that site. Fish released through the temporary surface weir survived at significantly ($p < 0.05$) higher rates (97.7 percent) than counter-parts released through a turbine (90.7 percent). Correspondingly, injury rates were higher and more severe in turbine passed fish (Normandeau 2014).
- Kelt Reconditioning: Preliminary results show increasing reconditioning success rates as the programs continue to develop in the Upper Columbia and the Snake River basins. Evidence also suggests that fecundity is either maintained or increased in repeat spawning. For example fertilization rates as well as juvenile growth measures were similar between maiden and repeat spawnings. In addition, preliminary parental based tagging results reveal that reconditioned fish that are released to spawn naturally are contributing to improved adult returns.

Tributary Habitat RME

The Tributary Habitat Research Monitoring and Evaluation program is identifying factors that limit fish survival (limiting factors) and the effect that habitat actions have on fish survival and productivity. Habitat monitoring further serves as baseline monitoring to understand the effects of climate change on species. Information collected is used to identify and prioritize habitat improvement projects and substantiate progress toward targeted benefits for specific fish populations. Work completed in intensively monitored watersheds (IMWs, BPA Project 2013-017-00) and fish population monitoring, as well as work completed in the Integrated Status and Effectiveness Monitoring Program (ISEMP 2003-*017-00*) and Columbia Habitat Monitoring Program (CHaMP 2011-006-00), continue to conduct evaluations and modeling that provide quantitative support for habitat planning and assessment needs for the duration of the BiOp. In addition, project level habitat action effectiveness monitoring continues to assess project benefits and support implementation planning.

The status and trend monitoring from these multiple projects identifies and tracks habitat and fish conditions. Action effectiveness research assesses the effects of habitat actions on habitat and fish condition. Both status and action effectiveness monitoring and research are used to develop and support fish habitat relationships.

Summaries of tributary habitat research and monitoring demonstrate the importance of freshwater habitat for various life stages of salmon, the negative impacts of human activities on habitat quality and salmon carrying capacity and growth, relationships between habitat and fish, the significance of habitat improvements in light of climate change, and the effects related to specific actions (Roni et al. 2014, BPA 2014, ISAB 2007, NMFS 2014).

Significant Results

- Intensively Monitored Watersheds: Throughout the Columbia River Basin, monitoring of habitat actions and fish habitat relationships (like the Bridge Creek IMW and the Grande Ronde Life Cycle Model process) indicate that projects are improving tributary spawning and rearing habitat, and improving growth, survival and spatial structure for numerous populations of salmon and steelhead (ISEMP/CHaMP 2015).
- Watershed Models: The ISEMP Watershed Production Model is proving to be a useful tool for evaluating the potential outcome of completed habitat restoration actions and identifying suites of restoration actions that could achieve targeted increases in salmon and steelhead productivity. Currently, the watershed model is being used in the Lemhi to examine potential restoration scenarios and actions that would meet or exceed survival targets in the basin for spring/summer Chinook. The watershed model is also being used in the Secesh, John Day, Wenatchee, and Entiat sub-basins to test its exportability to other regions (BPA Project 2013-017-00).
- Bridge Creek: In Bridge Creek, a watershed in the John Day Basin, simple, inexpensive habitat improvement actions have restored floodplain processes that result in increased base flow, increased groundwater elevation, lower

groundwater and surface water summer temperatures, decreased sediment loads, and increased habitat complexity (i.e., more frequent and deeper pools). In turn, these habitat changes have led to increased density, growth, production, and survival of juvenile steelhead, compared to a reference stream. In most cases, steelhead responses to habitat changes were large. Work in 2014 by CHaMP and ISEMP showed that installation of instream support structures led to the building of beaver dams on over half of the support structures installed, as well as a 300% increase in the number of natural beaver dams within the study area. Results demonstrate the positive effects of beaver dams on significantly reducing instream incision. Future evaluations in the Bridge Creek watershed will include evaluating smolts per spawner, SARs, and spawner-to-spawner ratios (BPA Project 2003-017-00).

