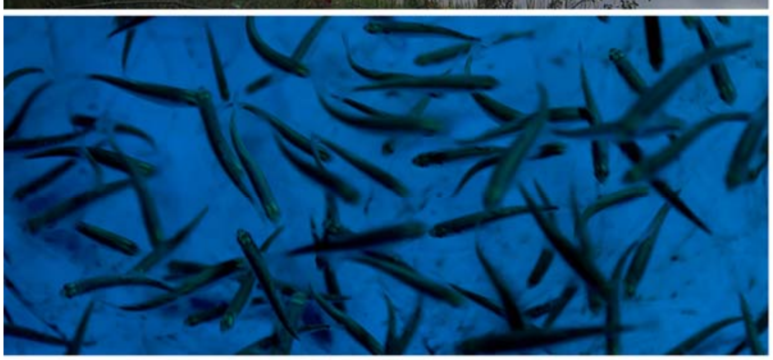
Endangered Species Act
Federal Columbia River Power System

2013 DRAFT
Comprehensive Evaluation
Section 1



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Introduction and Progress at a Glance

This Comprehensive Evaluation provides a thorough report of progress by the federal Action Agencies in carrying out the elements of the Biological Opinion (BiOp) for the operation of the Federal Columbia River Power System (FCRPS). It reflects an extensive regional effort to improve the survival of Columbia and Snake River salmon and steelhead throughout their life cycles.

The Columbia River Basin includes 13 evolutionarily significant units (**ESU**s) or distinct population segments (**DPS**s) of salmon and steelhead listed as threatened or endangered species under the ESA.

This report is required under the BiOp, issued in 2008 by the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries). The BiOp considered a Biological Assessment (BA) that included a suite of actions proposed by the Bonneville Power Administration (BPA), the Bureau of Reclamation (Reclamation), and the U.S. Army Corps of Engineers (Corps) (collectively referred to as the Action Agencies) to protect salmon and steelhead in the Columbia Basin (Figure 1). The BA provided scientific analysis under the Endangered Species Act (ESA) and proposed a Reasonable and Prudent Alternative (RPA) that NOAA largely adopted in its 2008 BiOp. The RPA consists of actions designed to avoid the likelihood of jeopardy to the fish and adverse modification to designated critical habitat by improving fish survival in areas including hydropower, habitat, hatcheries, and predator management.

On May 20, 2010, NOAA Fisheries completed the 2010 Supplemental BiOp, incorporating an Adaptive Management Implementation Plan (AMIP) into the FCRPS BiOp[1]. The United States District Court for the District of Oregon subsequently remanded the FCRPS BiOp to NOAA Fisheries with instructions to draft a new or supplemental BiOp by December 31, 2013. In the interim, it ordered for continued implementation of the existing RPA through the end of 2013. Therefore, this report summarizes the actions implemented by the Action Agencies from 2008 through 2012 to protect ESA-listed salmon and steelhead affected by operation of the FCRPS.

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

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

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

[1] *The 2008 FCRPS BiOp and 2010 Supplemental FCRPS BiOp are referred to collectively in this report as the FCRPS BiOp.*

In sum, the program of improvements outlined in the FCRPS BiOp is on track, although much work remains. The core of the program includes significant operation and configuration improvements at federal dams to increase salmon and steelhead survival through the system. Testing so far indicates that those improvements are increasing survival as projected. Hundreds of habitat improvements are underway across the Columbia River Basin and in the estuary, guided by the professional judgment of local biologists and other experts with the most immediate knowledge of the limiting factors affecting fish habitat. An extensive program of research, monitoring and evaluation provides further accountability by assessing the benefits of the FCRPS BiOp actions for fish and providing insight into how to make those actions most effective. That supports the adaptive management provisions of the FCRPS BiOp calling for the Action Agencies to learn as they go and adjust their actions to address new information.

The Action Agencies have not performed the described work alone. With Action Agency funding, Federal, state, tribal and local partner agencies and organizations have lent their energy and expertise to plan and complete many of the hundreds of BiOp actions outlined in this report. They deserve recognition for their contributions. Their involvement makes this a true regional effort.

The Columbia Basin Fish Accords epitomize the regional nature of this effort. These agreements – first signed in 2008 and since expanded – have brought together three federal agencies, seven Northwest Indian tribes, and three of the four Northwest states in a sweeping effort to protect and strengthen the basin's threatened and endangered salmon and steelhead populations. The Fish Accords provide dedicated funding over ten years and bring together the region's salmon managers. They put the focus where it belongs – on the well-being of the fish – and their results will continue to provide measurable and significant benefits for salmon and steelhead.

RPA Requirement for 2013 Comprehensive Evaluation

The Reasonable and Prudent Alternative in the NOAA Fisheries 2010 Supplemental Biological Opinion for the Federal Columbia River Power System calls for this Comprehensive evaluation by June 2013, with another due by June 2016.

Like the earlier Annual Progress Reports, this evaluation compares progress against scheduled completion dates. The requirement states:

"The Comprehensive Evaluations will also describe the status of the physical and biological factors identified in this RPA, and compare these with the expectations in the survival improvements identified in the Comprehensive Analysis or Supplemental Comprehensive Analysis. Physical and biological factors will include new information on climate change and its effects on listed salmon and steelhead. The Comprehensive Evaluation will include a discussion of the Action Agencies' plan to address any shortcomings of current estimated survival improvements as compared to the original survival estimates identified in the Comprehensive Analysis referenced in this Biological Opinion. This information will assist NOAA Fisheries in determining if the RPA is being implemented as anticipated in this Biological Opinion or, conversely, if re- initiation triggers defined in 50 CFR 402.16 have been exceeded."

This Comprehensive Evaluation is organized in three sections, each with increasing levels of detail. First, a series of tables provide an overview of progress “at a glance.” Section 1 includes RPA action implementation highlights and identifies findings that will inform future RPA action implementation. This section also presents information in formats requested by the federal-state-tribal Regional Implementation Oversight Group (RIOG). Generally, statements in Section 1 are supported by details and information in Section 2. Section 2 reports multi-year accomplishments on RPA implementation by action. Section 3 lists projects implemented through 2012 and includes completed habitat metrics.

The FCRPS 2013 Comprehensive Evaluation, which includes a Detailed Description of RPA Action Implementation (Section 2) and Project Tables for RPA Action Implementation (Section 3), is available online at http://www.salmonrecovery.gov. Previous FCRPS progress reports and information on other salmon and steelhead protection efforts are also available at *http://www.salmonrecovery.gov/BiologicalOpinions/FCRPSBiOp/ProgressReports.aspx*.

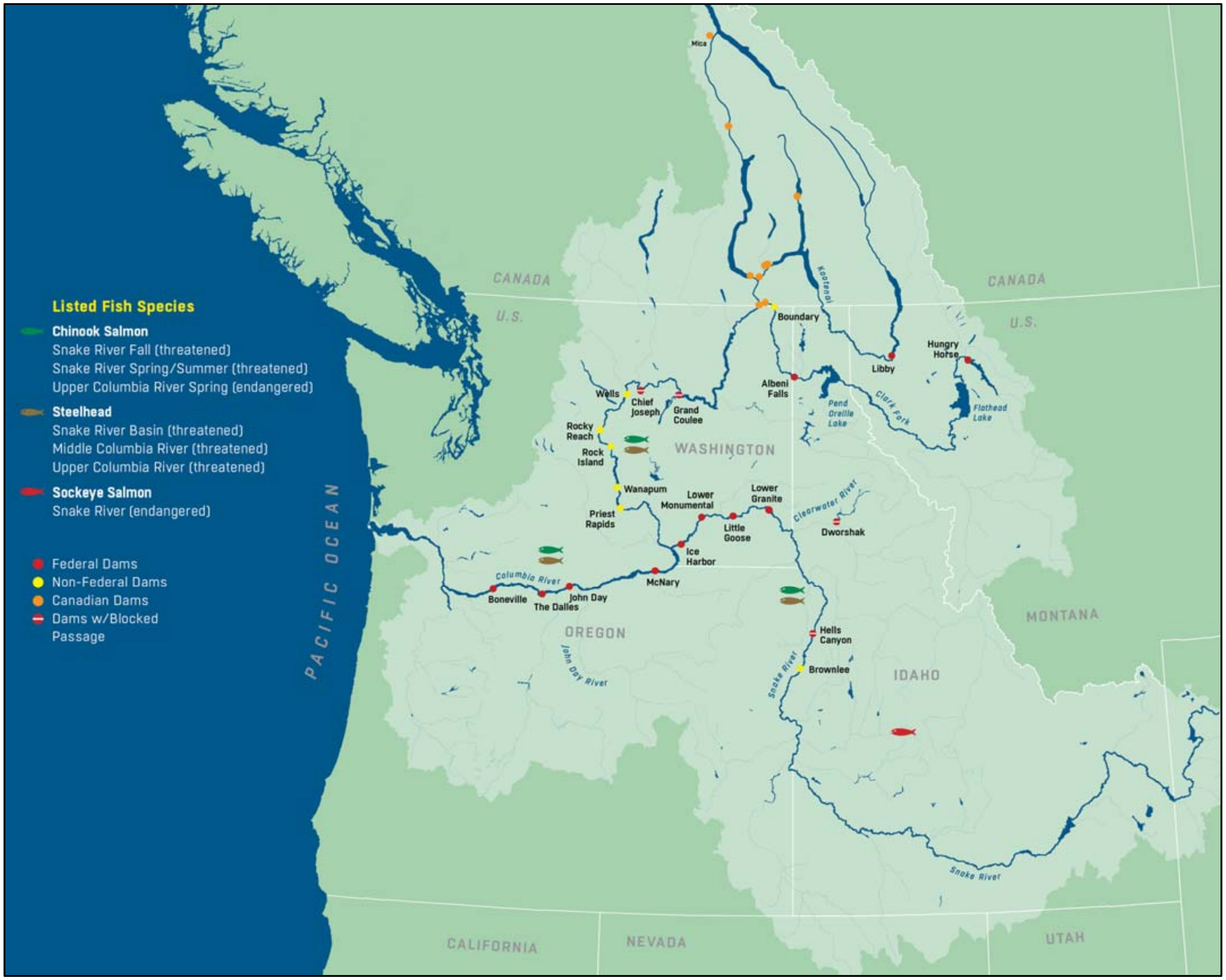

Figure 1. Map of the Columbia River Basin Showing Action Areas, Dams, and Listed Species.

2008-2012 Progress at a Glance

Goals	Accomplishments
HYDROSYSTEM	
Increase the survival rates of fish passing through the hydrosystem: • Manage water to improve juvenile and adult fish survival.	Storage projects were operated year-round to support passage of ESA-listed salmon and steelhead, while meeting flood control requirements and balancing multiple priorities such as resident fish requirements, refill and other ecosystem and public needs. Annual and in-season operations were coordinated with regional forums that included state and tribal representatives. The Corps managed the release of water from Dworshak Reservoir to moderate temperature in the Snake River during the summer to improve conditions for fish. This kept the tailwater temperature at Lower Granite Dam at or below 68 degrees with only a few hourly exceptions in 2009, 2011 and 2012. Operations have improved river conditions for listed species as demonstrated through improved in-river survival in recent years. Fish operations draw on up to 5 million acre feet of stored water, depending on the water year. Juvenile salmon benefited from higher peak flows and flow patterns that more closely resembled conditions prior to the FCRPS. Each year, BPA and BC Hydro successfully negotiated arrangements for 1 million acre feet of water for flow augmentation from Treaty storage reservoirs in Canada, included in the 5 million acre feet referenced above. In addition, in 2012 BPA and BC Hydro signed an agreement providing for long-term coordination and use of non-Treaty storage, providing additional operating flexibility beyond the already allocated storage space to shape flows for listed fish.
• Configure dam facilities to improve juvenile and adult fish passage.	The Corps has made numerous configuration improvements at Snake and Columbia River dams to improve passage conditions for juvenile fish and increase their survival through the hydrosystem. Surface passage systems such as spillway weirs are now operational at all federal dams on the Lower Columbia and Lower Snake rivers and provide among the highest survival of all passage routes. Surface passage systems make spill more effective and efficient because fish pass dams more quickly and safely at the surface, where they

Goals	Accomplishments
	naturally migrate. Monitoring indicates the combination of flow and passage improvements has reduced the number of juvenile fish passing through turbines, sped their movement past dams and improved their overall survival. For instance, the addition of spillway weirs at John Day Dam cut in half the number of fish passing through turbines, where fewer would survive. The Corps has improved bypass systems by relocating outlets at Lower Monumental and McNary dams to sites less vulnerable to predators. A spill wall completed at The Dalles Dam in 2010 significantly boosted survival of salmon and steelhead in the tailrace by guiding them into the main river channel, away from predators. Tests following completion of the spill wall showed increased numbers of yearling and subyearling Chinook passing the dam safely. Performance testing was initiated to determine whether the surface passage and other improvements were providing the benefits anticipated in the BiOp and meeting performance standards for dam passage. All projects tested to date are on track to meet the 96 percent or 93 percent performance standards. Chinook and steelhead in-river survivals have trended up since the mid-2000s.
• Operate and maintain fish passage facilities to improve fish survival.	Spill past the dams has been used to promote the downstream passage and survival of juvenile salmon and steelhead since 1981. The amount and timing of spill has been adjusted at each of the Lower Snake and Lower Columbia River dams over time in response to new information. The 2008 BiOp increased spill amounts based on the latest scientific information to improve juvenile survival. The BiOp provides 24-hour spill at all Lower Snake and Lower Columbia River dams throughout the migration season. The BiOp outlined a framework to adjust spill as needed to achieve the performance standards, with spill operations tailored at each dam to support fish survival given its hydraulic conditions and configuration. Increased availability of surface passage routes combined with spill has reduced the travel time of juvenile salmon and steelhead. Based on recent information, faster travel time

Goals	Accomplishments
	increases the likelihood of juveniles reaching the estuary and increases returns of adults. However, spill for juvenile fish must be balanced against other factors such as the potential for elevated levels of dissolved gas and possible interference with upstream passage of adult fish. Transporting a portion of juvenile migrants downstream from Snake River dams to the estuary has proven effective at increasing the adult returns of Snake River stocks under specific conditions. The Action Agencies provided transport operations consistent with the BiOp. Although there has been less benefit in recent years, analyses continue to indicate that yearling Chinook and steelhead produce higher adult returns when juveniles are transported in late April and May. In 2008/2009, the ISAB recommended that a spread the risk strategy (roughly half the fish transported and half left in-river) be implemented and continue to be evaluated. Since 2009, the transport percentage for Chinook and steelhead has generally been less than 40 percent transported compared to 60 percent left in-river. In 2012, the share of fish transported dropped to less than 30 percent. Hydro operations, coupled with configuration improvements completed to date, increased overall in-river survival of juvenile salmon and steelhead. The estimated survival of adult Snake River fall Chinook, Upper Columbia River spring Chinook and steelhead for the 2007-2011 period are near or meet the FCRPS adult performance standards, but the survival of Snake River spring-summer Chinook and steelhead are not yet meeting the performance standard. To address adult passage, the Action Agencies are modifying the North John Day ladder and plan to add PIT-tag detection systems to better detect adult losses and determine what action may be needed to meet adult performance standards. Several potential factors for this recent survival drop, such as adult fallback, pinnipeds, and harvest, are being assessed. <u>Looking forward for hydrosystem actions:</u> The Action Agencies will continue to provide flows from the storage projects to improve conditions for juvenile and adult fish. They will also implement actions at the dams and

<table>
<tr><th>Goals</th><th>Accomplishments</th></tr>
<tr><td></td><td>evaluate their effectiveness in meeting the juvenile and adult performance standards.

The Action Agencies will continue to evaluate the most effective balance between the number of fish transported and the number that migrate downstream in the river to optimize adult fish survival, taking into account ISAB recommendations to "spread the risk."</td></tr>
<tr><td colspan="2">TRIBUTARY HABITAT</td></tr>
<tr><td>Improve tributary and estuary habitat used by salmon for spawning and rearing:

• Protect and improve tributary habitat based on biological needs and prioritized actions.</td><td>The Action Agencies worked with states, tribes, watershed groups and other partner organizations to identify hundreds of potential habitat improvement actions targeting factors that are limiting salmon and steelhead populations.

The Action Agencies organized and convened panels of biologists and other knowledgeable local watershed experts to assess the percent improvement in habitat quality anticipated from these actions, based on how effectively habitat improvement actions address the limiting factors for each fish population. The assessments were informed by the best available science and the latest results of research and monitoring. The assessment in 2012 showed substantial progress towards the 2018 habitat quality improvement targets and evaluated actions for implementation through 2018.

With funding and technical assistance from the Action Agencies, project sponsors completed hundreds of habitat improvement actions throughout the Columbia Basin to address limiting factors. Key accomplishments since 2007 include:

• Reopening or improving fish access to 2,053 miles of rivers and streams by eliminating barriers such as deteriorated culverts or diversion dams, allowing renewed use of important spawning and rearing habitat. Monitoring has documented more fish using and spawning in the reopened stretches of streams. Reviews of the scientific literature describe improved fish passage as one of the highest priority and most effective habitat actions for salmon and steelhead, with fish rapidly colonizing newly accessible habitat.
• Installing or improving 247 water intake screens, preventing fish from being entrained and killed in irrigation diversions. A recent study on the Lemhi River in</td></tr>
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Goals	Accomplishments
	Idaho found that unscreened diversions could entrain a majority of out-migrating Chinook smolts and that screening is a highly effective strategy that could greatly reduce mortality in heavily irrigated drainages, such as many in the Columbia Basin. • Increasing stream flows by securing an additional 177,227 acre feet and 1,223 cubic feet per second of water, nearly as much as the average flow of the John Day River, in tributaries throughout the Columbia Basin. The water has restored flows to river and stream reaches that formerly ran dry and such flow improvements have been demonstrated in the scientific literature to dramatically benefit fish survival, increasing fish and the prey they rely on for food. • Improving 6,812 acres of riparian habitat and 206 miles of streams by recreating natural features such as logjams, side channels and meanders. Surveys of such improvements have found more fish using rehabilitated sections of streams and the scientific literature shows that such projects commonly increase the abundance of juvenile salmon and steelhead. The Action Agencies are funding extensive research into the relationship between habitat and fish performance, including the tracking of habitat status across the Columbia Basin, to inform habitat improvements, as well as detailed research and monitoring to learn from completed projects. For further details and research on the benefits of habitat improvement actions such as those described above, see "*Benefits of Habitat Improvement Actions; Results of Research, Monitoring and Evaluation*." <u>Looking forward for tributary habitat actions:</u> The Action Agencies will continue actions to improve tributary habitat and expect to meet all 2018 targets for habitat quality improvements. The Action Agencies have identified actions through Expert Panels, as well as Accord partners and other tribal implementers, in some key priority areas to achieve these targets.

<table>
<tr><th>Goals</th><th>Accomplishments</th></tr>
<tr><td colspan="2">ESTUARY HABITAT</td></tr>
<tr><td>• Improve juvenile and adult fish survival in estuary habitat.</td><td>Since 2007, the Action Agencies have completed more than 30 habitat improvement projects (or phases of projects) to increase the survival of salmon and steelhead traveling through the estuary.

Accomplishments include:

• Reopened 162 acres of estuary wetlands by breaching or removing dikes, providing fish access to additional food and refuge. Studies have found fish rapidly returning to reopened wetlands and feeding on prey produced there. Research has found that produced prey and organic matter is exported from wetlands to the mainstem river, where it benefits other fish that do not actually occupy the wetlands, and that salmon and steelhead life history types from upper and lower river populations feed in the estuary as their last opportunity for rapid growth before entering the ocean. Larger size of fish has been linked to increased ocean survival.
• Reconnected 169 acres of estuary habitat to tidal influence through the installation or improvement of tide gates or culverts. Where the removal of dikes is not possible, tide gates provide improved fish passage into productive wetlands and increase the export of food resources to the rest of the estuary. Research found that Chinook salmon density increased six-fold in wetland habitat following installation of a redesigned tide gate.
• Improved 151 acres of stream channels, increasing access by salmon and steelhead and improving food production. Research indicates that even upper Columbia River stocks once thought to not rely on the estuary may spend weeks or months feeding in estuary wetlands and that sites several miles up tributaries contribute to the estuary food web.

The Action Agencies have developed a classification system for the estuary, prioritizing projects to reopen and rehabilitate marsh and wetland habitat because research, monitoring and evaluation (RM&E) has demonstrated these actions promote the survival of salmon and steelhead and restore tidal influence. The Action Agencies have worked with local partners</td></tr>
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Goals	Accomplishments
	to develop a strong portfolio of estuary habitat projects addressing these priorities. An extensive program of research, monitoring and evaluation has greatly improved understanding of the productivity and dynamics of estuary habitat and how salmon and steelhead depend on estuary wetlands. It has also assessed the effectiveness of habitat actions, informing future plans by, for instance, describing the biological advantages of dike breaches compared to tide gate improvements. Research has found that fish from estuaries with larger proportions of functioning habitat survive to adulthood at significantly higher rates. For further information, see "Benefits of habitat improvements in the Columbia River estuary." (pending finalization) Looking forward for estuary habitat actions: The Action Agencies will continue habitat restoration actions in the estuary to meet all 2018 targets for survival benefits in the estuary. The Action Agencies have identified additional projects and are supporting further research on estuary habitat benefits to meet targets by 2018.
HATCHERIES	
Use hatcheries to address the biological priorities of ESA-listed salmon and steelhead: • Reduce potentially harmful effects of artificial production.	The Action Agencies have reviewed and hatchery operators have submitted to NOAA updated Hatchery and Genetic Management Plans for all 44 hatchery programs funded by the Action Agencies. The plans incorporate practices such as the use of local broodstock to avoid or minimize potential interference with naturally reared fish and the recovery of listed stocks. The Corps continued its review of the John Day Hatchery Mitigation Program with an alternatives study that included preliminary designs and cost estimates for the most feasible alternatives. The Corps is now revising the study in response to comments and will prepare a design report recommending reforms to the current program. The Washington Department of Fish and Wildlife revised its Hatchery Genetic Management Plan (HGMP) to eliminate releases of Lyons Ferry Hatchery steelhead into the Tucannon River and instead increase production of endemic Tucannon River steelhead. Per the HGMP,

Goals	Accomplishments
	the release goal of steelhead smolts in the short-term is 75,000 yearling fish and the goal over the long-term is 150,000 yearlings depending on available space for production. The Winthrop National Fish Hatchery has transitioned to local steelhead broodstock, increasing production from 25,000 in 2008 to 100,000 in 2012. Initial results indicate that the local broodstock shows improved survival and migratory success. The USFWS has increased efforts to remove hatchery adults from spawning grounds and Reclamation sponsored stakeholder meetings to discuss further reforms. Improvements at Dworshak National Fish Hatchery have significantly increased survival and production of listed hatchery summer steelhead by decreasing the incidence of the IHN virus, which can infect salmon. Snake River sockeye salmon recorded the highest adult returns since the 1950s following increased production and releases of captive broodstock progeny through a safety-net hatchery program operated by Idaho Department of Fish and Game in collaboration with NOAA Fisheries, the Shoshone-Bannock Tribes and Oregon Department of Fish and Wildlife. The program has preserved 93 percent of the genetic diversity of the species. Increased numbers of returning adult sockeye are again spawning naturally. Construction of a new, $13.5-million hatchery began in Idaho in 2012 to increase juvenile sockeye production by up to 1 million each year and rebuild the species to self-sustaining levels.
• Implement safety-net programs to avoid extinction.	Safety net programs for Catherine Creek and the Lostine River met their goals of 150 spawning adults and have been phased out, while safety-net programs for the upper Grande Ronde and Johnson Creek/South Fork Salmon stocks continue. Construction of the new Chief Joseph Hatchery is expected to be completed in 2013 and will support a program designed to reestablish a population of Upper Columbia River spring Chinook in the Okanogan River Basin to enhance this ESU.