- Lemhi River: In Idaho's Lemhi River Basin, establishing minimum flow targets and removing fish migration barriers have reconnected six tributaries with the mainstem Lemhi River. Adult steelhead are spawning and juvenile steelhead and spring/summer Chinook salmon now occupy these tributaries. Monitoring indicates that improving fish passage and instream flow conditions within the basin increases habitat capacity for Chinook salmon and steelhead. Results from the Little Springs Restoration Project show important changes in Lemhi populations due to restoration actions, including a 50 percent increase in juvenile Chinook survival over multiple years (BPA Projects 2003-017-00 and 2011-006-00).
- Fish Screens: In the Lemhi River, a 15-year effort to install fish screens in irrigation diversions has reduced the stranding of out-migrating juveniles from an estimated 71 percent to less than 2 percent, preserving tens of thousands of naturally spawned juvenile salmon (BPA Project 2003-017-00).
- Stream Flows: Research and monitoring in the Middle Fork Salmon and the Okanogan rivers shows that Chinook and steelhead population productivity increases as summer minimum streamflow increases. This supports ongoing mitigation efforts to improve stream flows (BPA Project 1990-055-00).
- Habitat Models: In the Grande Ronde River Basin, models are being developed that predict habitat conditions from restoration actions, and also predict fish and macroinvertebrate responses from habitat conditions. These models will feed into a Chinook salmon life-cycle model that will simulate fish population trends in relation to projected habitat conditions. That model will also examine the relative benefits of habitat improvements on fish population recovery potential. Results so far demonstrate that juvenile fish densities respond positively to habitat improvements, while also reflecting the need to address environmental conditions. For example, in the upper Grande Ronde, CRITFC has demonstrated that overall juvenile fish rearing densities were positively influenced by habitat complexity such as large wood and pools, but that densities also decreased in the period 2011-2014 which corresponded with a period of increasing water temperatures. Outside the Grande Ronde, other habitat modeling work and coordination has demonstrated correlation among methods that predict factors limiting carrying capacity for fish, namely compatibility and similarity of results from ISEMP's quantile regression forests (QRFs) with CHaMP NREI (Net Rate of Energy Intake) modeling, CHaMP Habitat Modeling, and data collected by collaborators in the Upper Columbia (BPA Project 2009-004-00).
- Grande Ronde Atlas: The Grande Ronde Model Watershed is applying a comprehensive project selection tool called the Atlas to inform restoration planning. The spatial distribution of spawning and fish use by juveniles relative to habitat quality is a key component of this tool. The ODFW's HabRate Model and CHaMP data were used to inform the project and support validation of limiting factor maps to guide development of the Atlas (BPA Project 2007-083-00).
- Entiat River: In the Entiat River Basin, habitat restoration actions designed to increase channel complexity and floodplain reconnection are being implemented under the guidance of the monitoring plan. Monitoring results in 2014 indicate that actions implemented in 2012 had local, positive effects on Chinook salmon and steelhead growth and abundance, though not all side channels demonstrated the same results. ISEMP and CHaMP combined Entiat IMW results illustrate that pool frequency and depth and the amount of large wood in the river are significantly greater post-restoration in the areas of restoration treatment. Furthermore, estimates of over-winter survival probabilities for juvenile steelhead and Chinook showed a significant increase in survival post-restoration in the area of the river receiving restoration actions. Responses at the reach and population scales will be assessed as restoration actions move through implementation. Further work will occur to evaluate the effectiveness of different

treatments (BPA Projects 2003-017-00 / 2011-006-00).

- Implementation Monitoring: In the Methow River, initial monitoring data show higher local juvenile population estimates for both juvenile Chinook and steelhead after construction of the Whitefish Island side channel project (Martens et al. 2014). In addition, Reclamation funded USGS to continue construction and testing of ecological models to evaluate the success of tributary habitat improvements for ESA-listed salmon and steelhead in the Methow River Basin. Results suggest an increase in local fish productivity associated with restoration. The model results and field data represent independent lines of evidence that habitat complexity projects are improving salmon and steelhead production and capacity.
- Limiting Factors: In the Okanogan River Basin, the Ecosystem Diagnostic and Treatment (EDT) model is identifying potential limiting factors and expected fish responses. Output from the model is being used to evaluate VSP recovery criteria, manage hatchery integration, and inform the expert panels. In addition, results are being used to develop, prioritize, and evaluate restoration actions, including the protection of high-quality habitat, restoring connectivity, improving stream flows, and reducing sediment recruitment in several tributaries to the Okanogan River. EDT modelers are effectively using network maps of fish use and habitat impairments monitoring results from the OBMEP (BPA Project 2003-022-00).
- Data Sharing: CHaMP and the U.S. Forest Service's PACFISH/INFISH Biological Opinion (PIBO) monitoring program have been working together to develop ways to share data and to develop common habitat metrics between the two programs. Efforts included expanding the CHaMP database to store and process PIBO metrics. So far, the programs have focused on interchanging stream temperature, pool frequency, and large woody debris frequency. Other metrics will be evaluated in the future. Successful completion of this effort illustrates the compatibility of large scale habitat monitoring programs in the Columbia River Basin and opens the door to inclusion of other habitat data sources.

Estuary and Ocean RME

Research in the Columbia River estuary, plume and ocean improves our understanding of how conditions affect salmon and steelhead survival. The Action Agencies continue to work with the Expert Regional Technical Group and other experts to integrate RME findings into restoration project design and selection. Findings help inform management habitat strategies by indicating what actions have the greatest potential to improve juvenile survival and productivity.

Significant Results

- Prey Foraging: A relatively high prevalence of a marine-estuarine nematode which uses an estuarine amphipod as an intermediate host was found in Chinook salmon that migrated as yearlings (i.e., as "stream-type" juveniles). Since the fish could have been infected with the nematode only by eating amphipods exposed to salt/brackish water, this demonstrates that the Columbia River estuary is used for foraging by stream-type Chinook salmon juveniles (BPA Project 1998-014-00).
- Monitoring: Estuary habitat improvement project sponsors began to implement the Action Agencies' Action Effectiveness Monitoring and Research (AEMR) plan in 2014, with the objective of determining the ecological success of estuary restoration actions at the site, landscape, and estuary-wide scales. While data are still preliminary, this effort represents a coordinated approach by multiple agencies to address the primary hypotheses in the estuary: fish- and habitat-based indicators (Johnson et. al. 2012) show positive effects from restoration actions. In 2014, 10 sites received level 3 AEMR monitoring, which includes evaluation of water surface elevations (a predictor of access by juvenile salmon and connectivity with the mainstem), sediment accretion, temperature, and photo point monitoring. Another 5 sites received level 2 monitoring, which adds vegetation, prey, and in some cases PIT detection (level 1) to the level 3 metrics.
- Competition: Hatchery and wild individuals from stocks located throughout the Columbia River were shown to be present in the estuary at the same time, resulting in the potential for competition between hatchery and wild salmon (Roegner et al. 2015).
- Avian Predators: Common murres and sooty shearwaters consistently exhibit high densities between Cape Meares, OR, and Grays Harbor, WA, during May and June. Therefore, even though absolute abundance of birds varies between months and years, the abundance of these potential predators on juvenile Chinook, sockeye, and steelhead is always greatest in this region. If predator abundance is a direct indicator of predation risk, then predation risk to juvenile salmon and steelhead is highest in this region during May and June (Zamon et al. 2014).