Goals	Accomplishments
• Implement conservation hatchery programs to build genetic resources and assist with promoting recovery.	The Yakama Nation, with BPA funding, completed construction of a steelhead kelt reconditioning site at Winthrop NFH to promote the repeat spawning of steelhead, which can further contribute to listed steelhead populations in the Entiat, Methow and Okanogan basins. The Yakama Nation and CRITFC continued reconditioning of mid-Columbia steelhead kelts, demonstrating that kelts can spawn successfully a second time, with fertilization rates and fry survival similar to initial spawning. Approximately 20 to 30 percent of the total annual steelhead migration has been successfully reconditioned, and monitoring has demonstrated successful spawning of reconditioned kelts in the wild. The Action Agencies have continued funding research into critical uncertainties surrounding the potential effects of hatchery programs on listed fish populations to better inform the improvement of hatchery practices. <u>Looking forward for hatchery actions:</u> The Action Agencies expect to meet hatchery reform goals specified in RPA Action 40 and track progress of safety net and supplementation programs.
PREDATOR MANAGEMENT	
Reduce the number of juvenile fish consumed by predators: • Reduce fish predation.	BPA continued to implement the successful Northern Pikeminnow Management Program, which rewards private anglers for removing the species that preys heavily on juvenile fish. The program's removal of nearly 3.65 million pikeminnow from the Columbia River since 1990 has reduced pikeminnow predation on juvenile salmon by about 38 percent, saving 4 to 6 million juvenile salmon that would have otherwise been eaten. The program has removed more than 15 percent of pikeminnow 11 inches and larger each year since 2008, except for 2009 when 12.9 percent were removed. In 2012 the removal rate of 16.1 percent equated to 157,846 pikeminnow eliminated. The Action Agencies also continued a program started in 2009 that employs two fishing crews to remove pikeminnow from the forebay and tailrace of The Dalles and John Day dams, areas inaccessible to the public. The crews removed 5,474 pikeminnow in 2012, up 38 percent from their 2011 catch.
• Redistribute avian predators.	The Action Agencies took several actions to control seagulls, Caspian terns and double-

Goals	Accomplishments
	crested cormorants – three birds that prey heavily on juvenile salmon and steelhead. The Corps improved or replaced wires that deter seagulls from preying on salmon and steelhead at John Day Dam in 2010 and The Dalles in 2011, reducing gull predation at the two projects from 124,000 fish in 2010 to 22,000 in 2011. The Corps has also developed nine alternative nesting areas with a total of 8.3 acres of habitat to attract Caspian terns away from the Columbia River estuary, while reducing tern nesting grounds on East Sand Island in the estuary from 6 acres in 2008 to 1.5 acres in 2012. Although terns remaining on East Sand Island responded by moving their nests closer together, their total number has declined from more than 10,600 pairs in 2008 to an estimated 6,400 pairs in 2012 and their consumption of salmonid smolts has dropped from more than 6.6 million in 2008 to about 4.9 million in 2012. The Corps began preparation of an Environmental Impact Statement evaluating options for managing double-crested cormorants on East Sand Island, the largest cormorant colony in western North America. The colony is home to about 13,000 nesting pairs that consume an estimated 20 million juvenile salmonids. Management actions are also in development to address the impacts of terns that nest on islands in the river near Pasco and Othello, Washington.
• Manage sea lion predation.	In 2012, the number of adult salmon and steelhead consumed by sea lions at Bonneville Dam dropped to its lowest point in nearly a decade. Sea lions had been consuming increasing numbers of fish through 2010 and as much as an estimated 4.7 percent of the total spring run. The Action Agencies took several steps to control sea lion impacts, including the installation of exclusion devices to keep sea lions out of fish ladders, contracting with the U.S. Department of Agriculture's Wildlife Services to harass sea lions away from fish ladders and allowing boats from CRITFC and state fish and wildlife departments to also harass the marine mammals. In addition, the states took management actions as authorized by NOAA Fisheries under the Marine Mammal Protection Act. As a result of both state and Action Agency steps, the estimated consumption of salmonids by sea lions dropped from 6,321 or 2.4 percent of the run in 2010 to 2,360 fish or 1.4 percent

Goals	Accomplishments
	of the run in 2012. Looking forward for predator management actions: Active management of northern pikeminnow will remain an important component of predation management efforts. The Action Agencies are continuing to monitor sea lion impacts and evaluate potential control methods, with NOAA Fisheries taking the lead on management. The Corps will continue actions on East Sand Island to reduce numbers of tern nesting pairs to reduce impacts on juvenile salmonids. The Corps is working with the USFWS in developing an Environmental Impact Statement (EIS) on cormorant management, which will lead to an action plan in the near future, as was done successfully for Caspian terns.

2008-2012 Fish Status and Environmental Conditions

Fish Status

Adult Fish Returns and Trends

Columbia River Basin salmon and steelhead have been adversely affected for well over a century by a range 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, 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 federal Endangered Species Act.

In the Pacific Northwest, salmon and steelhead status is tracked by comparing the number of fish that return each year to spawn. Many dams have fish counting stations where annual index tallies are made of the various species as they swim up the fish ladders. In 2012, more than 1.5 million adult and jack salmon and steelhead were counted as they passed Bonneville Dam, after ocean and lower river harvest. This number includes hatchery and naturally produced fish as well as listed and unlisted stocks. In a typical year, an estimated 80% of all returning adult salmon are of hatchery origin, although the actual percentage varies by species and population; many of these are also part of the listed ESUs/DPSs.

In addition, approximately 114,000 of these were jacks, which are young males that mature and return to spawning grounds earlier than others in the age class.

The 2012 counts exceed historical averages for 2000 and earlier and also exceed the more recent 10-year average (Figure 2). A number of factors affect the counts of returning fish at Bonneville Dam, such as fewer fish have been harvested before reaching Bonneville Dam than previously. Additionally, there is increasing reliance upon hatchery production. As shown in Table 1, counts in 2012 of adult salmon and steelhead passing Bonneville Dam were mixed. The overall total and returns of spring and fall Chinook were slightly above the 10-year average, while returns of summer Chinook were slightly below that average. Returns of steelhead and coho were substantially below the 10-year average. However, returns of sockeye set a new record at almost three times the 10-year average. Most of the sockeye that return to Bonneville Dam are unlisted, natural-origin fish from the tributaries of the upper Columbia River above nine mainstem dams.

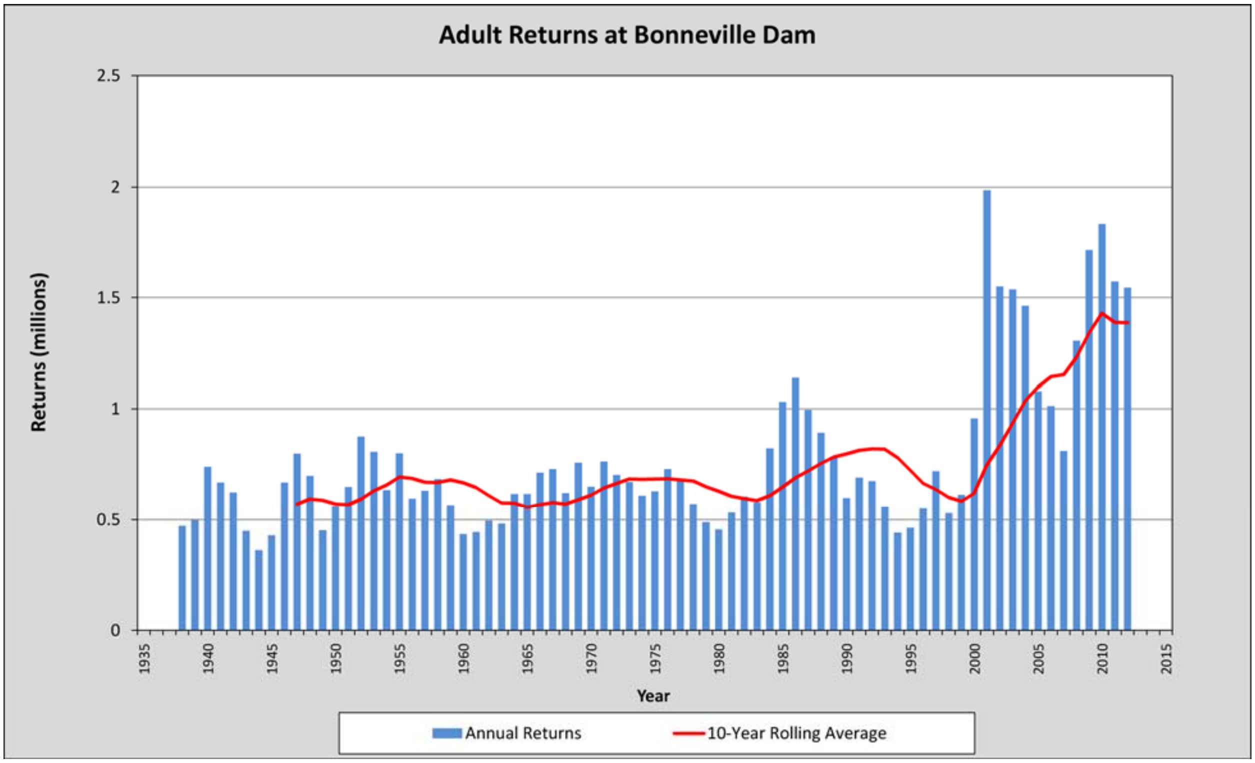

Figure 2. Adult and Jack Salmon/Steelhead Returns at Bonneville Dam, 1938 to 2012. Daytime counts only. Numbers include both ESA listed and unlisted hatchery and natural-origin fish. Harvest has varied over time. Sources: For 1938 – 2011 - U.S. Army Corps of Engineers Fish Passage Report 2011, Table 18b; for 2012 data see http://www.nwp.usace.army.mil/Missions/Environment/Fishdata.aspx.

Table 1. Adult Salmon and Steelhead Returns at Bonneville Dam – 2012 and 10-year Average (includes hatchery and natural origin fish).

Species	2012	10-year average
Chinook – Total [1]	733,884	717,575
Spring Chinook [2]	*165,681*	*161,530*
Summer Chinook	*93,898*	*105,642*
Fall Chinook	*474,305*	*450,403*
Steelhead	235,289	364,367
Sockeye	515,673	177,642
Coho [3]	60,009	127,156
Chum and Pinks	66	604
TOTALS of all species for period	1,544,921	1,387,344

Period of 10-year average 2003-2012. Data are for daytime counts – 0400 to 2000 PST. All 2012 data are from ***http://www.nwp.usace.army.mil/Missions/Environment/Fishdata.aspx.*** Data for years prior to 2012 are from U.S. Army Corps of Engineers *Fish Passage Report 2011 (2012), Table 18b, except:*

[1] Chinook data are from monthly values in Fish Passage Report 2011 (2012), Table 19. Values include jacks.

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

[3] Chinook and coho numbers includes jacks.

Overview by Species

The following summaries describe abundance and abundance trends at the species (ESU/DPS) level as of December 2012. Species-level status is determined by rolling up population-level status and includes consideration not just of abundance, but also productivity, spatial structure, and diversity attributes.[2] It should be noted that natural annual variation in populations and productivity can be substantial, so longer term trends are more significant than annual or shorter term results. Much of this natural variation is influenced by factors outside the impact and influence of the FCRPS, including tributary, estuary, and ocean conditions.

It is relevant to note, that NOAA Fisheries will review relevant population-level information as part of the jeopardy and adverse modification analyses for the 2013 Supplemental BiOp for operation of the FCRPS.

Species-level abundance is an important indicator under the FCRPS BiOp, which includes abundance and trend-based indicators at the ESU/DPS level. A decline in such indicators, though considered unlikely, would trigger contingency actions described in the Action Agencies' Rapid Response and Long Term Contingency Plan. Neither the FCRPS BiOp early warning indicator nor the significant decline triggers were tripped for any of the ESUs or DPSs in 2012.

Figures 3 through 9 display natural spawners only (with the exception of the Snake River sockeye ESU, which is sustained through a captive broodstock program). Though the charts below display only natural origin fish, each of the listed species also includes a hatchery origin component that contains and conserves some of the important genetic heritage of the species.

Snake River Fall Chinook Salmon

The Snake River fall Chinook salmon ESU was listed under the ESA as a threatened species in 1992. It includes one extant population of fall-run Chinook salmon spawning in the mainstem Snake River below Hells Canyon Dam, and in the Tucannon River, Grande Ronde River, Imnaha River, Salmon River, and Clearwater River subbasins. Four artificial propagation programs are considered to be part of the ESU: the Lyons Ferry Hatchery, Fall Chinook Acclimation Ponds Program, Nez Perce Tribal Hatchery, and Oxbow Hatchery fall-run Chinook programs. It is estimated that 85 percent of the ESU's historical spawning

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[2] *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 DART (Data Access in Real Time) at* http://www.cbr.washington.edu/dart/*, and upper Columbia Steelhead numbers, which were supplied by NOAA Fisheries. Trend lines are shown where the 1990–present trend is statistically significant (p<0.05). The trend estimation method is taken from Good et al. (2005).*

habitat was lost as a result of construction of the privately owned Hells Canyon Dam complex, which blocks all fish passage.

The most recent 10-year average return of natural-origin fish (through 2012) is estimated to be 4,442 adults. The most recent four-year average return is 6,642 adults (Figure 3). An analysis of adult returns from 1990–2012 indicates that the ESU-level trend in abundance was positive during this period.

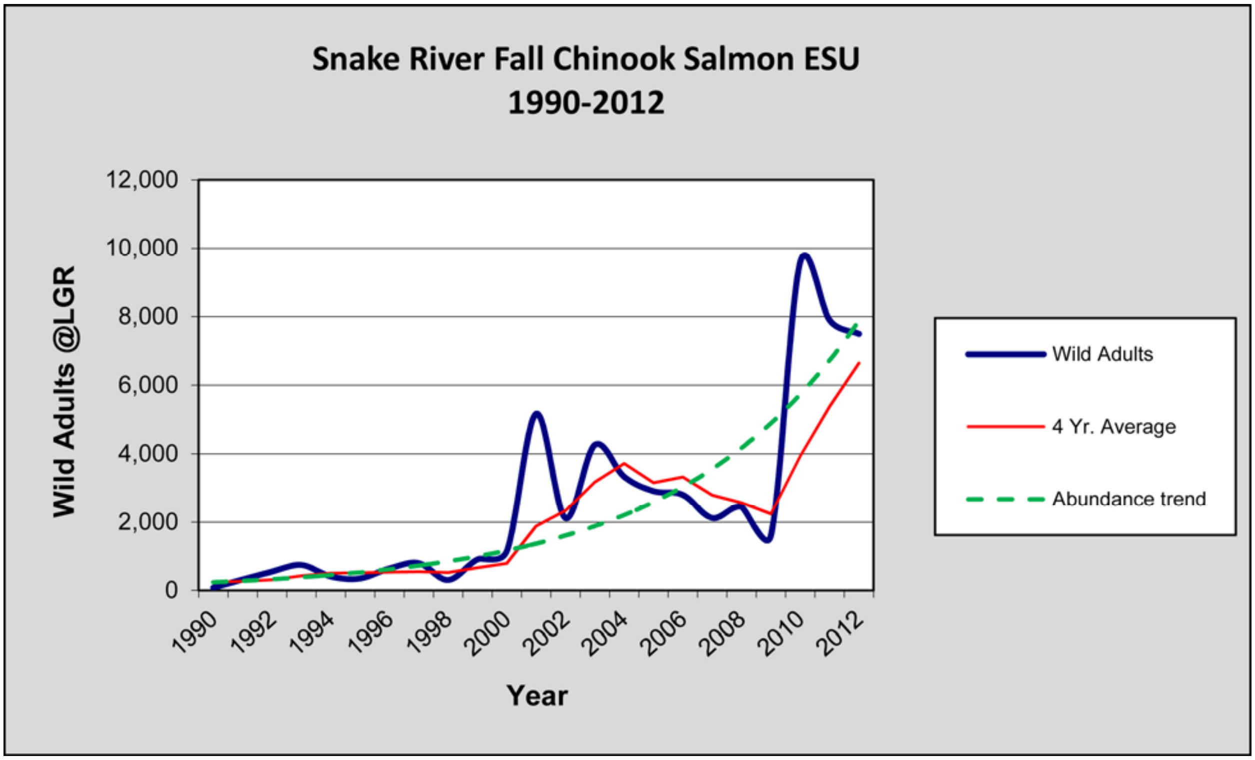

Figure 3. Returns of Naturally Produced Adult Snake River Fall Chinook Salmon at Lower Granite Dam, 1990–2012.

Snake River Spring/Summer Chinook Salmon

The Snake River spring/summer Chinook salmon ESU was listed under the ESA as a threatened species in 1992. The Snake River spring/summer Chinook salmon ESU includes 28 extant populations in five Major Population Groups (MPG). These populations spawn in the mainstem Snake River and the Tucannon River, Grande Ronde River, Imnaha River, and Salmon River subbasins. Fifteen artificial propagation programs are also considered to be part of the ESU: the Tucannon River conventional Hatchery, Tucannon River Captive Broodstock Program, Lostine River, Catherine Creek, Lookingglass Hatchery Reintroduction Program (Catherine Creek stock), Upper Grande Ronde, Imnaha River, Big Sheep Creek, McCall Hatchery, Johnson Creek Artificial Propagation Enhancement, Lemhi River Captive Rearing Experiment, Pahsimeroi Hatchery, East Fork Captive Rearing Experiment, West Fork Yankee Fork Captive Rearing Experiment, and the Sawtooth Hatchery spring/summer-run Chinook programs.

The most recent 10-year average return of natural-origin Snake River spring/summer Chinook salmon was 18,449 adults. The most recent four-year average return was 22,049 adults (Figure 4). An analysis of adult returns from 1990-2011 indicates that the ESU-level trend in abundance was positive during this period.

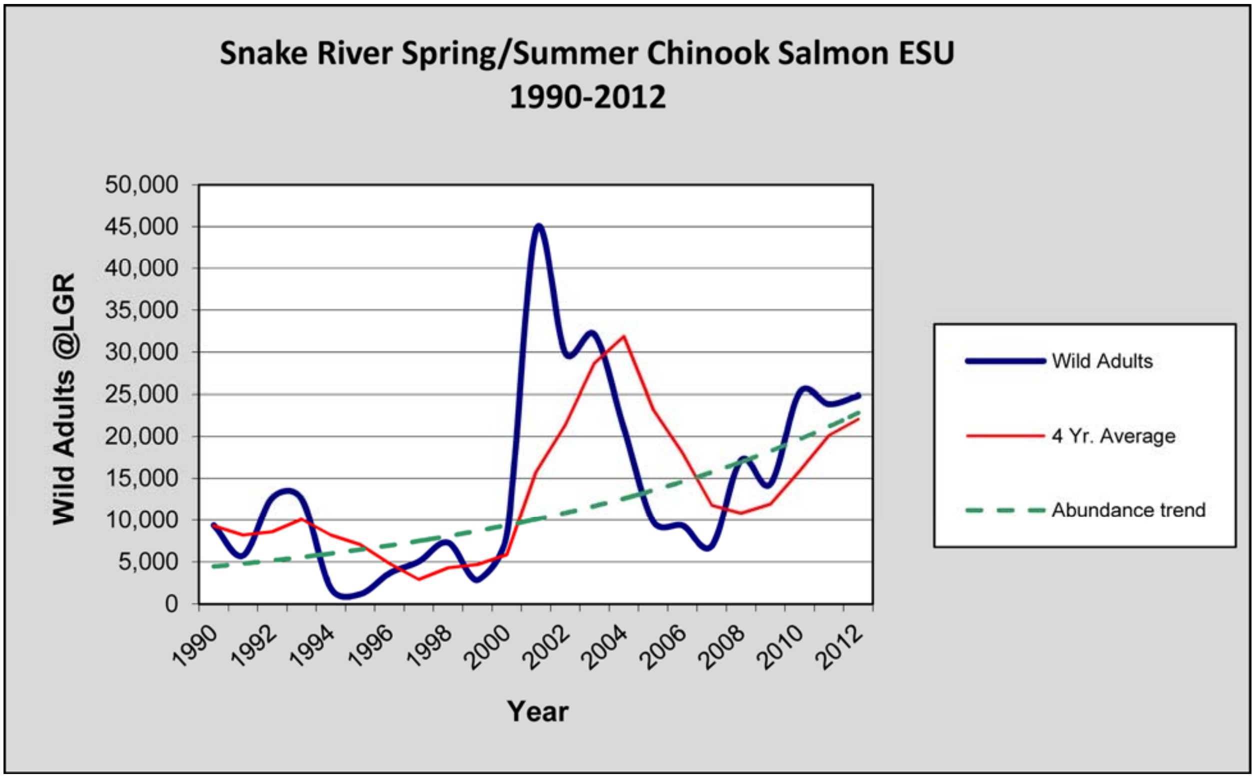

Figure 4. Returns of Naturally Produced Adult Snake River Spring/Summer Chinook Salmon at Lower Granite Dam, 1990-2012. The ESU-level trend in abundance was positive during this period.

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 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 build upon progress to date.

The average annual adult return from the captive broodstock program between 1991 and 1999 was 11 fish. The average return from 2004 to 2007 was 50 fish. The years 2008 to

2011 saw a significant increase in adult returns (Figure 5). These years included the largest sockeye returns since fish counts began at Lower Granite Dam in 1975. The NWFSC attributed the increased numbers in 2008 to favorable ocean conditions and an increase in smolt releases from the captive broodstock program (NOAA-NWFSC 2009). Factors affecting sockeye salmon returns to the Columbia River in 2008 are reported in *http://www.nwcouncil.org/library/isab/2010-2/NOAA%202008%20sockeye%20returns-final_2-6-09.pdf*).