- Migration Timing: Large variation in salmonid species composition and biomass were found within season and between years. Salmon migration patterns were largely consistent over time and narrow for subyearling runs of chum salmon and yearling runs of Chinook and coho salmon. In contrast, subyearling Chinook salmon were present year-round and exhibit more variability in peak migration timing (Roegner et al. 2015).
- Preferred Habitats: Studies revealed a diversity of species and stocks, including individuals from the interior basin, using emergent, scrub-shrub, and forested wetland habitats (Roegner et al. 2015).
- Shallow Water Habitat Use: A substantial number of unmarked, wild fish were found in shallow water habitats near the mouth of the Columbia River. Yearling Chinook and coho salmon were primarily hatchery derived, while subyearling Chinook salmon were a mix of hatchery and wild fish, and most chum were naturally produced (Roegner et al. 2015).

Harvest RME

In 2014, 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.

Significant Results

- Selective Gear: The Action Agencies continued to fund the development and implementation of selective fishing gear for harvesting anadromous salmon and steelhead in the Columbia and Okanogan rivers (BPA Project 2008-105-00).
- Selective Harvest: In 2014, the Colville Confederated Tribes select harvest yielded a total of 25,117 salmon and steelhead. This study also showed that 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 Okanagan rivers and Lake Osoyoos (BPA Project 2008-105-00).
- PIT Tags: Harvest managers were again able to collect PIT tag data from commercial catch in 2014, thus improving interrogation techniques and better informing harvest managers of stock composition of catch and impacts by gear (BPA Projects 2008-502-00 and 2010-036-00).

Hatchery RME

Hatchery RME in 2014 included project implementation monitoring, status and trend monitoring, action effectiveness research, and critical uncertainty research.

Implementation Monitoring

- Hatchery Monitoring: Hatchery programs continue to document and report on the number and origin of broodstock trapped, numbers of fish spawned, eggs taken, and other important metrics, such as survival from egg to release. They also continue to collect information on life stage survival within the hatchery and other information, such as disease occurrence, tagging rates, and numbers released. This information helps tracks compliance with hatchery biological opinions and helps address hatchery best management practices (e.g. BPA Projects 1998-007-02, 1998-007-03, 1998-007-04, 2007-402-00).
- Status and Trends: Many of the hatchery evaluation projects continued to collect the VSP parameters; abundance, productivity, spatial structure and diversity for both natural- and hatchery-origin fish (e.g. BPA Projects 1996-043-00, 1998-007-02, 2010-050-00). Hatchery programs collect this information to validate whether a conservation hatchery program is successfully enhancing the natural target population. In addition, for comparative purposes, some studies collect VSP information on populations that have no hatchery programs (BPA Projects 1995-063-25, 1998-016-00, 1997-030).
- Hatchery and Wild Interaction: Several studies continue to observe a general reduction in smolts-per-spawner at higher spawner numbers, indicating a density dependent relationship. Information on density dependent effects on juvenile production could affect regional discussions on both the benefits of habitat improvements to reduce density dependence and on the balance between hatchery and wild fish in a particular watershed (BPA Projects 1991-029-00, 1992-026-04 and 1998-007-02).
- Genetic Diversity: Information collected on the genetic diversity of various populations shows that, in general, genetic diversity of natural populations has not been notably affected by the hatchery projects (BPA projects 1989-096-00, 2010-031-00). However, in one study, researchers found that while the natural-origin population had fairly stable allele frequencies and genetic variability, the hatchery-origin population showed significant genetic drift and high variability in allele frequencies among years (BPA Project 2003-063-00).