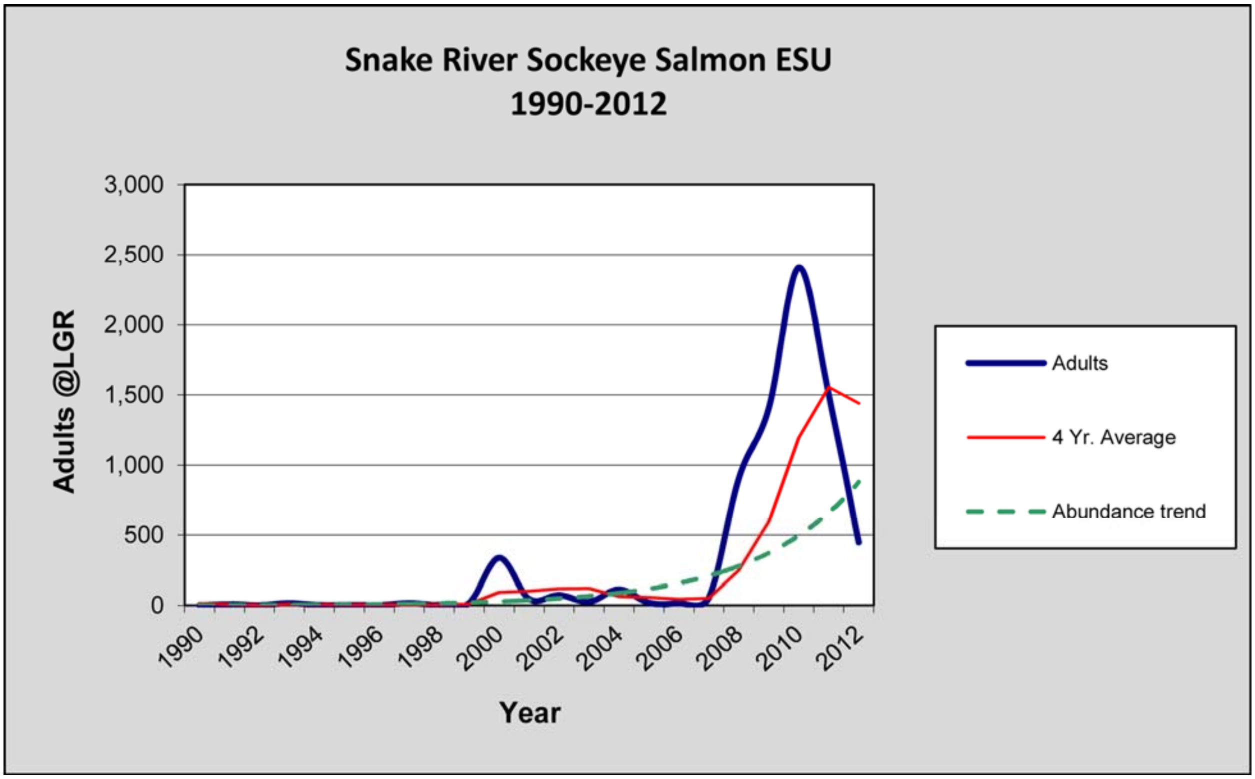

Figure 5. Returns of All Snake River Sockeye Salmon at Lower Granite Dam, 1990–2012. The ESU-level trend in abundance was positive during this period.

Snake River Steelhead

The Snake River steelhead DPS was listed as threatened in 1997. The Snake River steelhead DPS includes 24 extant populations of steelhead in six MPGs. These populations spawn in streams in the Snake River Basin of southeast Washington, northeast Oregon, and Idaho. Six artificial propagation programs are also considered part of the DPS: the Tucannon River, Dworshak National Fish Hatchery, Lolo Creek, North Fork Clearwater, East Fork Salmon River, and the Little Sheep Creek/Imnaha River Hatchery steelhead programs. Steelhead of the interior Columbia River Basin, and especially populations within 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 limited information regarding the status of most individual populations of Snake River steelhead, but it is believed that B-run steelhead spawn almost entirely in the Clearwater and Salmon Rivers, while A-run steelhead occur throughout the Snake River Basin. The NWFSC is reviewing and may revise the current classification of A- and B-run steelhead populations, because recent information seems to be indicating a lack of meaningful distinctions.

The most recent 10-year average return of natural-origin Snake River steelhead was 27,189 adults (2003-2012). The most recent four-year average return was 38,121 adults (Figure 6). (Adult return estimates for 2012 are incomplete.) An analysis of adult returns from 1990–2012 indicates that the DPS-level trend in abundance was positive during this period.

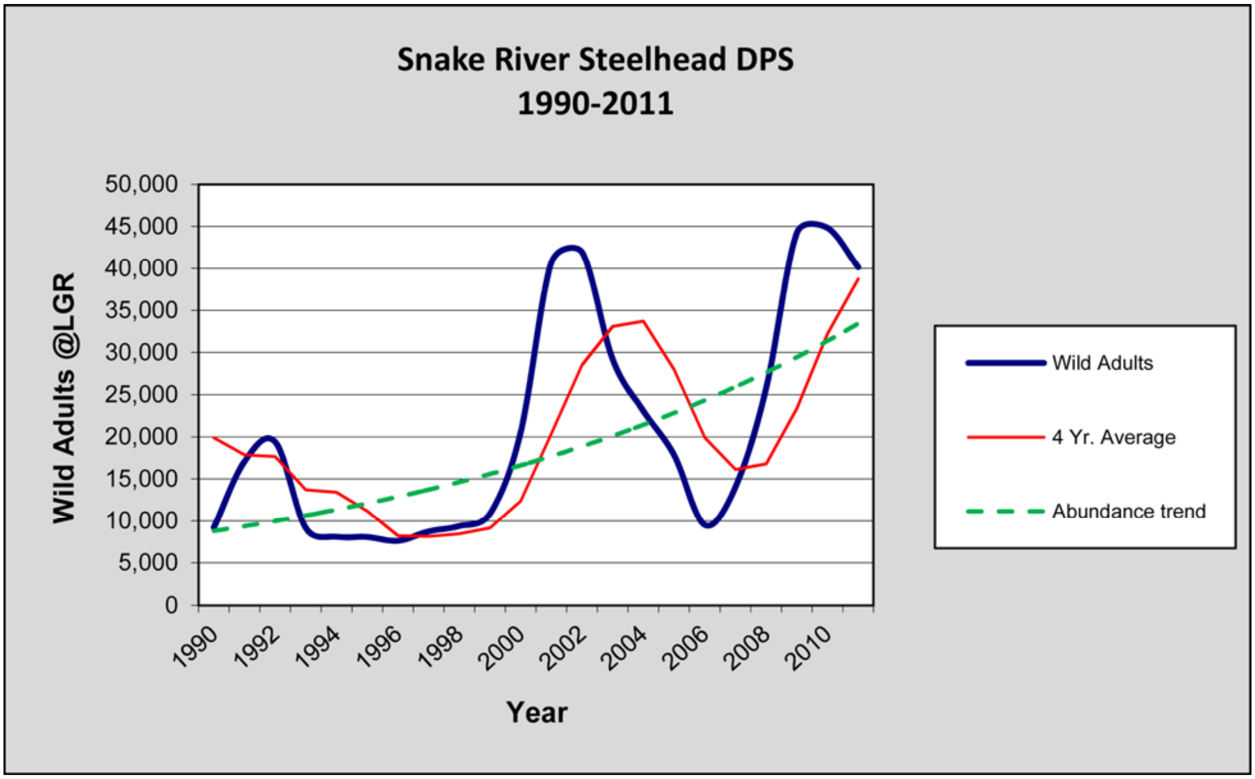

Figure 6. Returns of Naturally Produced Adult Snake River Steelhead at Lower Granite Dam, 1990–2012. The DPS-level trend in abundance was positive during this period.

Upper Columbia River Spring Chinook Salmon

The Upper Columbia River Spring Chinook salmon ESU was listed as endangered in 1999. The UCR Spring Chinook ESU includes three extant populations of Chinook salmon in one MPG. These populations spawn in streams upstream of the Rock Island Dam and downstream of Chief Joseph Dam in Washington, excluding the Okanogan River. Six artificial propagation programs are considered to be part of the ESU: The Twisp River, Chewuch River, Methow Composite, Winthrop NFH, Chiwawa River, and White River spring-run Chinook programs.

The most recent 10-year average return of natural-origin Upper Columbia River Spring Chinook salmon was 1,718 adults at Rock Island Dam (2003–12). The most recent four-year average return was 2,391 adults (Figure 7). An analysis of adult returns from 1990-

2012 indicates that there was no statistically significant ESU-level trend in abundance during this period.

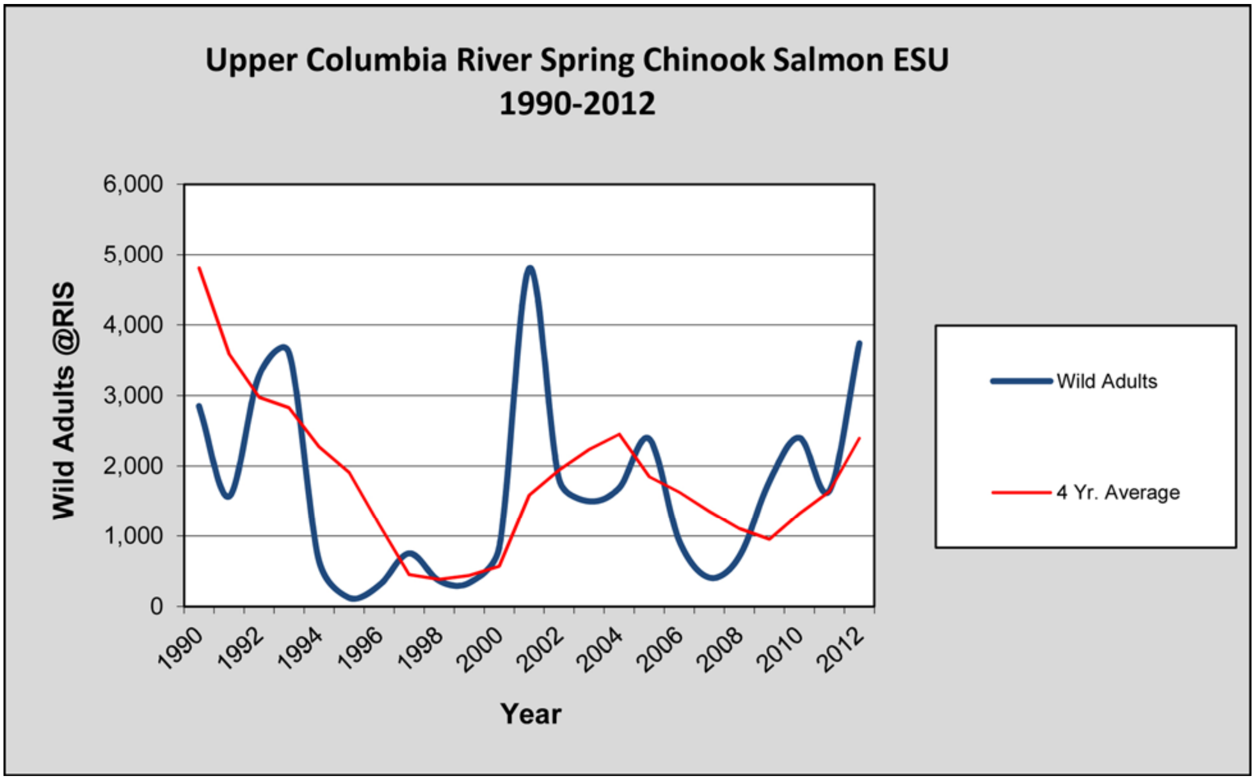

Figure 7. Returns of Naturally Produced Adult Upper Columbia River Spring Chinook Salmon at Rock Island Dam, 1990–12. An analysis of adult returns from 1990 to 2012 indicates that there was no statistically significant ESU-level trend in abundance during this period.

Upper Columbia River Steelhead

The Upper Columbia River steelhead DPS was listed as endangered in 1997 but was recently relisted as threatened. The UCR steelhead DPS includes four extant populations of steelhead in one MPG. These populations spawn in streams in the Columbia River Basin upstream from the Yakima River, Washington, to the U.S.-Canada border. Six artificial propagation programs are considered part of the DPS: the Wenatchee River, Wells Hatchery in the Methow and Okanogan rivers, Winthrop NFH, Omak Creek, and the Ringold steelhead programs.

The most recent 10-year average return of natural-origin Upper Columbia River steelhead was 3,932 adults (2003-2012). The most recent four-year average return was 5,736 adults (Figure 8). An analysis of adult returns from 1990-2012 indicates that the ESU-level trend in abundance was positive during this period.

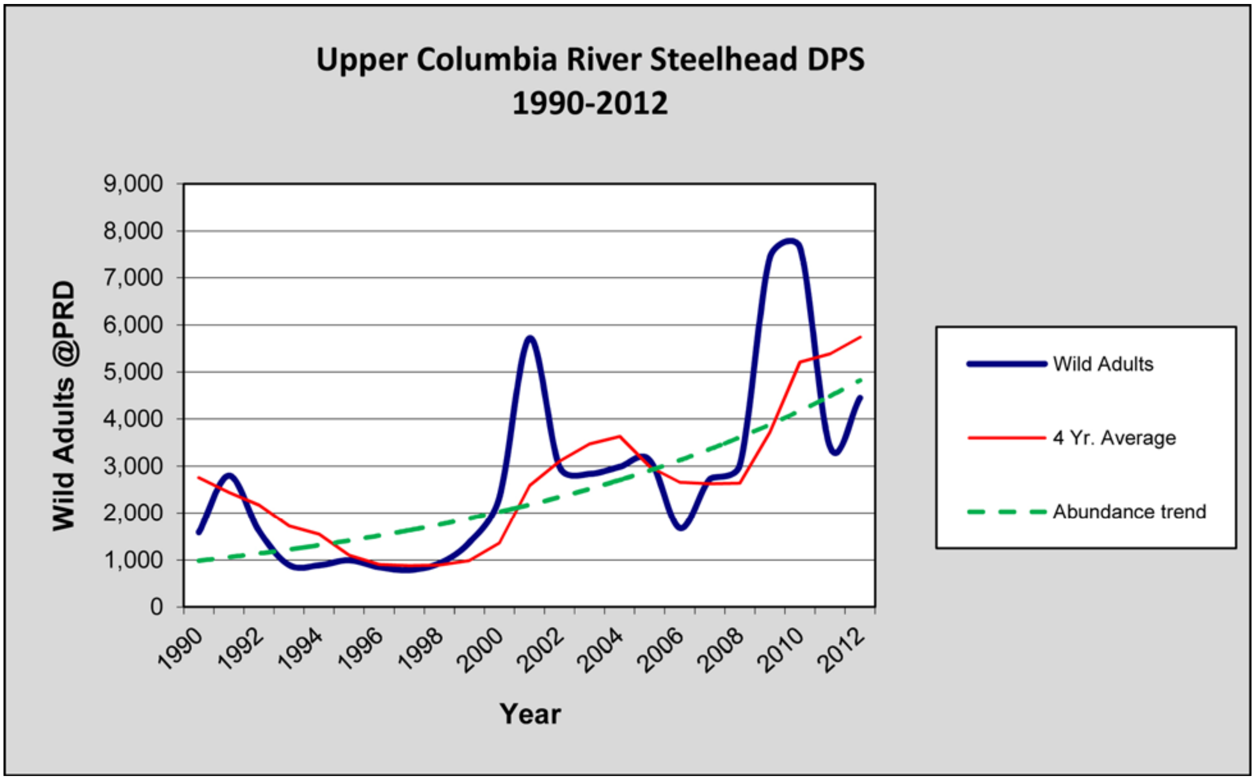

Figure 8. Returns of Naturally Produced Adult Upper Columbia River Steelhead at Rock Island Dam, 1990–2012. 2012 data is preliminary.

Middle Columbia River Steelhead

The Middle Columbia River steelhead DPS was listed as threatened in 1999. The MCR steelhead DPS includes 17 extant populations of steelhead in four Major Population Groups. These populations spawn in streams from above the Wind River, Washington, and the Hood River, Oregon (exclusive), upstream to, and including, the Yakima River, Washington, excluding steelhead from the Snake River Basin. Seven artificial propagation programs are considered part of the DPS: the Touchet River Endemic, Yakima River Kelt Reconditioning Program (in Satus Creek, Toppenish Creek, Naches River, and Upper Yakima River), Umatilla River, and the Deschutes River steelhead hatchery programs.

Based on preliminary estimates, the most recent 10-year average return from this DPS was 3,912 natural-origin adults (2001–12). The most recent four-year average return was 5,830 natural-origin adults (Figure 9). The abundance trend for this DPS between 1990 and 2012 was positive.

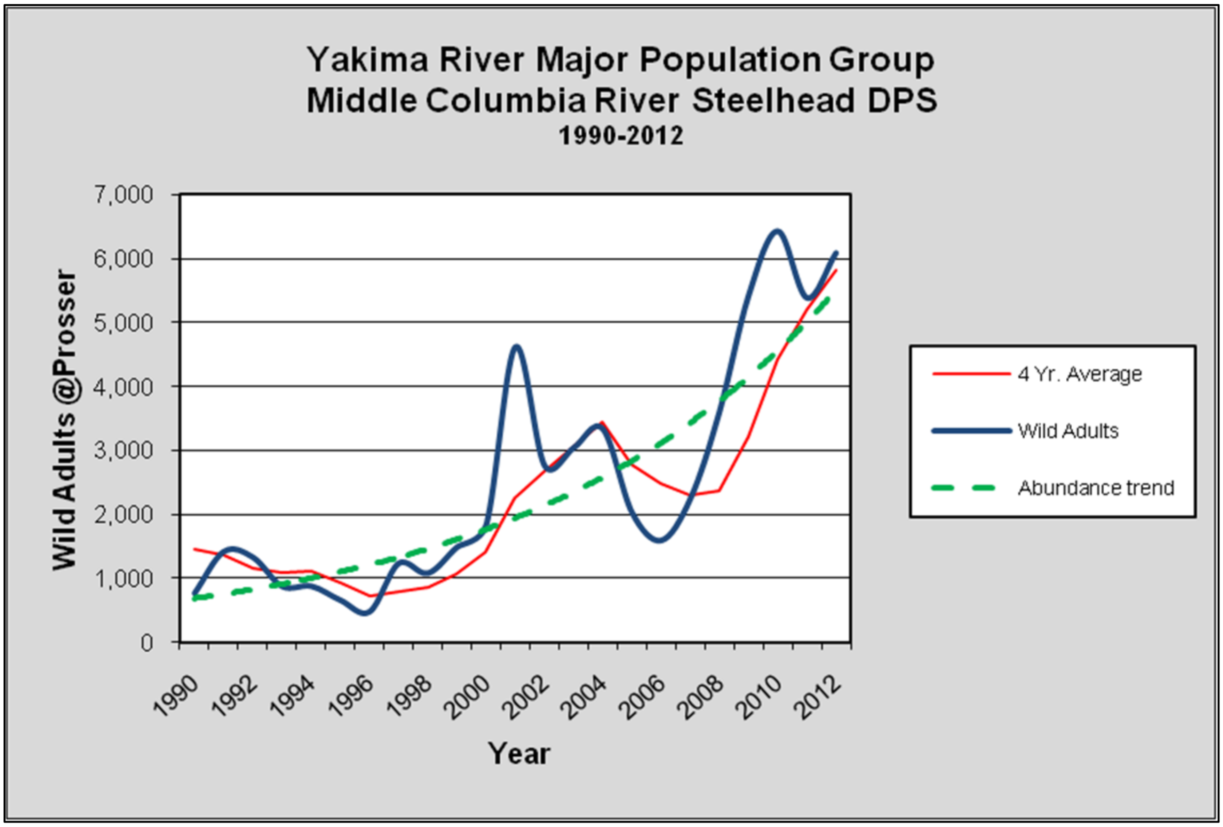

Figure 9. Returns of Naturally Produced Adult Middle Columbia River Steelhead (Yakima River MPG) at Prosser Dam, 1990–2012. Due to the difficulty in obtaining estimates of DPS-level abundance for middle Columbia River steelhead, the AMIP relies on abundance estimates based on dam counts for the Yakima River MPG of this DPS.

Lower Columbia and Willamette River ESUs

A total of six ESUs in the Willamette and Lower Columbia Rivers are currently listed under the ESA. The two listed ESUs in the Willamette River are also covered by a separate BiOp for the Willamette Project. Quantitative status information is lacking for many of the populations in these ESUs. For those populations for which data are available, the information indicates that abundance, while well below historic levels, is stable or increasing.[3] These ESUs are currently threatened by a broad array of habitat and other environmental factors. Because they largely do not migrate through the Federal dams on the Columbia and lower Snake Rivers, the proposed operation of the Columbia/Snake projects of the FCRPS has a limited impact on these populations, with the exception of certain populations in the upper Columbia River Gorge. However, the Action Agencies' estuary habitat program will provide survival benefits for all populations in these ESUs, including those that spawn below Bonneville Dam.

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

Environmental Conditions

Water Years and Streamflow Summary

Water conditions in the Columbia River Basin varied considerably during the 2008-2012 period (Figure 10). Overall, 2008 and 2009 were relatively average water years. Water year 2008 began somewhat below average in March and April, but increased to above average in May and June due to late melt of a somewhat above-average snowpack. In 2009 flows were about average throughout the March-August migration season. In contrast, 2010 was a below-average year; the January through September volume runoff as measured at The Dalles Dam was 80 percent of average. Water year 2010 began quite dry, with flows in March, April, and May substantially below average. However, early June rains, combined with snow melt, resulted in June-August flows being near normal.

Water year 2011 was a particularly challenging water year. For much of the fall of 2010 and the early winter of 2011, precipitation across the basin was about average. Snowpack in the northernmost portions of the basin was average or below average in December 2010 and January 2011. But by March heavy precipitation was present through the basin and continued through June. In addition, temperatures remained well below average, with snow accumulation continuing much later than normal, including at lower elevations. This led to large increases in the water volume forecasts between March and June. Flows were above average throughout the April-August migration season, with a pronounced June freshet; mean June flow at McNary Dam was more than 450 thousand cubic feet per second (kcfs). The high June flows led to flood damage reduction operations at several locations.

Water year 2012 was also above average, although the shape of the runoff hydrograph was different than in 2011. Flows increased earlier in the season and remained high late in the season. The April mean flow was higher than in 2011; the July and August mean flows were about the same as 2011. Although flows remained high during May and June, they were lower than in 2011.

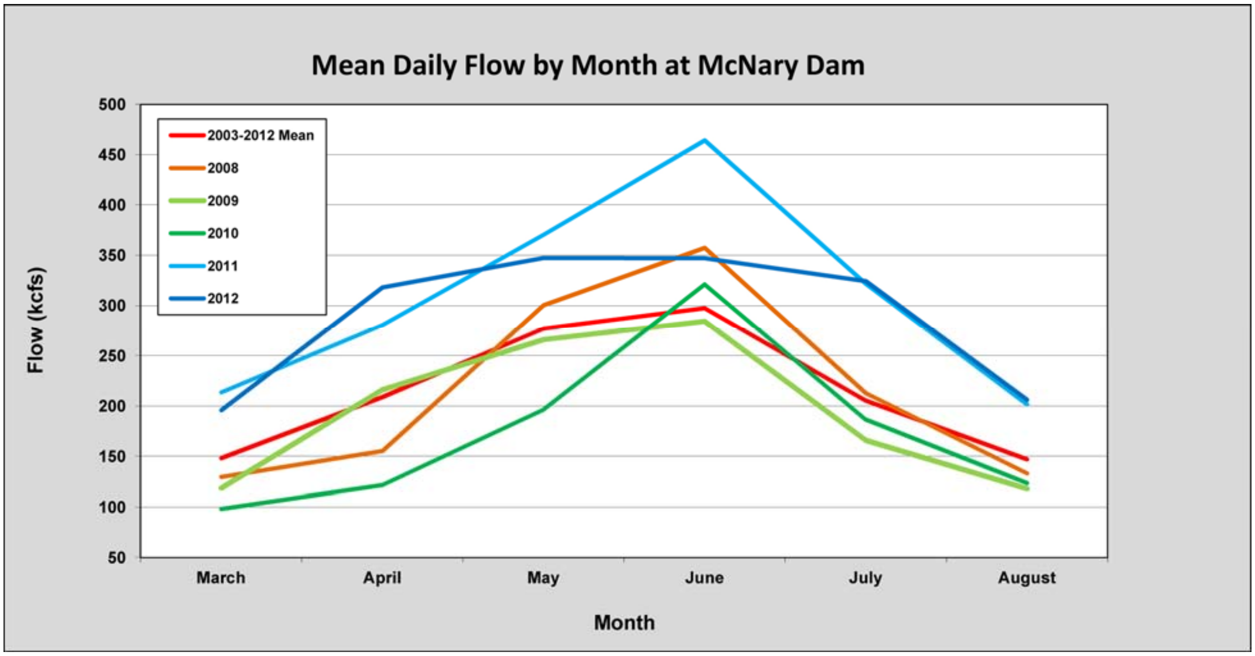

Figure 10. Mean Daily Flow by Month at McNary Dam, 2008 – 2012, with Average Values for the 2003-2012 Period.

Ocean and Climate Conditions

Columbia River Basin salmon and steelhead abundance is strongly correlated with periods of relatively warm or cold off-coast ocean conditions. In general, warmer conditions are less favorable for salmon and colder conditions are more favorable. Pronounced warm and cold cycles have occurred over most of the past century, lasting approximately 20 to 30 years each (Figure 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. Although it is not clear yet whether another longer-term shift has taken place or what effects might be associated with climate change, ocean conditions have been variable since about 1999, with relatively brief cool and warm periods.

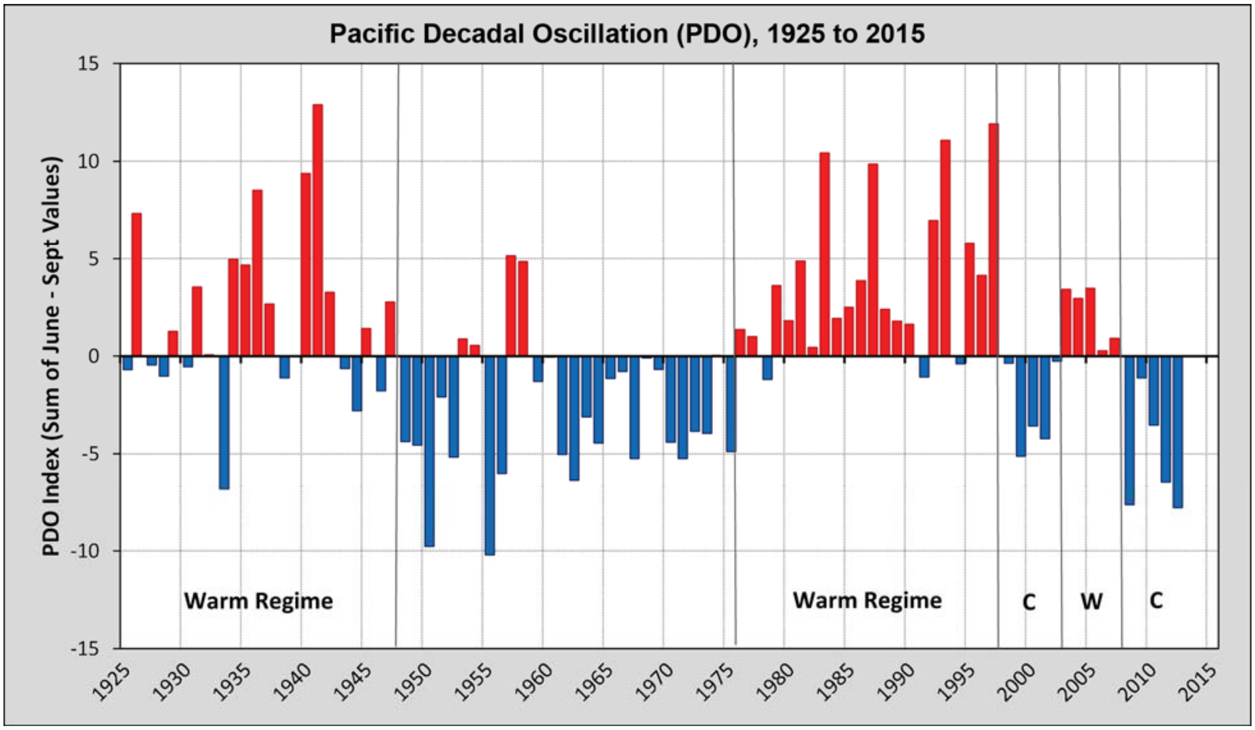

Figure 11. Time Series of Shifts in Sign of the PDO, 1925 to 2011. Values are averaged over the months of May through September. Red bars indicate positive (warm) years; blue bars negative (cool) years. Note that 2012 was the most negative since 1956. From http://www.nwfsc.noaa.gov/research/divisions/fed/oeip/ca-pdo.cfm.

NOAA Fisheries' Northwest Fisheries Science Center (NWFSC) administers the Ocean Ecosystem Indicators Project to track specific climatic and biological indicators believed to influence the growth and survival of juvenile salmon once they reach the ocean. The NWFSC forecasts the returns of coho and Chinook salmon based on a range of ecosystem indicators (Figure 12).

La Niña conditions are characterized by cooler than normal ocean conditions and are generally favorable for salmon survival. 2011 was characterized by La Niña conditions, which shifted towards a more neutral state in 2012. Conditions for juvenile salmon entering the ocean in 2012 were mixed, with a cool regime PDO and strong indicators for the food sources upon which juvenile salmon rely. These favorable conditions were moderated by a trend in 2012 towards unfavorable El Niño conditions in the North Pacific Ocean. The NWFSC predicts average to above-average returns of coho salmon in 2013 and Chinook salmon in 2014, but notes that the mixed indicators increase the uncertainty of the forecast.

	Juvenile Migration Year				Forecast of Adult Returns	
	2009	2010	2011	2012	Coho 2013	Chinook 2014
Large–scale ocean and atmospheric indicators						
PDO	■ (yellow)	■ (yellow)	■ (green)	■ (green)	● (green)	● (green)
ONI (Jan-Jun)	■ (yellow)	■ (red)	■ (green)	■ (green)	● (green)	● (green)
Local and regional physical indicators						
Sea surface temperature anomalies	■ (yellow)	■ (yellow)	■ (yellow)	■ (red)	● (red)	● (red)
Coastal upwelling	■ (yellow)	■ (red)	■ (red)	■ (red)	● (red)	● (red)
Physical spring transition	■ (green)	■ (yellow)	■ (yellow)	■ (red)	● (red)	● (red)
Deep water temperature and salinity	■ (yellow)	■ (yellow)	■ (yellow)	■ (yellow)	● (yellow)	● (yellow)
Local biological indicators						
Copepod biodiversity	■ (yellow)	■ (red)	■ (green)	■ (green)	● (green)	● (green)
Northern copepod anomalies	■ (yellow)	■ (green)	■ (green)	■ (green)	● (green)	● (green)
Biological spring transition	■ (green)	■ (yellow)	■ (green)	■ (yellow)	● (yellow)	● (yellow)
June spring Chinook	■ (green)	■ (yellow)	■ (yellow)	■ (green)	--	● (green)
September Coho	■ (red)	■ (red)	■ (yellow)	■ (yellow)	● (yellow)	--

Key				
	■ (green)	good conditions for salmon	● (green)	good returns expected
	■ (yellow)	intermediate conditions for salmon	—	no data
	■ (red)	poor conditions for salmon	● (red)	poor returns expected

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

Emerging Information on Toxics

Research has shown that exposure to toxics affects salmon and steelhead growth rates, increases susceptibility to diseases, and alters behavior (for example, predator detection and avoidance). While toxics are part of the existing environmental conditions that affect salmon and steelhead, NOAA Fisheries evaluates pertinent actions through other BiOps (e.g. EPA's proposed approval of Oregon's water quality criteria for toxic pollutants for aquatic life under section 303(c) of the Clean Water Act).

Climate Change Information

The 2010 Supplemental BiOp contained a thorough review of new climate science, and concluded that "new observations and predictions regarding physical effects of climate change are within the range of assumptions considered in the FCRPS BiOp and the AMIP." The Supplemental BiOp went on to state: "New studies of biological effects of climate change on salmon and steelhead provide additional details on effects previously considered and suggest that adult migration conditions in the mainstem lower Columbia may need particular attention through monitoring and proactive actions." The BiOp also included additional RPA action requirements to address this concern.

The Action Agencies monitor the latest climate change science research, with emphasis on peer-reviewed and published research on air and water temperature, precipitation and runoff over the Pacific Northwest. NOAA and the Action Agencies are currently updating lifecycle models for anadromous fish such as COMPASS (Comprehensive Fish Passage Model) with emerging climate data, and the estuary and tributary habitat programs are integrating climate change information into restoration planning. Flood control updates are quickly and seamlessly included in hydro regulation models such as Res-SIM and HYDSIM.

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

According to the Independent Scientific Advisory Board, mitigating for changes in hydrology and temperature in tributaries that are caused by climate change will involve many of the same approaches that have been initiated in the Columbia Basin. The Action Agencies continue to support water transactions, land acquisitions, and development of riparian buffers along streams to help create cold-water refuge areas for salmon, minimize temperature increases, and ameliorate the effects of climate change. (See Climate Change Report ISAB 2007-2.) Cool water releases from Dworshak Dam continue to be used to moderate summer temperatures in the lower Snake River, with a 68°F target.

Implementation Progress Overview

Hydropower

Actions to improve the overall survival of fish passing through the hydro system are an essential part of FCRPS BiOp commitments. Over the past decade, juvenile fish survival past the dams has increased dramatically through extensive dam modifications and more effective and efficient spill operations using surface passage. Under the hydropower strategies in the RPA, the Action Agencies implemented a wide-ranging program of actions at the federal dams. Actions included juvenile and adult dam passage modifications, operational improvements for spill and transport of juvenile fish, water management and water quality operations and improvements, and other activities (including ongoing maintenance) aimed at improving juvenile passage survival and adult returns.

Passage and Survival Improvements for Fish at the Dams

Most salmon and steelhead in the Columbia River Basin encounter one or more hydropower dams as they migrate to and from the ocean. Juvenile fish pass dams by many routes: through turbines, through juvenile bypass systems, through spillways, or by collection and transport in barges or trucks downstream. In general, survival of juvenile fish that pass through turbines can be lower than other routes of passage at the eight mainstem FCRPS dams. The Action Agencies therefore rely on spill operations and structural improvements designed in response to the specifics of each dam to both reduce the overall proportion of juvenile fish that pass through turbines and improve overall dam survival. Juvenile bypass systems, spill, and other surface passage routes are used to divert a large majority of migrating fish away from the turbines. Depending on location, time of year, and species, about 76 percent to 99 percent of the juvenile fish use these non-turbine routes. In addition to implementing alternatives that minimize the amount of fish passing through turbines, the Action Agencies installed improvements to juvenile bypass systems and spillways that reduced fish passage delay, improved safe conveyance of fish, minimized juvenile fish exposure to predation, and therefore increased juvenile fish survival through those non-turbine routes. Spill is currently the primary passage route for juvenile fish at each of the federal dams, with greatest benefit seen from surface spill, described further below. Dam survival performance standards of 93 to 96 percent through all passage routes and in-river survival targets guide the spill and passage operations at each dam.

Water Management for Anadromous Fish

Operators managed FCRPS storage reservoirs to more closely approximate the shape of the natural hydrograph and enhance flows and water quality to improve conditions for salmon and steelhead. The dams in the FCRPS were authorized by Congress for multiple purposes. The Action Agencies developed annual Water Management Plans to balance multiple priorities including providing salmon flows, cooling water temperatures, protecting listed and unlisted resident fish, managing flood risks, and serving other authorized purposes consistent with RPA Action 4 specifications. The annual plans can be found at http://www.nwd-wc.usace.army.mil/tmt/documents/wmp/ . These plans were developed and implemented with full regional coordination. 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 biologists and hydrologists. Figure 13 provides a high level summary of the operation constraints that have been put in place and actions that are taken during the year to provide improved conditions for fish. Operations for purposes such as power generation occur within the constraints established for flood control and fish operations shown in this figure.

Managing water in the Columbia River system for its many purposes is particularly challenging given the relatively small portion of the annual runoff volume that can actually be stored in reservoirs. Available storage—water that actually can be managed—is limited relative to total annual runoff in the Columbia River Basin. This means that operators cannot store water in one year to use in a subsequent dry water year.

Providing flows for fish is an important component of water management in the Columbia River Basin. Today, operators manage the storage reservoirs very differently than they did a few decades ago. In 2008-2012, 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. This allows for higher flows during the spring juvenile migration when storage reservoirs are refilling. 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, for each operating year 2008-2012, BPA and the Corps negotiated agreements with Canada that allowed storage of an additional 1 Million Acre-Feet (MAF) of water accounted for in Treaty space in Mica Reservoir. Each year this water was stored during the winter months and released in the spring and summer to support flow augmentation in the U.S. To help augment flows operators drew on up to about 5 MAF[4] of stored water annually – about one-sixth of the 32 MAF of storage available in U.S. and Canadian Treaty storage reservoirs. Because much of the available storage is in Treaty projects in Canada, use of this storage is governed by the Columbia River Treaty.

BC Hydro has additional water storage space that is not governed by the Columbia River Treaty. For operating years 2008-2011, BPA was also able to negotiate short-term agreements on use of non-Treaty storage space in Canada to provide spring and summer flow shaping to support fish operations. In 2012, BPA entered into a new long-term Columbia River non-Treaty storage agreement (NTSA) with BC Hydro which allows for coordinated use of non-Treaty storage in Canada to shape flows within the year for fisheries benefits, and provides up to an additional half MAF of water to benefit fish in dry water years.

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[4] *In 2008, 2009. 2010. 2011, and 2012, Reclamation provided 487,000 acre-feet of flow augmentation water from the upper Snake River above Brownlee Reservoir in accordance with the NOAA Fisheries 2008 Upper Snake River Irrigation Projects BiOp.*

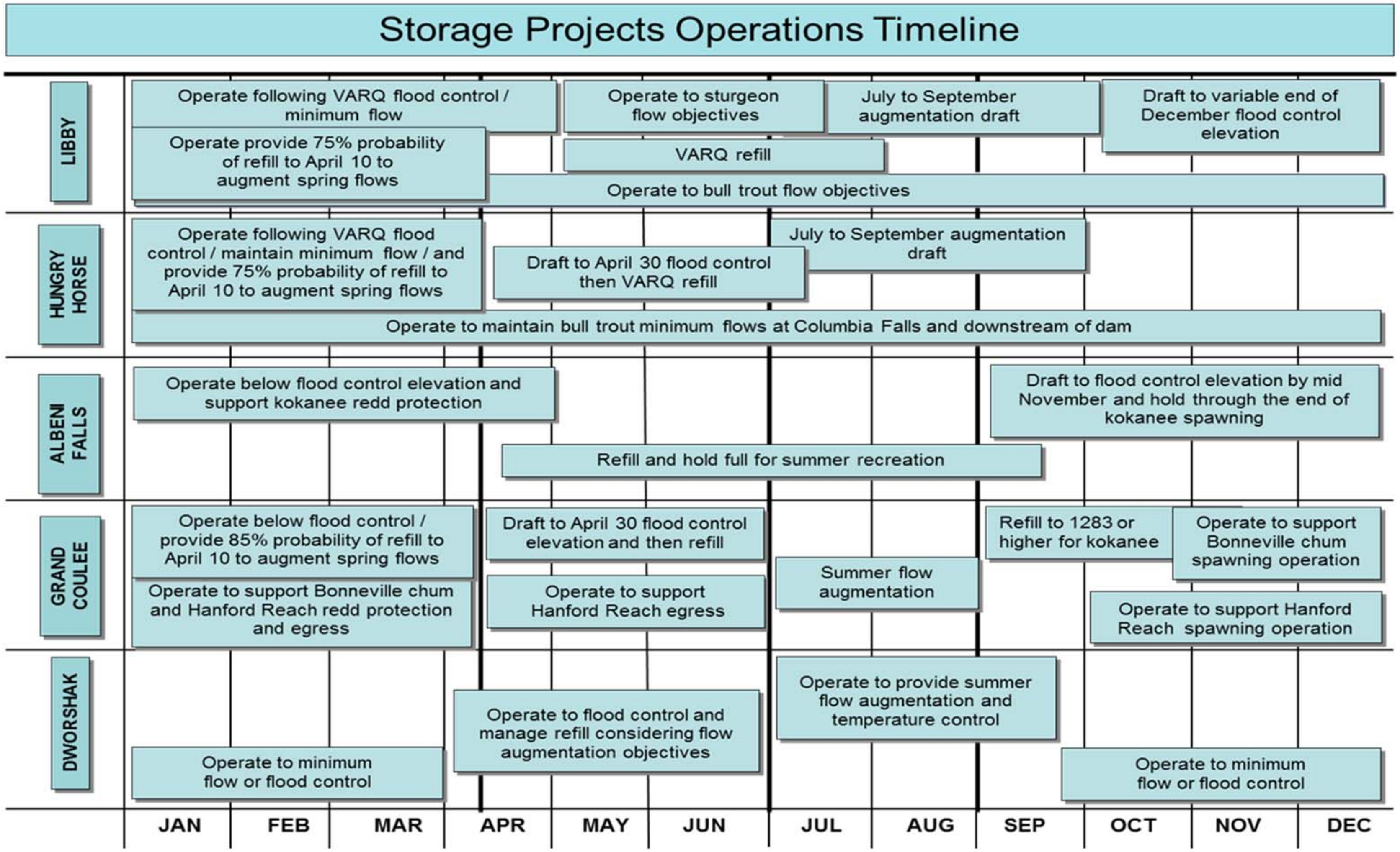


Figure 13. Storage Projects Operations Timeline. This figure provides a high level summary of the operational constraints that have been put in place and actions that are taken during the year to provide improved conditions for fish. The dams in the FCRPS were authorized by Congress for multiple purposes. These multiple purposes are considered and balanced in all the operation of the FCRPS. Operations for purposes such as power generation occur within the constraints established for flood control and fish operations shown in this figure.

Water Quality Implementation

The Action Agencies carried out a number of structural and operational actions to improve water quality, particularly with regard to water temperature and Total Dissolved Gas (TDG). In January 2009, the Corps, in a collaborative effort with regional sovereign partners, finalized a detailed Water Quality Plan for the Columbia River Basin. Structural and operational measures identified in the plan were implemented based on effectiveness and available funding.

To manage water temperatures in the lower Snake River during the summer, cold water is released from Dworshak Dam on the North Fork of the Clearwater River from early July through mid-September. Temperatures measured at the Lower Granite Dam tailrace did not exceed 68°F at any time during the 2008 and 2010 augmentation seasons. In 2009, there were 14 hourly readings in late July and early August that exceeded 68°F (ranging from 68.1 to 68.4°F), in 2011 there were six hourly readings of 68.1°F on August 6 and August 7, while in 2012 there were five hourly readings on July 24 of 68.1°F.

In February 2013 the Corps also finalized the "Location and Use of Adult Salmon Thermal Refugia in the Lower Columbia and Lower Snake Rivers" report, which provided a comparison of existing tributary and lower Columbia and lower Snake River temperature data, a summary of Snake and Clearwater River confluence study/modeling operations and Dworshak project releases and a compilation of University of Idaho studies of temperature regimes during upstream migration and the use of thermal refugia by adult salmon and steelhead in the Columbia River Basin. See the report at:

http://www.salmonrecovery.gov/Files/BiologicalOpinions/2010/Thermal%20refugia%20report%20Feb%2014%202013.pdf

Spill operations at the dams may result in the generation of TDG supersaturation in the Columbia and lower Snake rivers at levels above 110 percent, the current state and federal water quality standards. Structural measures to address TDG included the construction of spillway flow defectors on all 19 spillbays at Chief Joseph Dam, two new spillway flow deflectors at Little Goose Dam, an extended spillway flow deflector in spillbay 20 at John Day Dam and an extended spill wall between spillbays eight and nine at The Dalles Dam.

For voluntary spill to aid juvenile fish passage as called for in the BiOp, the states of Washington and Oregon provide exceptions to these standards. The Corps monitors TDG levels in the river and adjusts spill patterns and spill levels consistent with the applicable standards up to 120% TDG saturation in the tailrace of each dam and 115% TDG saturation in the forebay of the downstream project. Operational measures to address TDG include setting spill levels as a percent of flow or defined amount (i.e. 100 kcfs) rather than spilling to the TDG limit, developing and using spill patterns that minimize TDG generation, shifting spill from Grand Coulee to Chief Joseph Dam to utilize the degassing capability of the Chief Joseph flow deflectors, and daily spill management during fish passage season.

Involuntary spill occurs when high flows exceed the turbine capacity at any dam or when hydroelectric generation is reduced to keep the electricity supply from exceeding demand. High flows combined with periods of low electricity demand, such as at night, can sometimes lead to involuntary spill that exceeds the applicable TDG limits. This happens because electricity generation cannot exceed demand. BPA traditionally offered hydroelectric power at very low rates or for free during such periods to encourage other power providers to substitute the plentiful hydroelectricity for their own generation. But the growing wind fleet in BPA's system has a different revenue structure and continued to operate. To avoid the temporary oversupply of electricity in such conditions, BPA implemented its Interim Environmental Redispatch Policy in 2011 and Oversupply Management Protocol in 2012. Under these policies, BPA curtailed generation when necessary to balance energy supply and demand and to control the amount of total dissolved gas to the extent practicable.

During involuntary spill conditions, the Corps uses a spill priority list, developed in consultation with the TMT, to distribute spill on a system-wide basis to manage TDG levels throughout the Columbia River Basin. The spill priority list order is adjusted as needed to utilize structural improvements that reduce TDG such as the flow deflectors at Chief Joseph Dam.

On an annual basis, the Corps prepares a water quality report with more thorough discussion of how the system was operated during the year. See the *Dissolved Gas and Water Temperature Report: Columbia River Basin* reports at: *http://www.nwd-wc.usace.army.mil/tmt/wqnew/tdg_and_temp/*.

Juvenile Fish Survival

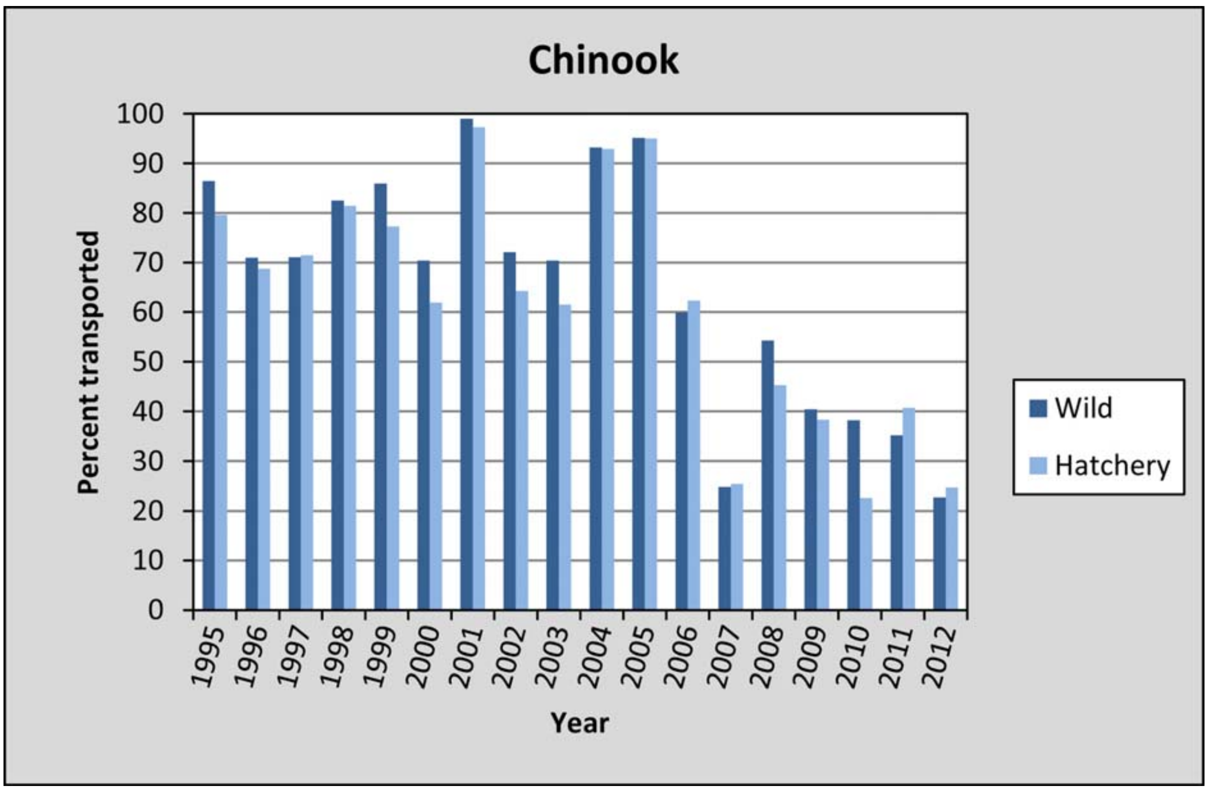
Juvenile fish survival through the Columbia and Snake rivers is influenced by, among other things, the operation and configuration of the FCRPS projects. Under the FCRPS BiOp, the Action Agencies have aggressively pursued major improvements and investments in operations and passage facilities to achieve rigorous performance standards of 96 percent average dam survival for spring migrating fish and 93 percent average dam survival for summer migrating fish.