Action Effectiveness Research

- Two Year Rearing: Hatchery reform research is investigating whether rearing steelhead juveniles from local broodstock for two years, instead of the usual one year, increases the likelihood that smolts better match the life-history characteristics of natural steelhead populations in the Methow River, including smolt development at the time of release and proportion of residuals (non-migrants). In addition, laboratory experiments of one- and two-year old steelhead smolts complement the applied hatchery production research. Preliminary results suggest that, as predicted, residualism in the two year rearing strategy was lower than in the one year rearing. In addition, survival and travel time through the hydrosystem was generally higher and faster for fish raised for two years (BPA Project 1993-056-00).
- Smolt Growth: Hatchery reform research is investigating whether growth modulation for hatchery programs can reduce the number and percentage of early-maturing Chinook hatchery fish after release. Previous findings show there is a higher rate of early maturation in hatchery fish than in natural-origin fish. Results indicate that increased growth rates during certain rearing periods is one contributor of early maturation of primarily male juvenile fish (i.e. jacks, "micro-jacks", and "mini-jacks"). To date, the results suggest that smaller yearling smolts can be successfully reared without a detrimental effect on smolt development. The project continues to collect returning adult data and future findings should help inform the management and optimization of rearing regimes in fall Chinook hatchery programs employing the yearling release strategy.
- Natural-Origin Improvements: Hatchery reform actions in the Tucannon River basin involve the use of local broodstock to improve return rates to natal tributaries and reduce the genetic influence of out-of-basin stocks and genetic introgression that could reduce the viability of naturally produced populations. Another study is monitoring the application of the sliding scale management tool for spring Chinook salmon disposition in Catherine Creek. Challenges noted to date include in-season changes to weir management. For example, broodstock collection percentages and wild:hatchery escapement ratios are made using pre-season forecasts and total returns to the tributary; however there can be error associated with these forecasts and it is difficult to make mid-season changes without affecting the run composition for both natural-origin spawners released above the weir and for broodstock collection (BPA Project 2002-031-00).

Critical Uncertainty Research

- Relative Reproductive Success: In general, relative reproductive success (RRS) studies have found that hatchery-origin fish reproduce at a lower rate than naturally produced fish. In a couple of projects (e.g., Chinook in Johnson and Catherine creeks) (BPA Projects 1996-043-00 and 1989-096-00), hatchery-origin fish reproduced at similar rates when measured at the parr/migrant juvenile life stage, but at lower rates when measured by returning adult offspring. The causes or mechanisms for lower relative reproductive success of hatchery-origin fish spawning in the wild continue to be investigated (e.g. BPA Projects 2003-039-00 & 2010-033-00). One study suggested high density rearing in the hatchery environment may contribute to lower RRS in steelhead (Hood River, BPA Project 2003-054-00). Another study in the Wenatchee River has found evidence that differential spawning locations for hatchery- versus natural-origin fish appears to be another factor (BPA Project 2003-039-00).
- Integrated Hatchery Programs: After three generations of study, research results in the Yakima River suggest that a well-designed and carefully managed integrated hatchery program using 100 percent natural-origin broodstock can produce fish for harvest and return fish to the natural spawning grounds with minimal negative impacts to the target ecosystem (BPA Project 1995-063-25).
- Genetic Tagging: Parental based tagging (genetic tracking) is continuing to show success in determining the proportion of hatchery-origin fish on spawning grounds). The information obtained through this program will also assist managers in estimating total run sizes of fish returning to areas where spawning ground estimates are difficult to obtain (BPA Project 2010-031-00).

Predation and Invasive Species Management RME

Predation RME studies were conducted to evaluate and monitor the northern 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. Action Agency management plans to address predation on juvenile salmon and steelhead and predator management projects also continued to include monitoring components to assess action effectiveness.

Significant Results

- Avian Predation Control: Implementation of the IAPMP is already yielding encouraging results. In accordance with the plan, dissuasion efforts and reductions in Caspian tern colonies are focused at strategic locations in the Columbia Plateau, with positive outcomes. For example, management efforts at Goose Island in Potholes Reservoir reduced predation on Upper Columbia River steelhead attributable to that colony from a 2007-2013 average of 15.7 percent to 2.9 percent in 2014, and the predation rate on listed Upper Columbia River Spring Chinook from a 2009-2013 average of 2.6 percent to 0.5 percent in 2014 (Roby et al. 2015).