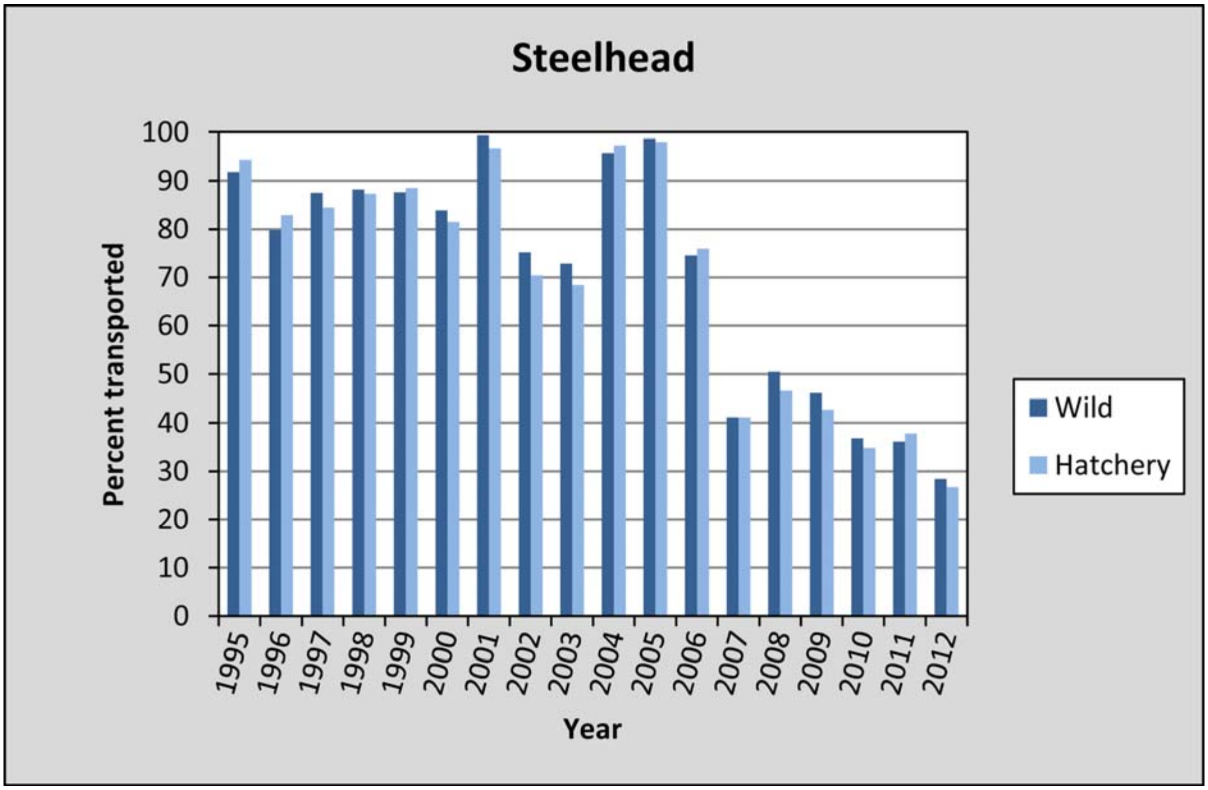
Hatchery and natural-origin juvenile salmon and steelhead that migrate to the ocean through the Snake and Columbia rivers can either be left "in-river" to migrate past the dams or transported by barge or truck to below Bonneville Dam. Empirical evidence is used to track the percent of fish that return as adults among those transported and those left in river to migrate. Generally fish are transported during time periods that yield higher adult returns than in-river migration.

For juvenile fish, total system survival is a combination of transportation and in-river survival, and is influenced by factors such as flow, timing of runoff, water quality, temperature, and fish condition. Survival for transported fish is estimated to be 98 percent, as recently confirmed by a 2011 study. In 2012, total system survival from the Lower Granite tailrace to the Bonneville tailrace (survival of in-river and transported groups combined) was about 64 percent for natural-origin and hatchery Chinook combined. During 2008 – 2011, total system survival for natural-origin Chinook ranged from about 65 percent to just over 80 percent, and total system survival for natural-origin and hatchery Chinook combined ranged from 69 percent to 72 percent. In 2012, total system survival for combined natural-origin and hatchery steelhead was about 70 percent. During 2008-2011, total system survival for natural-origin steelhead ranged from 66 percent to 75 percent, while total system survival for combined natural-origin and hatchery steelhead ranged from 72 percent to 81 percent. Because significant proportions of juvenile upper Columbia River spring Chinook and steelhead are left to migrate in river, in-river survival rates are equivalent to total system survival rates for these species.

As described further below, transportation provides a survival benefit and improves total system survival during some migration windows. Research is being carried out under the FCRPS BiOp to better understand any delayed effects of transport. Given this ongoing evaluation and improvements at the dams, transportation has been implemented using a "spread the risk" approach. The estimated percent of Snake River steelhead and Chinook salmon transported declined each year starting at just under 50 percent in 2008 to less than 30 percent in 2012 (Figures 14 and 15).

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 2012 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.





Figures 14 and 15. Estimated Percent of Yearling Chinook Salmon and Steelhead, Respectively, Transported to Below Bonneville Dam, by Year, 1995-2012. 2012 values are preliminary and subject to revision.

The FCRPS BiOp included a metric to estimate in-river survival performance for Snake River and upper Columbia River Chinook and steelhead. This metric provides important information for both the annual adaptive management process and the comprehensive evaluations in 2013 and 2016. The Action Agencies empirically estimated in-river survival in 2008-12 (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 2012 migration season using 2012 river conditions, fish migration patterns, and dam and transport operations. Figure 17 shows the results of these comparisons. Results indicate that the benefits from the hydro operation, passage improvements and predation deterrent actions implemented to date are generally accruing as expected in the FCRPS BiOp analysis.

Travel time through the hydropower system during 2011 was among the fastest observed in recent years for both yearling Chinook salmon and steelhead (Figure 18). During 2011, flows at Snake River dams were above the historic average (1994-2010) and increased to high levels during May. These high river flows resulted in increased water velocity and spill in excess of fish passage spill. Travel time was likely shortened by these high levels of flow and spill and by the use of surface bypass structures that provided more effective surface spill at most projects during 2011. In particular, recent studies have shown that surface passage, which spills fish at the surface of the water column compared to conventional spill, generally reduces delay and improves passage time.

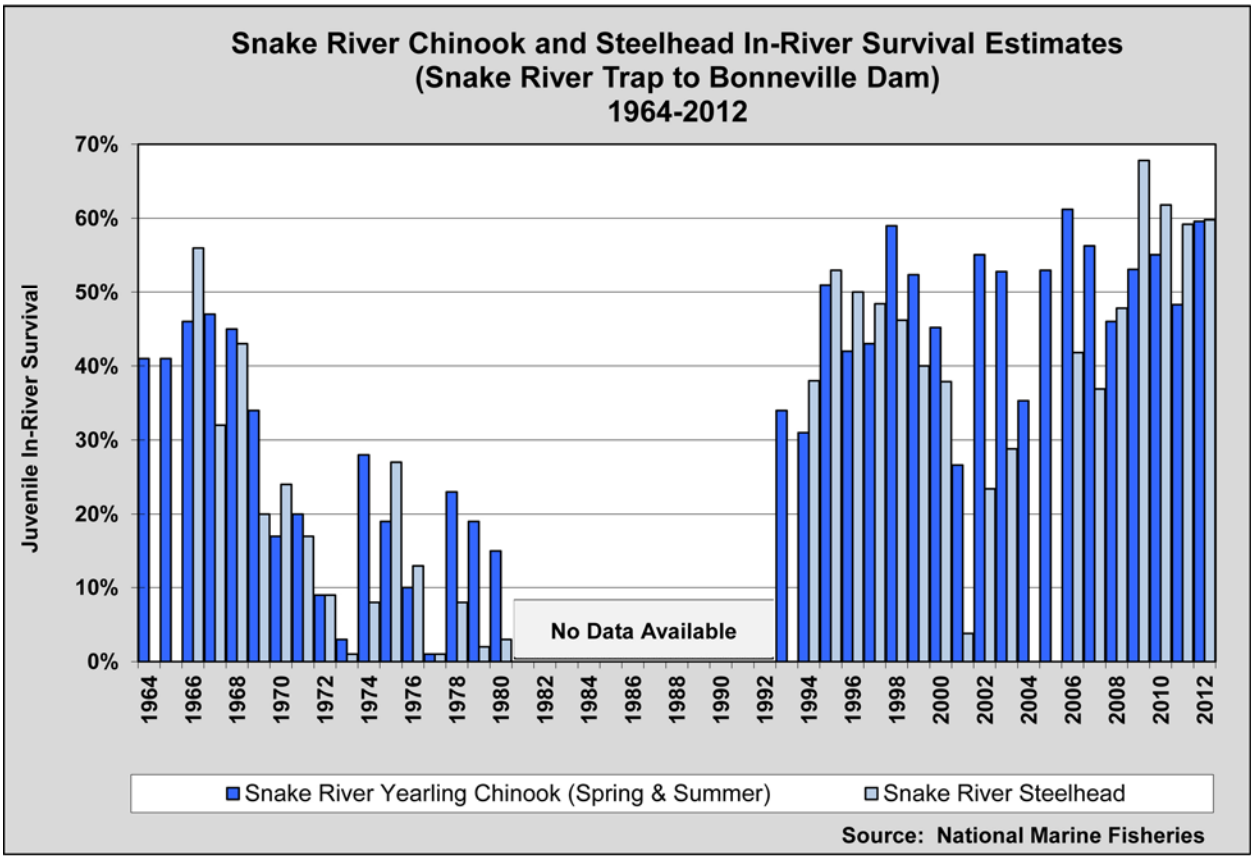


Figure 16. In-river Survival Estimates (Hatchery and Natural-origin Combined) for Snake River Spring-Summer Chinook and Snake River Steelhead. Steelhead estimates for 2004 and 2005 are not available due to low PIT-tag detection efficiency at Bonneville dam. Survival estimates are not available for 1981 through 1992. Estimates for 2012 are preliminary numbers and subject to change.

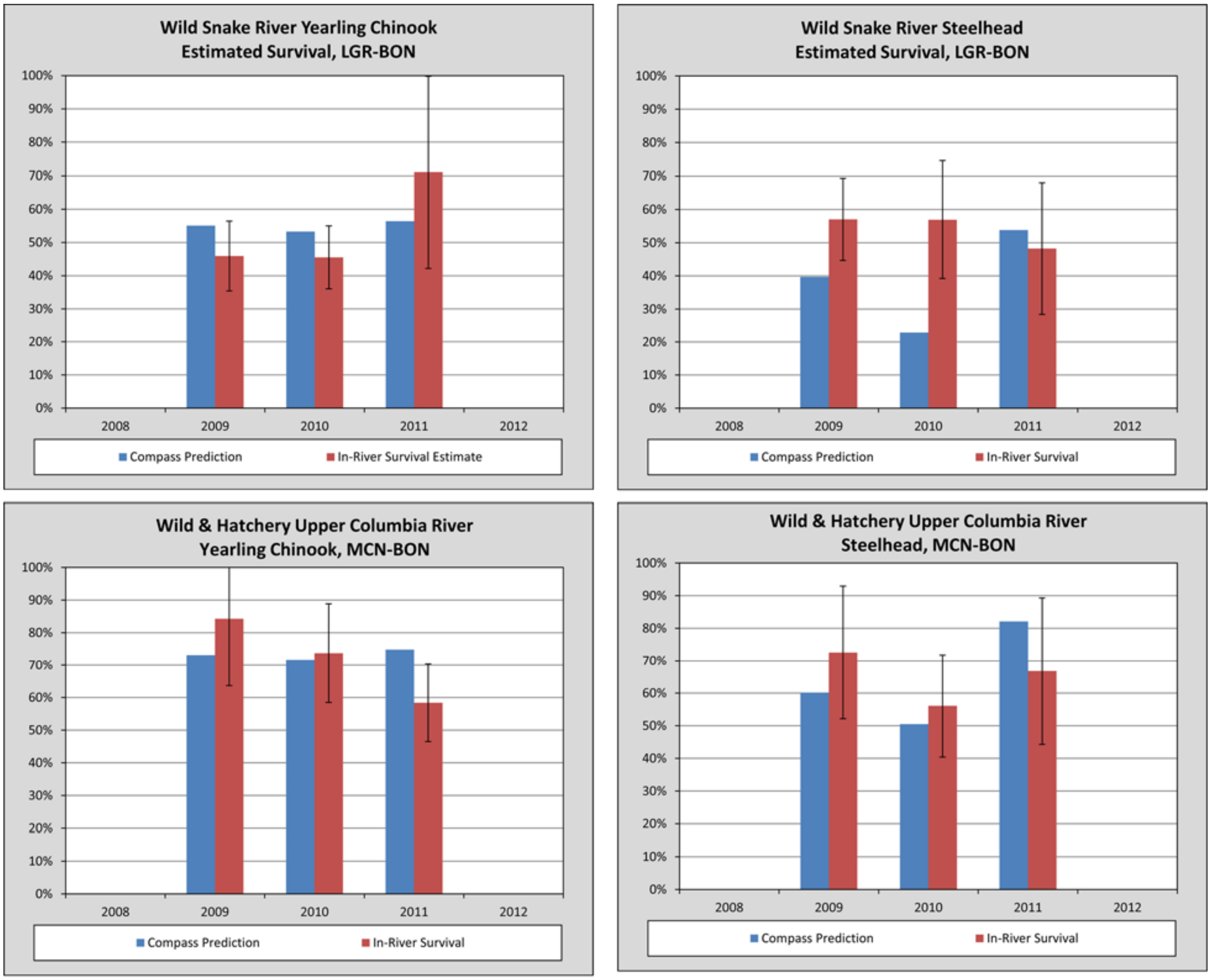


Figure 17. COMPASS Model Predictions and PIT-Tag Estimated In-river Survival for Juvenile Snake River (SR) Natural-Origin Spring/Summer Chinook and Steelhead, and for Upper Columbia River (UCR) Natural-Origin/Hatchery Spring Chinook and Steelhead. Error whiskers indicate 95 percent confidence intervals. (BON – Bonneville, MCN = McNary, LGR = Lower Granite)

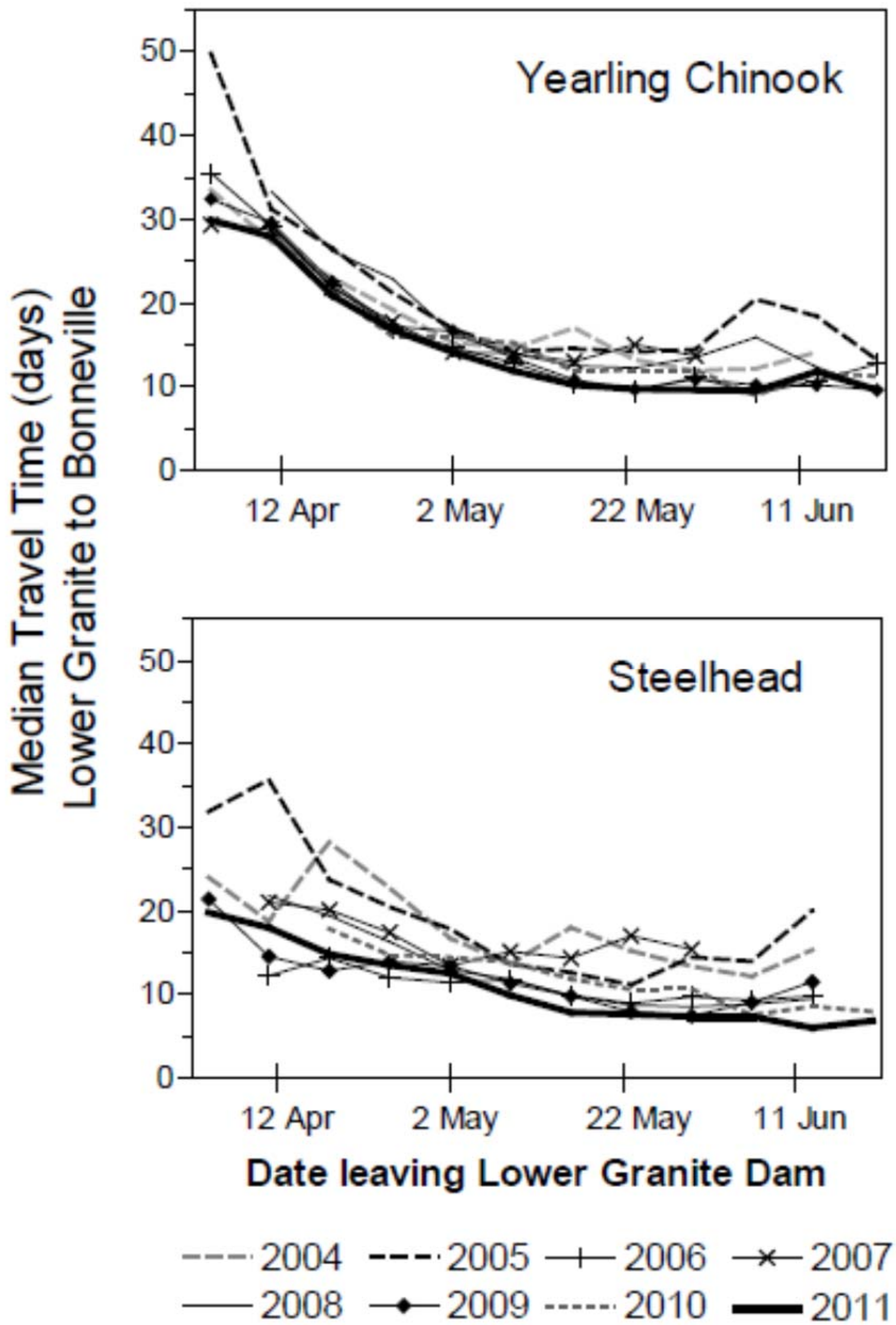


Figure 18. Median Travel Time (Days) from Lower Granite Dam to Bonneville Dam for Weekly Release Groups of Snake River Yearling Chinook Salmon and Steelhead from Lower Granite Dam, 2004-2011.

Surface Passage and Spill

Spill has long been a key strategy employed by the Action Agencies to reduce the proportion of fish passing through turbines and increase overall dam passage survival. For example, spill was first used to pass juvenile fish at Bonneville, The Dalles, John Day, Ice Harbor, Lower Monumental, Little Goose, and Lower Granite dams in 1983. The Action Agencies have since conducted many years of extensive engineering and biological studies to understand how to best operate spillways to accommodate downstream juvenile fish passage without excessive TDG generation or impeding upstream adult passage. In recent years, spill has become increasingly important because of the installation of spillway weirs. Because of their high fish passage effectiveness, surface passage structures such as spillway weirs pass large numbers of fish with less flow than conventional spillbays. Since the early 2000's, much of the Action Agencies' focus has been on using spill in conjunction with surface passage structures to facilitate safer juvenile fish passage at dams. In general, the addition of surface passage structures at all eight dams, combined with refined spill operations, decreased the proportion of juveniles that passed through powerhouses and turbines, decreased forebay residence times, reduced the number of juvenile fish diverted through the fish bypass facilities at some dams, and increased overall dam survival (Figures 19 and 20).

Surface passage structures are now in place at all eight mainstem dams, although each dam has a unique hydraulic configuration that requires tailored spill to provide safe fish passage. Two types of surface passage structures are employed at FCRPS dams: spillway weirs (e.g., the Lower Granite Dam spillway weir) and powerhouse surface collectors (e.g., Bonneville Dam Corner Collector). Lower Granite, Little Goose, Lower Monumental, Ice Harbor, McNary, and John Day dams all have spillway weirs. The Dalles Dam and both powerhouses at Bonneville Dam have powerhouse surface collectors. Surface passage structures transform conventional spillways to provide more natural river passage conditions for surface-oriented juvenile fish, improve juvenile fish survival, reduce juvenile fish passage delay, improve water quality, and make more efficient use of spill by passing more fish through safer surface passage routes per unit of water spilled. Most juvenile salmon tend to travel in the upper 10 to 20 feet of the water column as they migrate downstream to the ocean. When approaching dams without surface passage, juvenile fish need to dive to depths of 40 to 50 feet to access passage routes such as a spillbay opening or a guidance screen that will guide them into a juvenile bypass channel. Surface passage structures such as John Day Dam's spillway weirs and the Bonneville Dam corner collector provide downstream migrating fish with an improved passage option at the surface; these routes are generally very effective at passing large numbers of fish safely. For example, about 70 percent of all juvenile steelhead that pass through Powerhouse 2 at Bonneville Dam do so via corner collector spill and survive at rates higher than 98 percent on average. The addition of two spillway weirs to provide surface spill at John Day Dam cut by half the proportion of juvenile salmon and steelhead passing through turbines. Fish survival through surface passage spill is often as high, or higher than, survival via conventional spillbays while using less water.

The Action Agencies have also implemented improvements at Bonneville and The Dalles dam spillways. At Bonneville Dam, the spill level was adjusted and resulted in an increase in subyearling Chinook survival. At The Dalles Dam, an 800-foot long spillwall was constructed to improve tailrace downstream egress and provide safer conveyance for juvenile fish passing through the immediate tailrace where high concentrations of piscivorous predators are known to occur. The spillway at The Dalles Dam is the primary passage route for juvenile fish, with approximately 80 percent of the fish that pass the dam passing through the spillway. Results from 2010-12 performance standard testing indicated a marked improvement over the pre-spillwall configuration in survival of both spring and summer migrants (Figures 19 and 20).

In general, the configuration and operation actions taken at many of the dams to increase the survival of yearling Chinook salmon and juvenile steelhead have met the benefits anticipated in the FCRPS BiOp (Figures 19 and 20).

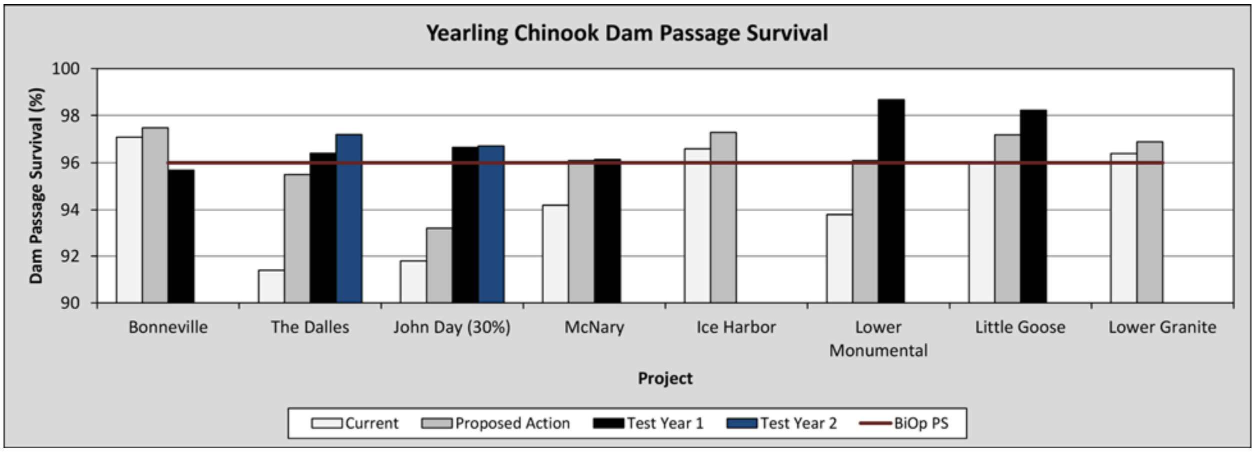


Figure 19. Yearling Chinook COMPASS Juvenile Dam Passage Survival Estimates Compared to Recent Empirical Test Results. "Current" = COMPASS-based expected survival based on improvements in place at the time of the FCRPS BiOp. "Proposed Action" = COMPASS-based expected survival after implementation of the improvements called for in the FCRPS BiOp's RPA. Empirical survival estimates derived from post-construction juvenile dam passasge survival studies.

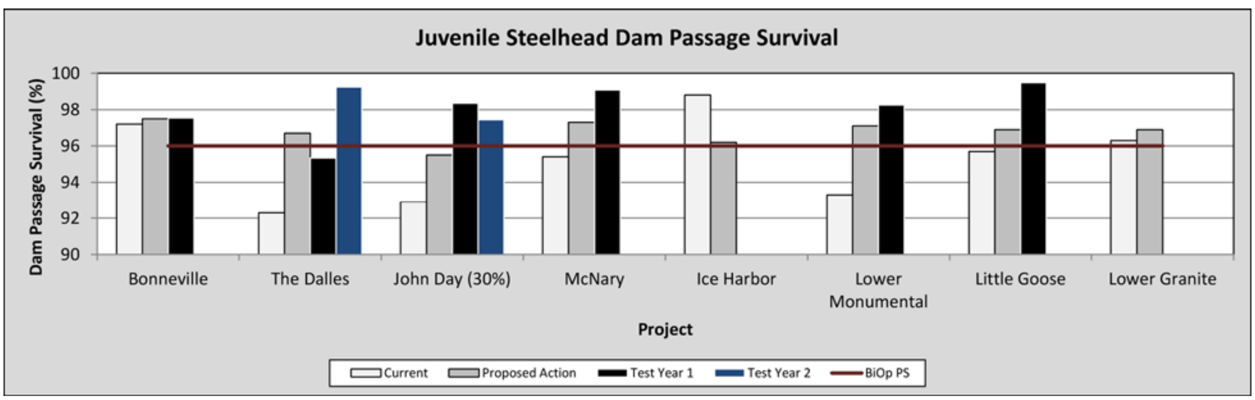


Figure 20. Juvenile Steelhead COMPASSJjuvenile Dam Passage Survival Estimates Compared to Recent Empirical Test Results. "Current" = COMPASS-based expected survival based on improvements in place at the time of the FCRPS BiOp. "Proposed Action" = COMPASS-based expected survival after implementation of the improvements called for in the FCRPS BiOp's RPA. Empirical survival estimates derived from post-construction juvenile dam passasge survival studies.

Juvenile Bypass Systems

Seven of the eight lower Columbia and Snake river dams have screened juvenile fish bypass systems. These bypass systems guide fish away from turbines by means of submerged screens installed in the turbine intakes. As juvenile fish travel with flow toward the turbine intakes, the guidance screens redirect them up through channels in the dam, routing them away from the turbines. The fish are then either passed back to the river below the dam or loaded into barges or trucks for transport downstream past the remaining dams. Juvenile fish survival through bypass systems is generally much higher than survival through turbines and is, therefore, an important component in increasing overall juvenile fish survival. Most of the juvenile bypass systems were installed at dams in the late 1970s and early 1980s. Work to increase the proportion of fish guided by these systems occurred in the 1990s, and more recently survival improvements to bypass systems have been completed by the Corps. Specifically, in 2011-2012, the bypass system outfall locations at Lower Monumental and McNary dams were relocated to areas that better protect from predation juvenile fish passing through the bypass system.

Basic Approach – Performance Standards

Passage improvements to achieve dam passage performance standards, identified in coordination with the region, have been completed at seven of eight Snake and lower Columbia river dams. With these improvements in place and plans for additional improvements at the eighth dam, Lower Granite Dam, the Action Agencies anticipate meeting the juvenile dam passage survival performance standards specified in the 2010 Supplemental BiOp.

In collaboration with the region, the Corps applied state-of-the-art methods and tools to ensure that the best available science was applied in acquiring juvenile Chinook and steelhead dam passage survival estimates. The Corps developed a mark-recapture system that resulted in the smallest acoustic tag available on the market to date, as well as the highest detection probabilities achieved to date for marked fish migrating through the FCRPS. This equated to reduced tag effects on tagged fish and precise survival estimates not possible without this technology. In addition to development of an improved marking system, the Corps conducted multi-year laboratory and field studies to fully understand the limits of using the smaller active tags on estimating dam, reach, and system fish survival. Additionally, an improved survival model was developed to minimize the probability of bias seen in earlier paired-release survival model studies, adding more rigor to the studies outlined in the 2008 BiOp. Improved and standardized fish handling protocols were developed in coordination with regional salmon managers and researchers. Finally, as part of the scientific process, the Action Agencies and their partners sought peer review of all aspects of this work, with more than 12 peer-reviewed papers having been published in professional journals to date and additional manuscripts in press. In addition, the Independent Scientific Advisory Board (ISAB) reviewed the new survival model and methods, and the Anadromous Fish Evaluation Program regional teams reviewed all aspects of this work. More details on development of tools and methods, along with references, are provided in Section 2 under RPA Subaction 54.8.

The Action Agencies, in coordination with NOAA Fisheries and with the RIOG, prepared a document which presents how the Action Agencies and NOAA Fisheries expect to conduct future juvenile dam passage performance standards evaluations to determine if a particular dam is meeting the performance standards specified in the 2010 Supplemental BiOp (2012 FCRPS Performance Standard Paper). The document includes criteria on flow year, target spill level vs. actual spill level, and variability between flow years when tests are conducted. For a given dam to achieve the juvenile dam passage survival performance standards, two years of testing must occur with survival either meeting or exceeding the performance standard each year.

Beginning in 2010, full performance standard testing was initiated at The Dalles Dam. The 2010 estimates of juvenile steelhead dam passage survival were slightly below the performance standard of 96 percent at 95.3 percent; however, elevated levels of avian predation occurred downstream of the dam during testing (Table 2). Additional avian deterrent wires were installed following 2010 performance standard testing. This helped reduce avian predation, and as a result, estimates of juvenile steelhead dam passage survival increased in 2011 to 99.5 percent (Table 2). Estimates of yearling Chinook dam passage survival were either at or above the performance standard in 2010 and 2011 (Table 2) and estimates of sub-yearling Chinook dam passage survival were either at or above the performance standard in 2010 and 2012 (Table 2). Based on 2010, 2011 and 2012 test results, the Action Agencies believe the BiOp performance standard has been met for steelhead, yearling and sub-yearling Chinook at The Dalles Dam. The Action Agencies, in coordination with NOAA Fisheries and an appropriate regional forum, are reviewing test results to confirm that the standard has been met.

Full performance standard testing was also conducted at John Day Dam in 2011 and 2012 for both yearling Chinook and steelhead at 30 percent and 40 percent spill levels. Estimates of dam passage survival for both species met the standard at both spill levels in 2011. In 2012, high flow thwarted attempts to maintain the planned spill levels. Actual spill levels averaged about 37 percent during the test and the estimated survival met the standard. As described in the Performance Standard Paper, this variance between actual spill level and targeted spill level does not invalidate the test but can result in an upward adjustment of future spill levels. Based on the 2010 and 2012 test results, the Action Agencies believe the FCRPS BiOp performance standard has been met for steelhead and yearling Chinook at John Day Dam. The Action Agencies, in coordination with NOAA Fisheries and the appropriate regional forum, are reviewing the test results to confirm that the standard has been met.

Since 2010, full performance standard testing has also been conducted at Bonneville, The Dalles, John Day, McNary, Lower Monumental, and Little Goose dams. Results from these studies indicate that the Action Agencies are on track to meet the juvenile dam passage survival performance standards specified in the 2010 Supplemental BiOp (Table 2).

Table 2. Juvenile Dam Passage Survival Performance Standard Test Results.

Dam	Year	Species	Survival (%)	Spill Operation (Target/Actual)
Bonneville	2011	Yearling Chinook Salmon	95.69	100 kcfs / 100 kcfs
Bonneville	2011	Steelhead	97.55	100 kcfs / 100 kcfs
Bonneville	2012	Subyearling Chinook Salmon	97.39	85 kcfs day – 121 kcfs night / 149 kcfs 95 kcfs 24 hrs / 149 kcfs
The Dalles	2010	Yearling Chinook Salmon	96.41	40% / 40%
The Dalles	2011	Yearling Chinook Salmon	96.00	40% / 40%
The Dalles	2010	Steelhead	95.34	40% / 40%
The Dalles	2011	Steelhead	99.52	40% / 40%
The Dalles	2010	Subyearling Chinook Salmon	94.04	40% / 40%
The Dalles	2012	Subyearling Chinook Salmon	94.69	40% / 40%
John Day	2011	Yearling Chinook Salmon	96.66 97.84	30% / 30% 40% / 40%
John Day	2012	Yearling Chinook Salmon	96.73	30% / 37.1% 40% / 37.1%
John Day	2012	Steelhead	97.44	30% / 37.1% 40% / 37.1%
John Day	2012	Subyearling Chinook Salmon	94.14	30%/37.9% 40%/37.9%
McNary	2012	Yearling Chinook Salmon	96.16	40% / 51%
McNary	2012	Steelhead	99.08	40% / 51%
McNary	2012	Subyearling Chinook Salmon	97.47	50% / 62%
Lower Monumental	2012	Yearling Chinook Salmon	98.68	Gas Cap (26 kcfs) / 29.7 kcfs
Lower Monumental	2012	Steelhead	98.26	Gas Cap (26 kcfs) / 29.7 kcfs
Lower Monumental	2012	Subyearling Chinook Salmon	97.9	17 kcfs / 25.2 kcfs
Little Goose	2012	Yearling Chinook Salmon	98.22	30% / 31.8%
Little Goose	2012	Steelhead	99.48	30% / 31.8%
Little Goose	2012	Subyearling Chinook Salmon	95.1	30% / 38.5%

Fish Transportation and Barging

Juvenile fish transportation is an ongoing program that collects fish from juvenile bypass facilities at Lower Granite, Little Goose, Lower Monumental, and McNary dams and transports them by either barge or truck to release sites below Bonneville Dam. Transporting fish around the dams reduces the effects of dam passage, adverse in-river migration conditions, and predation, thereby improving their survival to the ocean and ultimately increasing their returns as adults.

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, 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. Figure 21 is an example of the intra- and inter-annual variation in smolt-to-adult returns (SARs) from juveniles that migrated in river versus those that were transported.

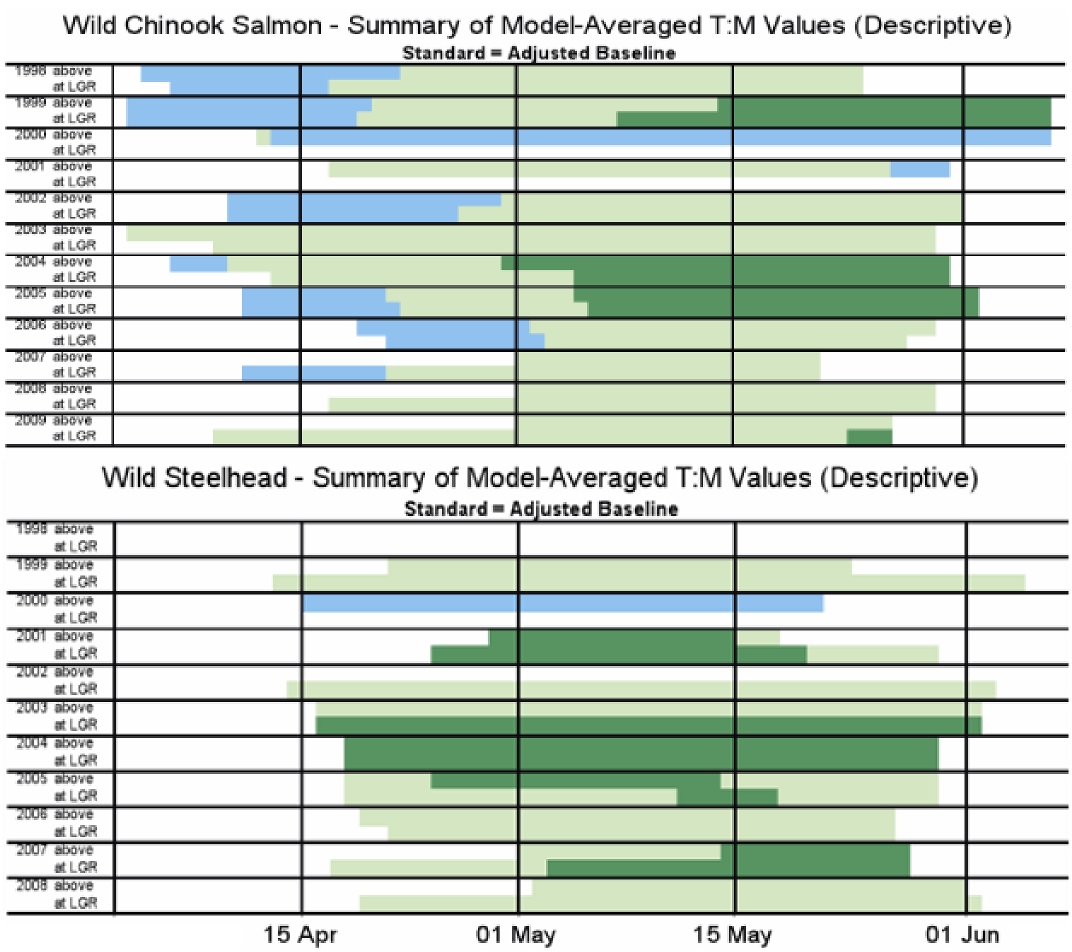


Figure 21. Color Coded Summary of T:M Ratios from Lower Granite Dam for Snake River Natural Origin Chinook and Steelhead. Color coding: dark blue cells – T:M significantly < 1; light blue cells – T:M < 1 but not significantly; light green cells – T:M > 1 but not significantly; dark green cells – T:M significantly > 1. White cells indicate no data. Statistical significance determined from 95% confidence envelope around model averaged curve.

From 2007-2012, more fish were left in-river than were transported compared to previous years (Figures 14 and 15 above). This reduction was attributed to two factors: surface passage structures at each dam combined with an increased proportion of spill relative to total river flow and regional recommendations to keep more fish in the river. Transportation results continue to indicate higher adult returns of yearling Chinook salmon and juvenile steelhead that are collected and transported compared to those that migrate in-river during part of April and all of May, indicating that more fish would survive to adults with greater transportation of fish in the spring than is currently occurring.

Adult Passage Improvements

The majority of fish ladders at Columbia and Snake river dams continue to perform well for adult salmon and steelhead. However, John Day Dam ladders have been a concern, with problems including adult fish dropping back out into the tailrace after entering the ladders, long passage times, fish jumping out of the ladder in the exit sections, and difficulties with fish counting related to fish delaying just above the count stations. At the John Day north ladder, these problems have been attributed primarily to hydraulic issues at two separate locations: the count station exit area and the lowest section of the ladder from the entrance to the transition pool. Modifications to the John Day north lower ladder entrance area, including a non-mechanical keyhole weir entrance, removal of lower weirs, re-plumbing and new pumps for the auxiliary water supply system (AWS), and other Pacific lamprey modifications, began in 2011 and were completed for the 2013 passage season. In addition to renovating the John Day north ladder, the Corps completed several studies and modifications to ladders aimed at increasing the reliability of these systems to ensure continued good upstream passage through the FCRPS.

Adult Fish Survival

Adult fish survival in the Columbia and Snake rivers is influenced by the operation and configuration of the FCRPS dams including spill operations to benefit juvenile fish passage and the operation and configuration of fish ladders at the dams. Sea lion predation, levels of straying, and harvest-related mortality also affect adult fish survival. Annual survival rates of listed adult fish through defined hydrosystem reaches are estimated based on detections of fish tagged with passive integrated transponder tags (PIT-tags) at Bonneville, McNary, and Lower Granite dams, with corrections for harvest and straying.

Survival through the hydrosystem for adult fish is evaluated for five stocks using a five-year rolling average of annual survival estimates (Figure 22). Snake River stocks are used as surrogates for Snake River sockeye and mid-Columbia River steelhead.

Data from 2007-11 indicate that adult survival relative to the performance standards is mixed.

The estimated survival of adult Snake River fall Chinook salmon, Upper Columbia River spring Chinook salmon, and Upper Columbia River steelhead for the 2007-2011 period are near or meeting the FCRPS BiOp standards for these ESU/DPSs. But the survival of adult Snake River spring-summer Chinook salmon, steelhead, and sockeye are not meeting their standards (Figure 22). Although mean survival among years varies considerably, the available information suggests that survival over the five-year period of three Snake River ESUs is less than target levels.

Because these standards were being met previously for a number of years, emerging factors have been identified that likely impede the attainment of adult performance standards. For example, high flows and high spill levels, such as those seen in 2011, are known to increase fallback and delay of adults. Increased fallback and delay can result in increased levels of straying and harvest-related mortality and, at Bonneville Dam, in increased losses due to sea lion predation. These potential factors are being assessed through FCRPS BiOp

Research, Monitoring & Evaluation (RM&E) actions. The Action Agencies have added PIT-tag detection capability to adult passage facilities at The Dalles Dam, and are investigating adding PIT-tag capability in fisheries above Bonneville Dam to better understand and quantify unexplained and higher-than-anticipated losses within those reaches.

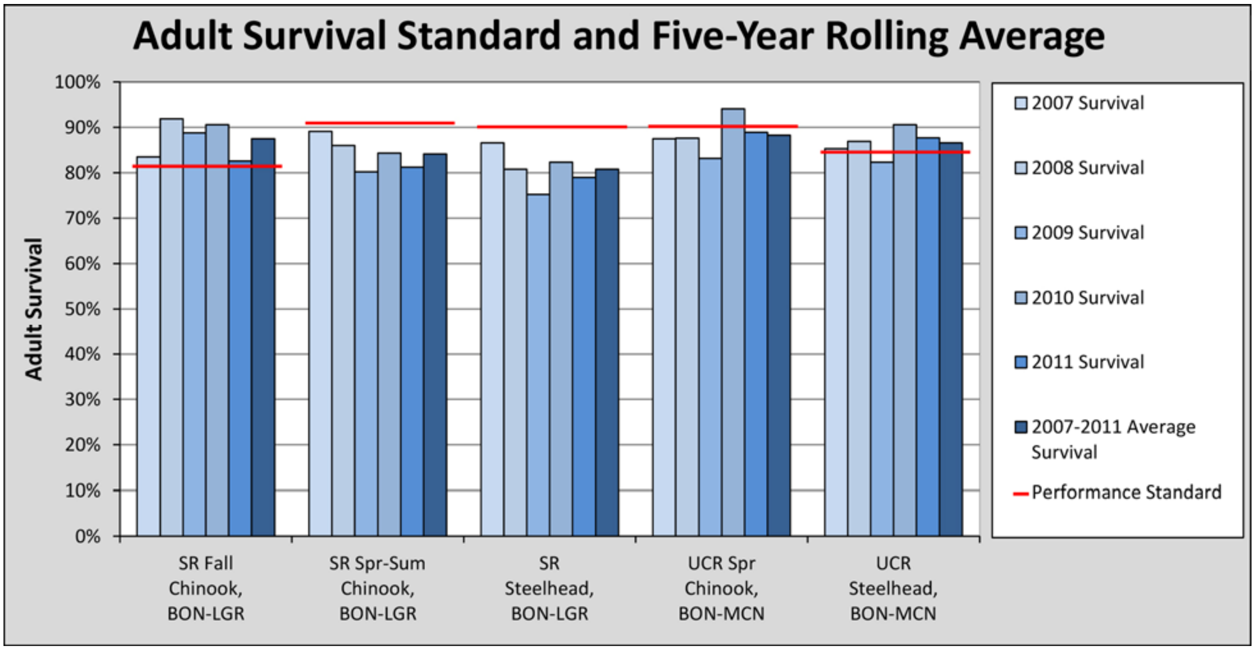


Figure 22. FCRPS BiOp Adult Survival Standard and Five-Year Rolling Average Survival of Adults that Migrated In-river as Juveniles, Based on PIT-tag Conversion Rates of Snake River (SR) and Upper Columbia River (UCR) ESUs. (BON = Bonneville, MCN = McNary, LGR = Lower Granite)

Kelt Management

Kelts are steelhead that survive to spawn again in subsequent years. The goal of kelt management actions are 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.

Progress towards FCRPS BiOp Goals

The first successful release of natural-origin reconditioned Snake River B-run steelhead occurred in 2012, contributing to the FCRPS BiOp goal of a 6 percent increase in Snake River B-run female steelhead abundance. Recent advances in research to improve reconditioning techniques, infrastructure improvements at the holding and hatchery facilities and plans to increase kelt collection are expected to enable the Action Agencies to meet the FCRPS BiOp goal of 6 percent by 2018.

In addition to expanding reconditioning efforts, beginning in 2010 the Action Agencies extended the operating season of the ice and trash sluiceway at The Dalles Dam to enhance kelt passage. The Action Agencies, with NOAA Fisheries, developed and implemented a benefit analysis that calculated an increase in adult steelhead returns associated with this operation. The Action Agencies are investigating operational opportunities at other FCRPS dams which could yield additional benefits towards Snake River B-run steelhead.

Description of Accomplishments Since 2008

Snake River Kelt Management Plans (KMPs) have been released annually since 2010 to describe and support Snake River kelt program actions. The 2012 document built upon the framework of previous plans, and also identified future direction for 2013 and beyond. The KMPs annually review new information and findings as well as assess progress towards goals and can be found at http://www.salmonrecovery.gov/Hatchery/KeltReconditioning.aspx.

Several multiyear studies have monitored transport survival among kelts undergoing short and long-term reconditioning treatments. Kelts transported from Lower Granite and Prosser dams have shown little to no increase in return rates compared to fish left in the river; therefore the highest priority research efforts, for the time being, have been directed at evaluating strategies other than transport.

Beginning in 2010, Snake River B-run steelhead kelts were collected at Lower Granite Dam and taken to Dworshak National Fish Hatchery (NFH) for reconditioning. Results to date support the objective that Snake River B-run steelhead kelts survive and recondition to spawn again. In 2012, nine natural-origin B-run steelhead kelts were successfully reconditioned and released into the Snake River.