- Northern Pikeminnow: Predation by northern pikeminnow is being successfully controlled, with significant ongoing salmon survival benefits. The multiyear index for estimating system-wide exploitation on northern pikeminnow greater than or equal to 250 mm fork length was calculated as 11.5 percent. The 2014 estimate was near the lower end of the range necessary to achieve project goals. Northern pikeminnow RME is conducted to measure interspecific compensation (small mouth bass and walleye responses) and intraspecific compensation (increased growth rate, fecundity, age-class recruitment in the remaining northern pikeminnow population) to see if there are any responses that offset the benefits we see from the Northern Pikeminnow Sport Reward Fishery Program (BPA Project 1990-077-00).

- Sea Lions: The Corps continued to monitor the effectiveness of predation management efforts on sea lions in the tailrace of Bonneville Dam. SLEDs continue to be effective at keeping sea lions from entering fishways. As in past years, hazing efforts moved some sea lions out of tailrace areas, but the animals typically returned shortly after hazers left the area (Stansell et al. 2014).

- Avian Predation Monitoring: A suite of avian studies continue to document predatory bird abundance, distribution, and movement patterns in the Columbia Basin. Tern populations have been decreasing in size, but nesting success has increased at some locations, whereas at East Sand Island nesting success has decreased over the decade. Double-crested cormorant populations have expanded and continue to have a major impact on juvenile salmon. System-wide, gulls have a minor impact on juveniles (Roby et al. 2015).

Regional Coordination, Data Management and Implementation

Federal, state and tribal partners work together to standardize and integrate their data collection and management efforts. This improves efficiencies and accessibility and exchange of data and allows for synthesis, or “roll up” of data that can identify trends and opportunities at the regional level.

Significant Results

- PNAMP: The Pacific Northwest Aquatic Monitoring Program continued to support method standardization and work with BPA project sponsors to document protocols, but found the quality of documentation of location and protocols varied among sponsors. Work continues to address these issues (BPA Project 2007-216-00).

- Data Exchange: The Coordinated Assessments process, led by StreamNet and PNAMP, continued to make progress on standard management and exchange of regional fish data. In addition to ongoing progress on VSP and juvenile out-migrant abundance metrics, the project made progress toward creating a data exchange standard for hatchery metrics. In addition, StreamNet formed an executive committee that is expected to prioritize development of new data exchange standards for high level indicators and ensuring resources are directed to priority datasets.

- Data Storage: StreamNet provided a list of recommended data repositories that states and tribes should use to store their fish data to ensure efficient storage, access and exchange.

- Data Standardization: Use of standardized metrics and creation of common database storage systems facilitated integration of CHaMP and BPA’s action effectiveness monitoring program. Standardization and creation of crosswalks between methods allowed for BPA’s CHaMP and the U.S. Forest Service PIBO programs to share summary metrics.

- Monitoring Forms: Standardization and methods, data entry forms and integration of technology allowed WDFW to create standard smolt monitoring forms that integrate with WDFW corporate systems and the PIT Tag Information System allowing rapid data sharing, and saved over a month’s time of employee data processing.

- Data Exchange: PNAMP’s Monitoring Explorer provided for sharing of key geographic information system layers from NOAA to the Grande Ronde restoration Atlas.

Working with the Region

Regional Forum

The Regional Forum process was developed in 1995 and has been employed by NOAA Fisheries, the Action Agencies and other federal agencies, and regional sovereigns to implement ESA provisions for protection 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 implementation authority in the Columbia River, including NOAA Fisheries, 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 middle Columbia public utility districts, also participate. The Regional Forum consists of the Regional Implementation Oversight Group (RIOG), and several technical workgroups, including the TMT, the System Configuration Team, the Studies Review Work Group, and the Fish Passage Operations and Maintenance Workgroup.