Results from 2012 showed that kelt survival improved after the installation of surface spillway weirs compared to the 2003-2005 period, before weir installation was complete. Survival estimates ranged from 0.891 to 1.002 (for individual river reaches) within the FCRPS. Survival estimates were highest for kelts that passed through spillway weirs and through traditional spill. Kelts that passed through the Juvenile Bypass System (JBS) also had high survival estimates when compared to all other routes. These findings suggest there is higher survival in-river for kelts than previously estimated, which may contribute towards meeting the Snake River B-run steelhead abundance goal.

Habitat Protection and Improvement Actions

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

Conservation Council's Columbia Basin Fish and Wildlife Program provide reliable implementation and science oversight for these efforts.

Research and recovery plans in the Columbia River Basin and beyond have documented connections between habitat attributes and fish performance, underscoring the role of habitat improvements in strengthening fish populations. Studies have established relationships between habitat quality and fish survival and is pinpointing those factors that most influence salmon numbers, such as water flows, the number, depth and proportion of pools, gravel sizes, and temperature. The scientific literature has established that such habitat improvement projects, when properly planned and designed, benefit fish through improved habitat capacity that supports increased fish survival. For more details see the report, Benefits of Tributary Habitat Improvement in the Columbia River Basin; Results of Research, Monitoring and Evaluation, 2007-2012.

An understanding of fish-habitat relationships, combined with detailed watershed and population assessments, helps biologists target the most critical habitat issues or limiting factors, the best mitigation projects, and more accurately estimate the benefits for fish. In coordination and partnership with tribes and federal, state, and local entities, the Action Agencies are increasing the volume of water in streams, installing or retrofitting fish screens at water diversions to keep fish safely out of irrigation canals, reconnecting side channels and floodplains to add complex and diverse habitats, removing barriers to expand access to blocked habitat, and acquiring easements or other protective interests for riparian areas along tributaries.

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

Tributary Habitat

The Action Agencies continued to expand an already significant tributary habitat program with the onset of the FCRPS BiOp. The program focuses on tributary habitats used by populations of fish identified in the FCRPS BiOp as having the greatest biological needs. The main goal of the program is to increase survival of the FCRPS BiOp priority populations by addressing key habitat factors that limit spawning and rearing success.

Tributary Habitat Performance Measures: Percent of Habitat Quality Improvement

Under the FCRPS BiOp, the tributary habitat performance measures are called habitat quality improvements, or HQIs. HQIs are established for 56 populations of Chinook and steelhead and represent an estimated percent of improved habitat condition relative to the estimated current habitat condition for an entire population. Action Agency progress towards the HQIs are determined from estimates of local experts with the most knowledge of local watershed processes, habitat conditions and fish populations in their respective areas.

To support this goal, Reclamation initiated tributary and reach assessments[5] and increased technical planning and design assistance, while BPA increased implementation funding in key watersheds. In addition to the expanded efforts for FCRPS BiOp priority populations, the Action Agencies continued to improve habitat for other anadromous fish populations throughout the Columbia River Basin.

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

See Section 3 for a comprehensive list of completed projects implemented by the Action Agencies and regional partners.

Projects to protect or improve critical fish habitat employ location-specific approaches, depending on habitat type and condition, targeted to the specific limiting factors affecting each population. The following sections summarize Action Agency accomplishments from 2005 to 2012 and provide examples of the work completed in 2012.

Progress towards FCRPS BiOp Goals

The FCRPS BiOp includes two strategies (RPA Actions 34 and 35) to protect and improve tributary habitat. Both RPA actions require the Action Agencies to provide funding and technical assistance to implement projects that improve the quality of spawning and rearing habitat for specific populations of Snake River and upper Columbia River Chinook and steelhead and for middle Columbia steelhead.

Table 5 in RPA Action 35 includes performance targets of Habitat Quality Improvements (HQIs). The performance targets are established for 56 populations that spawn and rear in the tributaries. 18 of these populations were designated as priority populations having highest biological needs. These targets are set in terms of a percent improvement of habitat quality that the Action Agencies are to achieve by 2018 through the implementation of habitat actions.

Since 2008, the already significant tributary habitat program has been expanded in terms of both budget and execution of projects on the ground to ensure that the HQIs are achieved. The Action Agencies, Fish Accord partners, and numerous other local entities throughout the

[5] *These pre-project studies scientifically characterize existing geomorphic, hydraulic, and vegetation conditions and identify opportunities for sustainable habitat improvement projects within specific river channels.*

region are now engaged in an extraordinary level of coordination and collaboration to implement projects that are best suited to improve and sustain the habitat quality for the targeted fish populations. Reclamation's detailed tributary and reach assessments are providing a steady supply of high value habitat improvement projects for future implementation in key areas. In 2012, BPA devoted almost $60 million to execute its portion of the FCRPS BiOp tributary habitat program, which doubles the approximately $30 million spent in 2008. The Action Agencies have achieved the FCRPS BiOp HQIs for 31 Chinook and steelhead populations with habitat improvement projects already completed between 2007 and 2011.

Chinook and steelhead maps (Figures 23 and 24) depict the habitat quality improvement status achieved by 2011 based on projects evaluated by the Expert Panels and completed through 2011 to meet the overall 2018 HQI performance measure as identified in RPA Action 35, Table 5. HQIs for the remainder of the populations will be met or exceeded by 2018 through additional projects identified after 2011 in conjunction with Expert Panels and Accord partners.

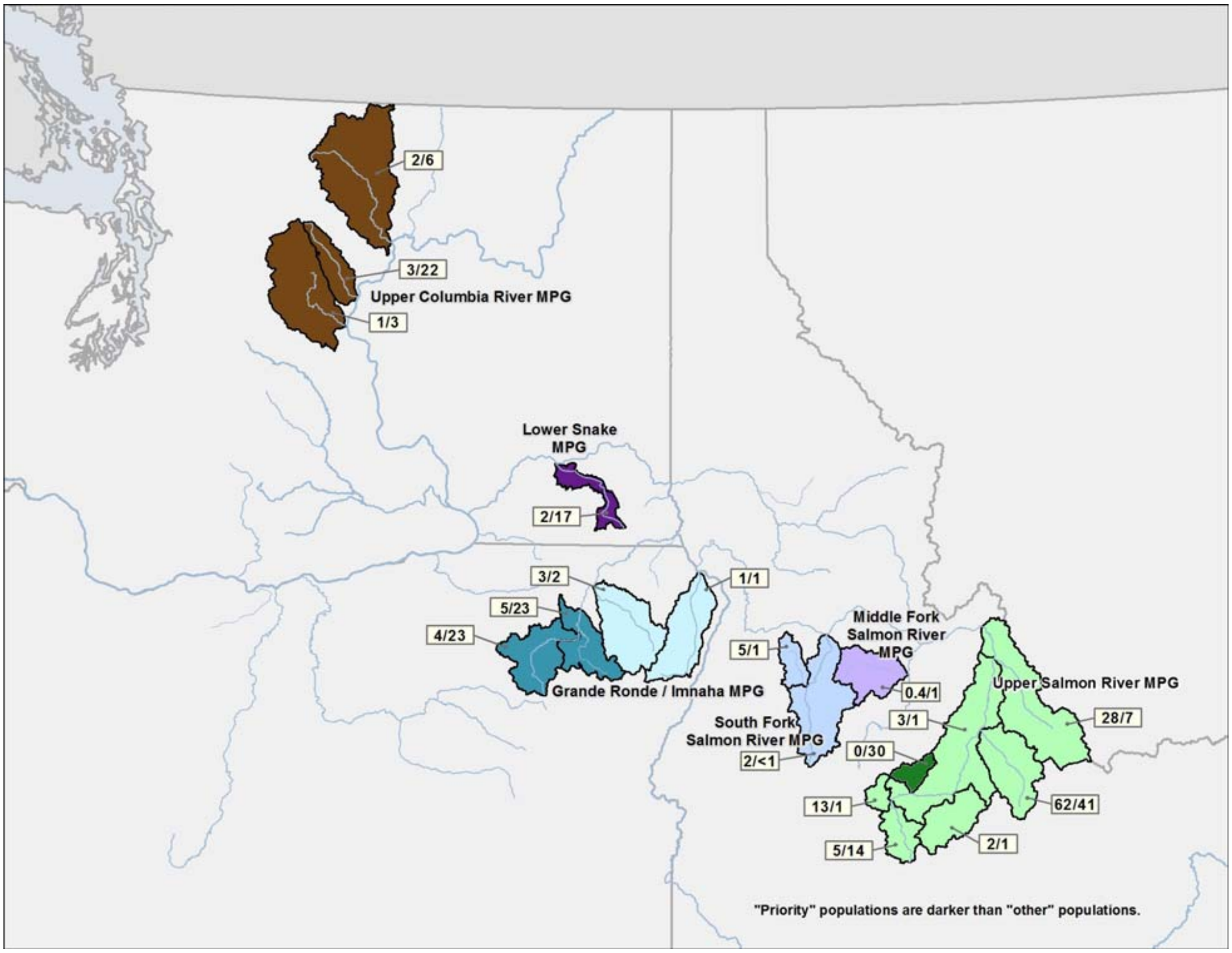


Figure 23. Tributary Habitat Quality Improvement Progress By 2011 for Chinook Salmon. This map of the Columbia River Basin in Oregon, Washington, and Idaho, depicts (in color) the tributary basins where habitat is being improved by the Action Agencies and partners. Darkest shades depict areas with priority populations. Actual progress as of 2011, based on completed habitat improvement projects evaluated by the Expert Panels, is shown in the white boxes near each basin. The number to the left of the slash represents the percent habitat quality improvement through 2011; the number to the right of the slash represents the percent habitat quality improvement to be achieved by 2018 for Chinook salmon (RPA Action 35, Table 5).

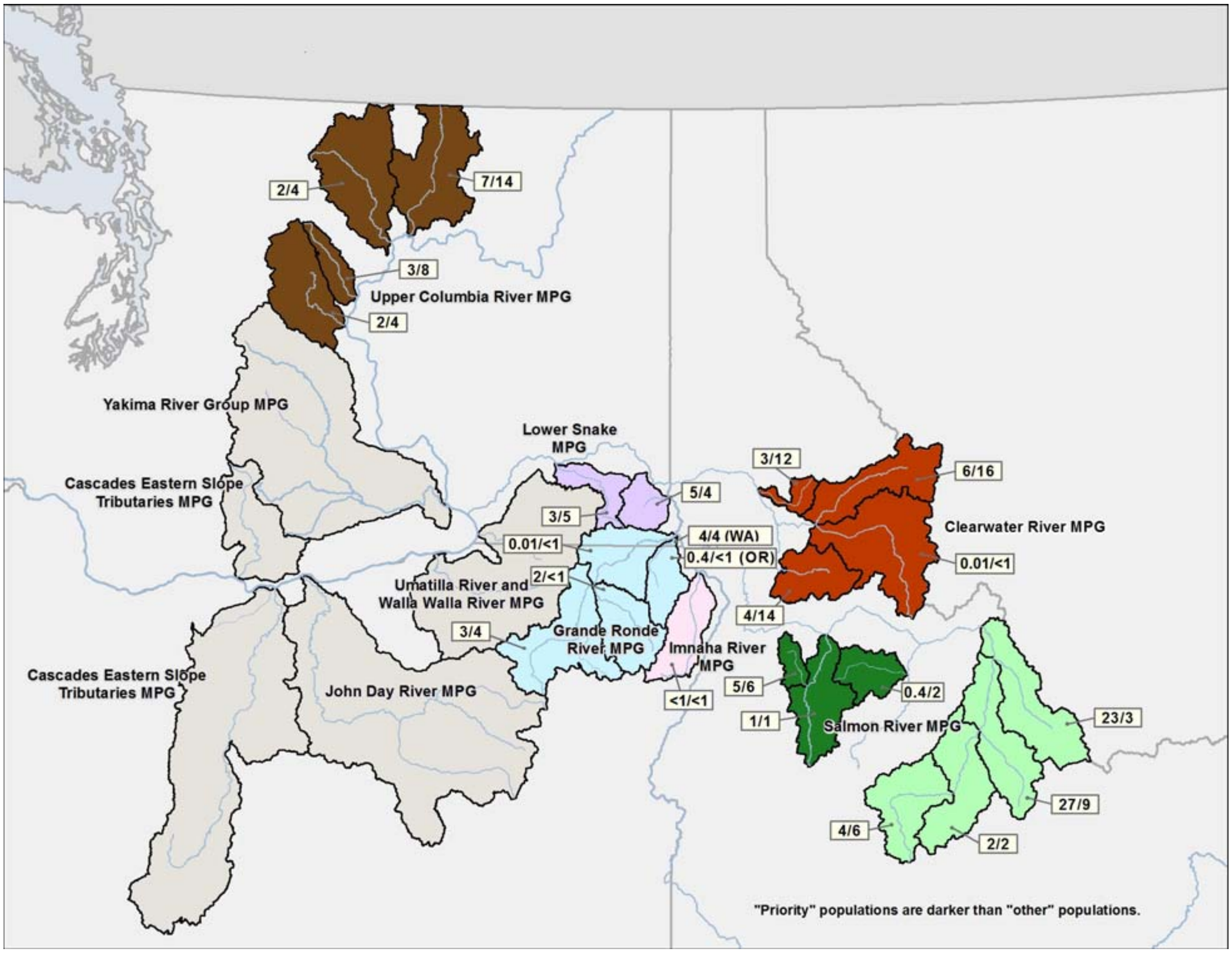


Figure 24. Tributary Habitat Quality Improvement Progress By 2011 for Steelhead. This map of the Columbia River Basin in Oregon, Washington, and Idaho, depicts (in color) the tributary basins where habitat is being improved by the Action Agencies and partners. Darkest shades depict areas with priority populations. Actual progress as of 2011, based on completed habitat improvement projects evaluated by the Expert Panels, is shown in the white boxes near each basin. The number to the left of the slash represents the percent habitat quality improvement through 2011; the number to the right of the slash represents the percent habitat quality improvement to be achieved by 2018 for steelhead (RPA Action 35, Table 5).

Expert Panel Evaluations

The expert panel evaluation process was developed through collaboration among NOAA Fisheries, the Action Agencies, and Pacific Northwest sovereign states and tribes for the FCRPS BiOp. The process draws on the best available science information and applies a cause-and-effect chain of events linking key salmon and steelhead limiting factors with habitat improvement actions; habitat improvement actions to changes in habitat condition; and changes in habitat condition to habitat quality improvement. The expert panel process is employed for the FCRPS BiOp to evaluate HQIs associated with habitat improvement projects that address key limiting factors for the Snake River and upper Columbia River Chinook and steelhead populations shown in Figures 26 and 27.

Seven Expert Panels were assembled for the FCRPS BiOp. Six panels address salmon and steelhead populations in the upper Columbia River, lower Snake River, Wallowa and Imnaha rivers, upper Grande Ronde River, lower Salmon River, and upper Salmon River. A seventh panel addresses Clearwater River steelhead. Expert Panels in each of these areas include federal, tribal, state and local project sponsors who plan, develop, and implement habitat improvement projects in their respective areas and federal, tribal, state and local fish biologists who have the specific knowledge and experience to evaluate how habitat improvement projects affect salmon and steelhead. The panels follow guidance developed through collaboration with Pacific Northwest states and tribes (FCRPS Comprehensive Analysis of the FCRPS and Mainstem Effects of Upper Snake and Other Tributary Actions (August 2007), Appendix C, attachment C-1). For a guide to the tributary Expert Panel process see: Science and the Evaluation of Habitat Improvement Projects in Columbia River Tributaries: Regional Science Review & the Expert Panel Process *(*March 2013).

Adaptive Management Strategies

Through a combination of continued and expanded implementation efforts and the application of strategic adaptive management approaches, the Action Agencies will achieve the HQIs for all 56 populations by 2018. Since the beginning of the FCRPS BiOp, the Action Agencies recognized that habitat implementation efforts needed to be enhanced, refined, or adjusted especially in areas where additional effort needs to be made to meet FCRPS BiOp RPA Action 35, Table 5 HQIs. This prompted the Action Agencies to design adaptive management strategies to address specific geographic and local needs using approaches such as increased funding to implement on-the-ground improvements; improved tools and processes to plan, prioritize and select better habitat improvement projects; organizational support with professional staff dedicated to working with local watershed groups; and research, monitoring, and evaluation programs designed to adequately inform habitat implementation decisions.

As evidenced by Figures 26 and 27, the Action Agencies and partners have successfully completed habitat projects that improve conditions for ESA-listed salmon and steelhead. This work has been accomplished over a broad landscape, including areas with significant legacy impacts from mining, agriculture, or other human endeavors. For example, even in very challenging watersheds like the Yankee Fork (legacy mining impacts) and Catherine Creek (legacy irrigation impacts), the planning, relationship-building and infrastructure are now in place to implement projects to meet BiOp targets.

Cumulative Metrics/Description of Accomplishments Since 2007

The Action Agencies and partners have worked together to put tributary habitat improvement projects on-the-ground that achieved the following metrics since 2007. Most of these projects and their associated metrics have been evaluated by expert panels.

Protecting and Improving Instream Flow

Fish survival can suffer from the combined effect of naturally low summer flows and water withdrawals for human uses. One of the most effective and immediate steps the Action Agencies take to improve fish habitat is to install water efficiency improvements or lease or purchase water rights to increase the amount of water in streams. This in turn provides immediate improvements to salmon and steelhead survival by cooling water temperatures and providing higher quality habitat for spawning and juvenile rearing. Since 2007, the Action Agencies have secured water rights for and protected approximately 177,227 acre-feet of instream water in the Columbia River Basin (Figure 25).

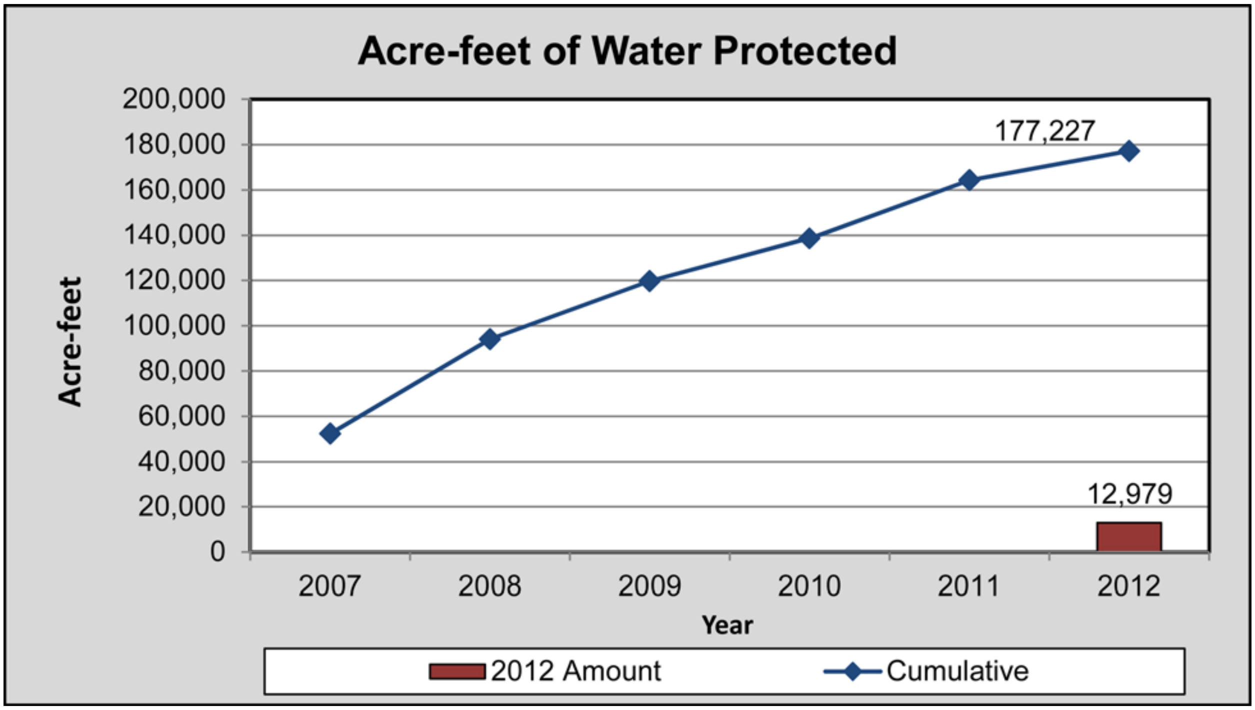


Figure 25. Water Secured and Protected, in Acre-feet of Instream Flow, 2007 to 2012. Cumulative acre-feet/year can include annually renewed water leases. An extensive F&W program was in place and significant accomplishment prior to this BiOp period occurred. For purposes of the CE, accomplishment is reported for 2007-2012 only.

The Action Agencies have worked with state fish and wildlife agencies, local land owners and others to implement multiple water efficiency and conservation actions. Additionally, BPA has worked with the National Fish and Wildlife Foundation, state water agencies, local water trusts, and others to implement water transactions as part of the Columbia Basin Water Transactions Program and the Columbia Basin Fish Accords. These funded efforts resulted in approximately 12,979 additional acre feet per year of instream water to enhance flows for anadromous fish in the Columbia Basin in 2012. Some of the highlights from 2012 include:

- The Loup Loup Creek water transaction implemented in the Okanogan subbasin with the Washington Water Trust and Colville tribe. This 20-year lease agreement will provide up to 3.21 cfs and 665 acre-feet of yearly instream flow to Loup Loup Creek to help passage of ESA-listed steelhead. This water transaction will rewater 1.3 stream miles between the Okanogan River and critical steelhead habitat in the upper portions of the creek. The Washington Water Trust and Colville tribe have worked with the irrigation district to decommission the old irrigation structure and to ensure these flows remain in the stream.

Figure 26. The Work by the Washington Water Trust has Helped Rewater Loup Loup Creek in the Okanogan to Improve Habitat Access in the Stream for Upper Columbia Steelhead.

- Another example of flow improvements using water transactions is the Lostine River water lease in the Grande Ronde subbasin in Oregon. This water transaction maintains 10-15 cfs instream for Snake River Chinook through agreements with over 80 irrigators on the stream. The Freshwater Trust is working on additional water transactions to keep water permanently in the stream to benefit Snake River Chinook fish populations.

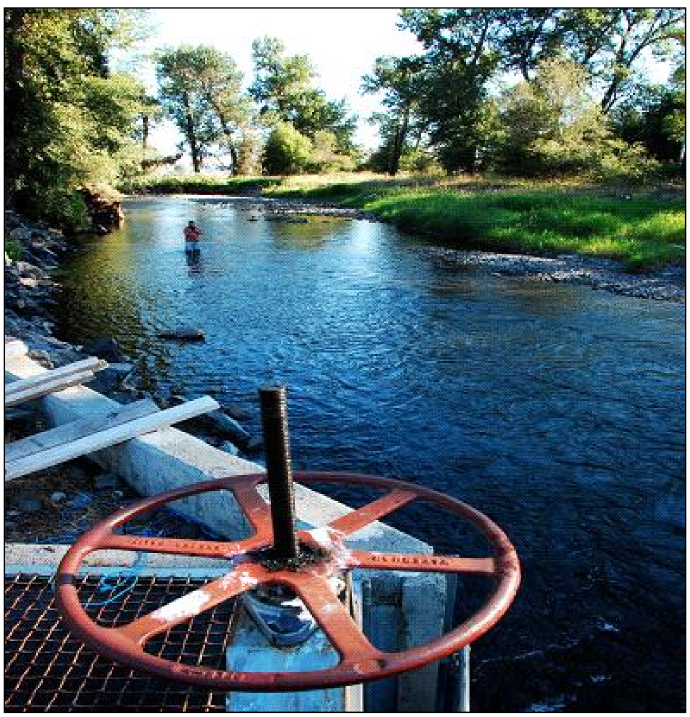


Figure 27. The Lostine River water transaction involves working with irrigators to keep over 10 cfs instream in the river to benefit Snake River Chinook in the Grande Ronde subbasin.