Regional Implementation Oversight Group

The RIOG was established in 2008 to provide sovereign policy review for the Columbia River Basin, bringing together federal, state, and tribal agencies with the common aim of salmon protection to discuss and coordinate implementation of the BiOp. The RIOG structure includes technical subgroups (e.g., the TMT) to support regional review. Through this structure, RIOG explores the issues relevant to the effects of the FCRPS on ESA-listed species and ensures that the new and emerging scientific data are identified, reviewed, and available to inform the agency decisions. In 2014, the Action Agencies met with RIOG on seven occasions to discuss, review, and coordinate on the 2014 FCRPS Supplemental BiOp, inland and estuary avian predation management, the Fish Operations Plan and spring and summer operations, AMIP triggers, performance standards test results, the 2013 Annual Progress Report, and the updated tributary habitat benefits paper.

In 2014 the RIOG requested the Senior Hydro Team to evaluate a proposal from the state of Idaho for modifying spring spill operations at Lower Monumental and Ice Harbor dams from April 3 through June 20. The Team carried out that evaluation, but did not recommend implementation of the proposal.

Columbia Basin Fish Accords

The Columbia Basin Fish Accords have established long-term agreements among the Action Agencies and 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 Reservation, the Shoshone-Bannock Tribes of Fort Hall, and the states of Idaho, Washington, and Montana. The Fish Accords strengthen the successful planning and implementation of actions under the BiOp, especially tributary and estuary habitat actions. These partnerships help accomplish “on-the-ground” implementation of actions that are beneficial to ESA-listed fish.

Northwest Power and Conservation Council Fish and Wildlife Program

Under the Northwest Power Act, the NPCC works to protect and mitigate 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 actions 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 Act calls for the NPCC to review the Program every five years. In 2013, the NPCC began a regionwide process to review the 2009 Program, and the most recent 2014 Program can be found at:

http://www.nwcouncil.org/fw/program/2014-12/program.

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Abbreviations and Acronyms

AEMR	action effectiveness monitoring and research
BiOp	FCRPS Supplemental Biological Opinions
BPA	Bonneville Power Administration
CEERP	Columbia Estuary Ecosystem Restoration Program
CHaMP	Columbia Habitat Monitoring Program
cfs	cubic feet per second
c.i.	confidence interval
COMPASS	Comprehensive Fish Passage
Corps	United States Army Corps of Engineers
CRE	Columbia River Estuary. Also refers to numeric designators for different restoration action types as assigned in NOAA Fisheries' Estuary Recovery Module
CREST	Columbia River Estuary Study Taskforce
CRITFC	Columbia River Inter-Tribal Fish Commission
CSS	Comparative Survival Study
CTUIR	Confederated Tribes of the Umatilla Indian Reservation
DPS	distinct population segment
EDT	ecosystem diagnosis and treatment
ESA	Endangered Species Act
ESU	evolutionarily significant unit
FCRPS	Federal Columbia River Power System
HGMP	Hatchery and Genetic Management Plan
IAPMP	Inland Avian Predation Management Plan
ISAB	Independent Scientific Advisory Board
ISEMP	Integrated Status and Effectiveness Monitoring Program
KMP	Kelt Management Plan
Maf	million acre feet
MPG	major population group
NMFS	National Marine Fisheries Service (also known as NOAA Fisheries)
NPCC	Northwest Power and Conservation Council
NPMP	Northern Pikeminnow Management Program
OBMEP	Okanogan Basin Monitoring and Evaluation Program
ODFW	Oregon Department of Fish & Wildlife
PDO	Pacific Decadal Oscillation
PIBO	U.S. Forest Service PACFISH/INFISH Biological Opinion
PIT	passive integrated transponder
PNAMP	Pacific Northwest Aquatic Monitoring Program
Reclamation	Bureau of Reclamation
RIOG	Regional Implementation Oversight Group
RME	research, monitoring and evaluation
RPA	Reasonable and Prudent Alternative
RRS	relative reproductive success
SBU	survival benefit unit

SAR	smolt-to-adult return ratio
SLED	sea lion exclusion device
TDG	total dissolved gas
TIR	transported vs. in-river survival ratio
TMT	Technical Management Team, a technical subgroup of RIOG
USDA	United States Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VSP	viable salmonid population
WDFW	Washington Department of Fish & Wildlife
WMP	Water Management Plan

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