- The Lemhi River in the Salmon subbasin of Idaho. As part of the Columbia Basin Water Transactions Program, the Idaho Water Resources Board worked with multiple partners and landowners to secure instream water in the Lemhi to augment flows for Snake River Spring/Summer Chinook in the Upper Salmon River. Thus far, 19 cfs from permanent flow transactions has been secured instream in the Lemhi River. The Idaho Water Resources Board is working with partners to add permanent transactions and renew annual water use agreements to keep 25 to 35 cfs instream in the Lemhi River to benefit salmon.

Figure 28. The Idaho Water Resources Board is Using Support from the Fish Accord to Work with Irrigators to Keep More than 25 CFS Instream in the Lemhi River to Benefit Salmon.

Improving Habitat Complexity

Salmon evolved in streams that exhibited a variety of natural functions, such as seasonal flooding and riparian successional processes that culminated in large wood inputs into the stream, movement of large and small sediment, and natural connections of multiple meandering channels. The complex habitats, with a variety of pools, runs, and riffles provided important spawning and rearing areas for juvenile salmon and steelhead, as well as cool-water refuges during the heat of summer. Human development has changed the nature of most of the Columbia River Basin’s river systems, interrupting some of these natural processes and depriving salmon of some of these habitat attributes.

An important component of the Action Agencies’ habitat program involves funding actions and providing technical assistance to improve channel complexity by reconnecting side channels and, where feasible, increasing floodplain function (i.e., adding large wood or boulder clusters to create pools, simulate natural river processes, and improve instream habitat conditions). The Action Agencies have improved 206 miles of stream since 2007, with 33 miles completed in 2012 (Figure 29).

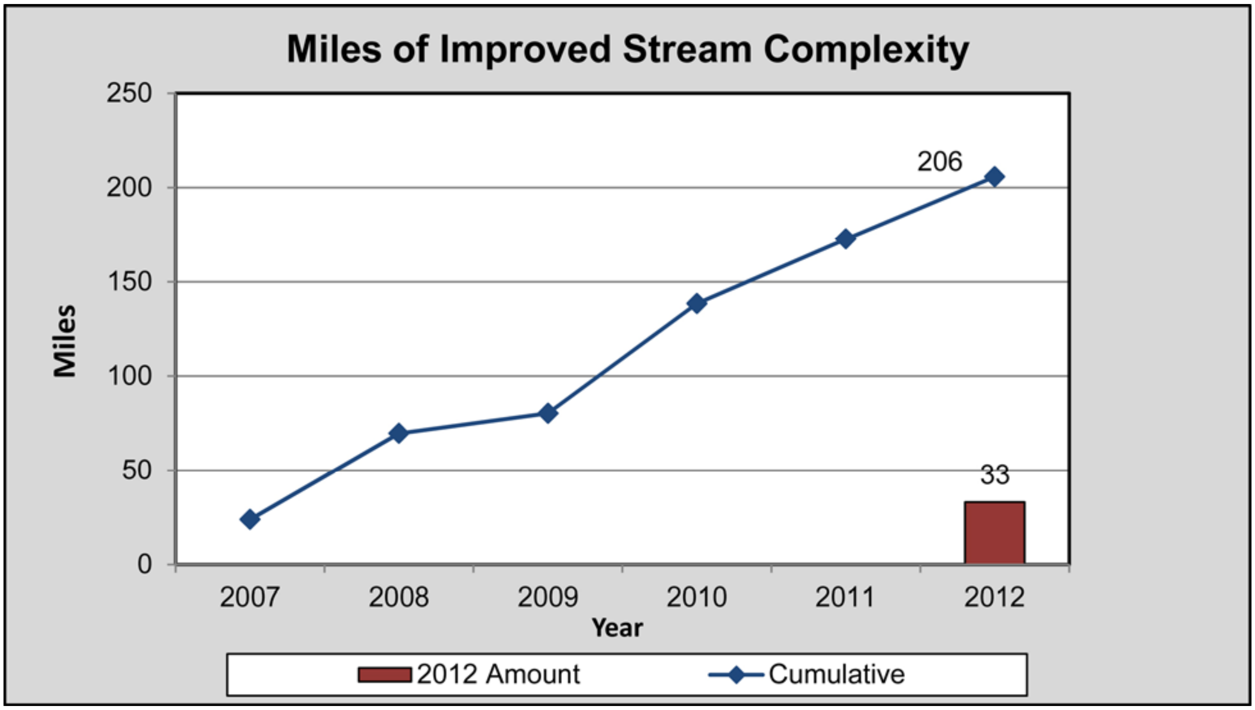


Figure 29. Miles of Improved Stream Complexity, 2007 to 2012. An extensive F&W program was in place and significant accomplishment prior to this BiOp period occurred. For purposes of the CE, accomplishment is reported for 2007-2012 only.

The Whitefish Island channel complexity enhancement project, completed in 2012, provides a good example of this type of work that is designed to improve survival. This project represents the first phase of the multi-year Middle Methow Habitat Project, a coordinated effort among the Methow Salmon Recovery Foundation (MSRF), Yakama Nation (YN), WDFW, U.S. Geological Survey (USGS), public and private landowners, and the Action Agencies. Past land management activities -- including forest practices, bank hardening, levee construction and periodic removal of wood from the stream -- had resulted in poor side channel connectivity and simplified channel conditions that reduced fish spawning and rearing habitat. Side channels can provide critical fish habitat for juvenile and adult anadromous fish, especially at higher flow levels. The Whitefish Island project involved a comprehensive suite of interconnected habitat improvement actions within floodplain and riparian areas, such as a 1,500-foot long seasonal side channel converted to permanent flow, a forested island, and improvements to the mainstem channel of the Methow River.

In particular, habitat Improvements consisted of:

1) a large, engineered logjam at the side channel inlet to increase the side channel flow during high and low flow periods, thus providing rearing habitat throughout the year,

2) large wood habitat structures constructed throughout the side channel and the mainstem river improve habitat by providing cover from predators and increasing instream complexity, and

3) plantings and livestock exclusion to improve riparian processes. These recent improvements in the main channel and improved activation of the side channel now provide more feeding, hiding and resting habitat for juvenile fish, improve winter rearing conditions, and provide refuge habitat for young fish as they migrate downstream.

Figure 30. Whitefish Island in the Methow River – Improved Side Channel Activation and Complexity in the Main Channel Improved Conditions for Juvenile Salmon and Steelhead Growth and Survival.

Figure 31. Structures were Added in the Side Channel to Provide Cover from Predators and a Variety of Velocity Conditions for Feeding and Resting.

Improving and Protecting Riparian Areas to Improve Water Quality

Riparian habitat—the streamside environment—has a considerable influence on water quality and long-term salmon survival. While only the anticipated short-term benefits of actions to improve and restore degraded riparian habitat are credited toward the FCRPS BiOp targets, the benefits of many of those actions will continue to accrue beyond 2018. In addition, because these actions can help moderate stream temperatures, they are an important hedge against the longer term effects of climate change, which is expected to cause stream temperatures to increase seasonally throughout the Columbia River Basin.

Riparian habitat can be protected through land purchases or conservation easements, which aim to reduce adverse land use impacts and allow continued restoration. Riparian improvement actions such as fencing to protect stream side vegetation from livestock grazing, invasive species removal, and restoration of native riparian vegetation provide direct benefits in the form of improved water quality, streambank stabilization, and habitat complexity. In many instances, plantings or natural revegetation are used to jumpstart habitat enhancement and reestablish a viable riparian zone by providing shade and other benefits for the stream. Since 2007, the Action Agencies have improved approximately 6,812 acres and protected 36,851 acres of habitat (Figure 32).

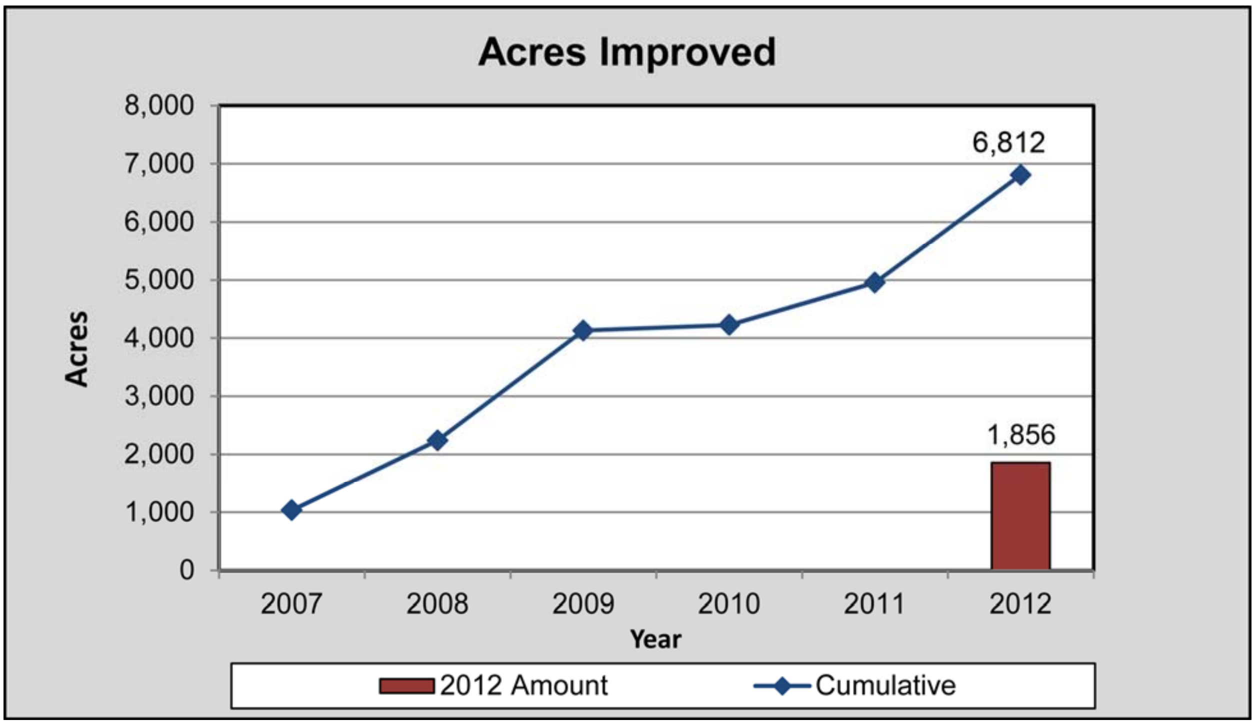


Figure 32. Acres of Habitat Improved, 2007 to 2012. Note: Improvement measures include creating, connecting, or realigning channels; conducting controlled burns; planting; practicing no-till farming; removing mine tailings and invasive plant species; enhancing floodplains; or improving wetlands. An extensive F&W program was in place and significant accomplishment prior to this BiOp period occurred. For purposes of the CE, accomplishment is reported for 2007-2012 only.

By way of illustration, the Hancock Springs project completed in 2012 has resulted in significant riparian habitat improvements. This creek in the Upper Columbia had become badly degraded by grazing and other impacts. BPA, in cooperation with the Yakama Nation and other partners, installed fencing and enhanced streambank habitat for upper Columbia River spring Chinook.

Figure 33. Hancock Springs (left) as a Wide, Shallow and Barren Expanse Prior to Habitat Improvements and After (Right) with More Natural Stream Contours, Habitat Complexity, and Deeper Pools.

Improvements at Hancock Springs in the Upper Columbia demonstrate the benefits of rehabilitating riparian habitat. The springs drained to a creek that had become badly degraded by grazing and other impacts. Prior to 2007, salmon and steelhead had poor access to Hancock Springs and no redds were counted in 2005 or 2006. Improvements included fencing and constructed instream structures to improve habitat for upper Columbia River spring Chinook. Both Chinook and steelhead now spawn successfully in the stream. In 2010, 14 steelhead redds and 20 Chinook redds were counted where previously there had been none. Increased spawning has continued in the improved reach through 2012, with fewer redds in a control reach that was left unimproved for comparison. Improvements at Hancock Springs are continuing.

Reducing Fish Entrainment at Irrigation Diversions

The Action Agencies have funded projects to replace, improve, and install fish screens at irrigation diversions to prevent fish from becoming trapped, or entrained, in irrigation ditches. The fish screens, which are designed according to state and federal criteria, keep fish in the streams—and out of irrigated fields—and thus provide immediate improvements in juvenile fish survival. Diversion consolidation projects combine two or more surface diversions into one, reducing the number of diversion and screen facilities fish must navigate. Some projects eliminated the need for screens and associated surface water diversions by replacing surface diversions with groundwater wells. The latter type of screen elimination project also increases instream flow for fish while maintaining the original offstream water use. Screens also are installed where irrigation canals rejoin the main river to protect adults returning to spawn that can potentially be attracted by irrigation "return flows" and swim into canals. In 2012, the Action Agencies addressed fish entrainment with installation of 42 fish screens (Figure 34).

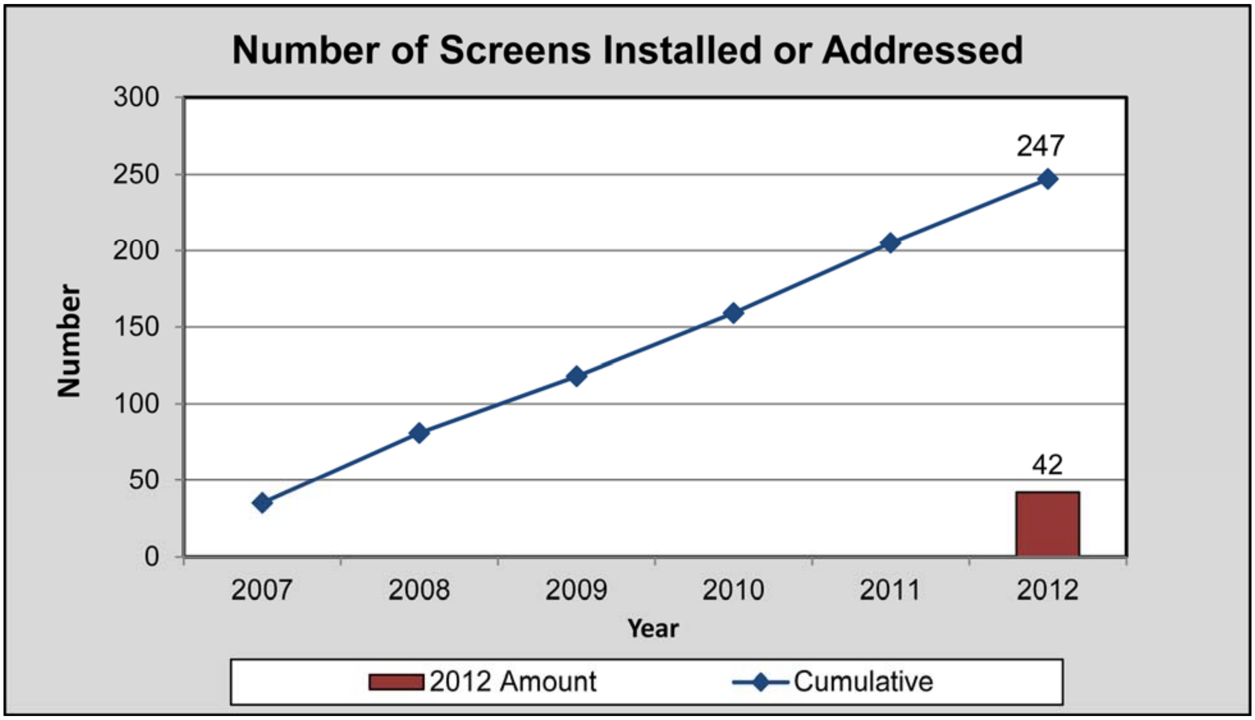


Figure 34. Number of Fish Screens Installed or Improved, 2007 to 2012. An extensive F&W program was in place and significant accomplishment prior to this BiOp period occurred. For purposes of the CE, accomplishment is reported for 2007-2012 only.

A program in the John Day Basin manufactures, installs, and services fish screens designed to protect wild populations of Chinook salmon and steelhead in the John Day, Umatilla and Walla Walla subbasins. The John Day Fish Screen and Passage Program works in cooperation with public and private landowners and managers, irrigation districts and others to install approximately 15 to 25 new and improved screens annually. For example, in September 2012 BPA helped fund two screens for pumps used to irrigate hay and alfalfa fields on East Birch Creek in the Umatilla Basin. The Oregon Department of Fish and Wildlife's District Biologist considered the screening a high priority to meet federal and state screening criteria and reduce impacts to native fish, including listed summer steelhead.

A recent study documented the potential impact of entrainment and the benefits of screening in the Lemhi River in Idaho, which is home to listed salmon and steelhead but is heavily diverted for irrigation. The study estimated that under median streamflow conditions with no screens, approximately 71 percent of Chinook salmon smolts would be lost to entrainment at the 89 diversions they encounter during their migration out of the Lemhi. However, the research demonstrated that screening is a highly effective strategy that could reduce cumulative mortality to about 2 percent with all diversions screened. Most major diversions in the Lemhi have indeed been screened through programs funded by the Action Agencies and other organizations, so much of the estimated survival improvements have probably been realized.

Improving Access to Spawning and Rearing Habitat

Human development has restricted access to significant portions of the historical range of Columbia River Basin salmon and steelhead in many Columbia River tributaries. Many of these blockages can be fixed without adversely affecting agricultural activities. Since 2007, the Action Agencies have improved access to approximately 2,053 miles of instream habitat for anadromous fish (Figure 35).

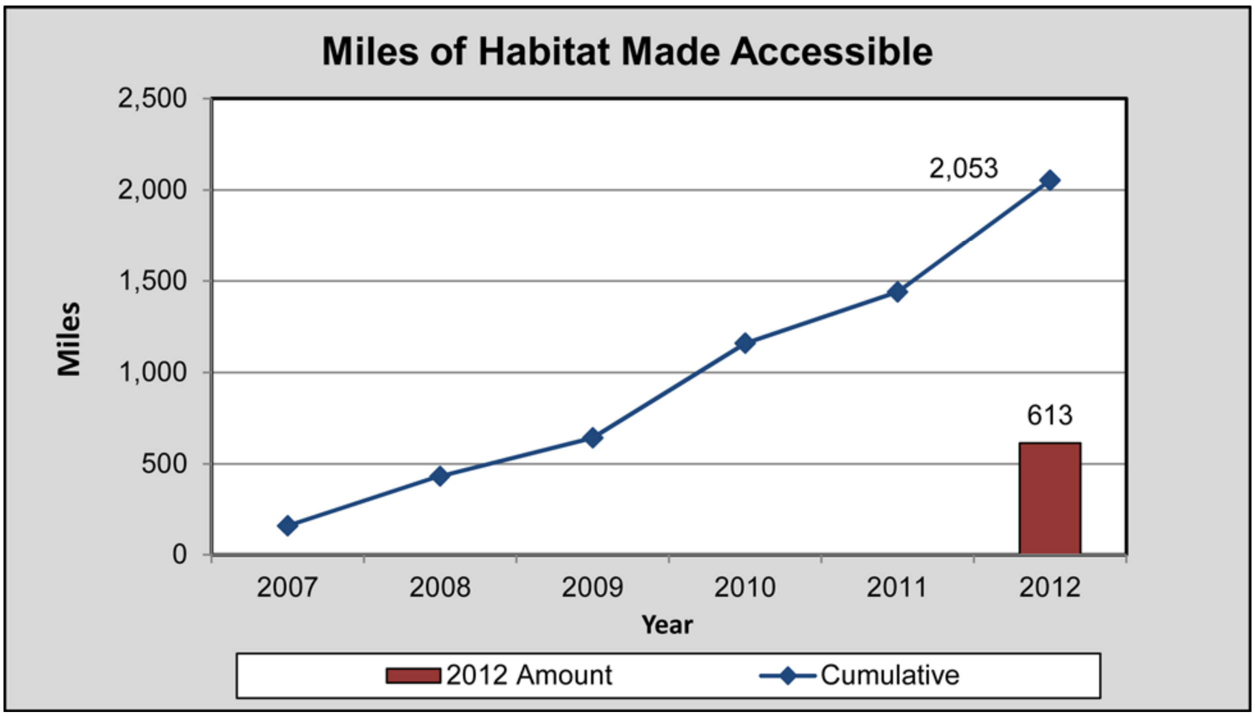


Figure 35. Miles of Habitat Made Accessible, 2007 to 2012. An extensive F&W program was in place and significant accomplishment prior to this BiOp period occurred. For purposes of the CE, accomplishment is reported for 2007-2012 only.

In 2012, the Action Agencies funded projects that opened or protected access to 613 miles of fish habitat.

The Canyon Creek culvert replacement is a good example of a fish passage improvement project that was completed in 2012 in the upper Lemhi River, Idaho. The culvert was an upstream passage barrier for adults and juveniles under low flow conditions and when velocities within the culvert were too great for adult or juveniles to negotiate under high flow conditions. The existing culvert was replaced with a small, pre-fabricated steel bridge.

The bridge was comparable in cost to a larger fish-passable replacement culvert, but with the added benefit of retaining a continuous natural streambed below the road. This project was coordinated among the Idaho Office of Species Conservation, Upper Salmon Basin Watershed Program, Trout Unlimited, Lemhi County Road and Bridge Department, IDFG, private landowners, and the Action Agencies.

Figure 36. The Canyon Creek Culvert Impeded Adult and Juvenile Passage Before it was Replaced .

Figure 37. Canyon Creek Crossing After the Project.

This culvert replacement was the latest in a string of projects and activities that together support cumulative improvements in Chinook and steelhead growth and survival in Canyon Creek. Past agricultural activities also dewatered the lower 1-3 miles of Canyon Creek during the summer irrigation season. Also, other passage barriers in Canyon Creek made it difficult or impossible for fish to reach high quality spawning and rearing habitat in upstream reaches of Canyon Creek. Surveys showed Canyon Creek to be regularly void of Chinook salmon before any of these projects were completed.

Other improvements included replacement of two other barrier culverts, an irrigation project that removed a cross-ditch barrier, and two irrigation improvement projects that allowed 7 cfs of stream flow to reach the Lemhi River where Canyon Creek was previously dewatered. Additional water secured in the upper Lemhi is expected to further improve conditions where most Chinook spawn and rear. The combined effects from the irrigation projects coupled with the barrier removals outweigh the benefits of individual projects. Recent surveys conducted by IDFG biologists after the projects were implemented found rearing juvenile salmon after the suite of projects were implemented where there previously had been none.

Summary of Biological Effects

Current and Recent Research

A substantial amount of research has been conducted over the last decade to better understand fish response to habitat improvement actions and elucidate habitat-fish interactions. Importantly, research and monitoring is confirming that salmon are using and benefiting from the projects.

Below are a few examples of habitat improvement actions where action effectiveness monitoring has demonstrated a relationship between habitat improvements and salmon and steelhead growth and survival.

Elbow Coulee—A levee was breached on the Twisp River in Washington that allowed periodic flooding of a side channel. Juvenile salmon and steelhead were documented using and persisting in this newly accessible rearing habitat after each flooding event.

Beaver Creek—Barriers to upstream migration in a tributary of the Methow in Washington were replaced with rock vortex weirs. Adult steelhead moved upstream soon after the barriers were replaced, as did mountain whitefish and coho salmon. Juvenile Chinook salmon were also documented in the creek upstream of the rock vortex weirs.

Bridge Creek—Bridge Creek in Oregon was highly incised and disconnected from the floodplain. Installation of posts provided anchor points for stabilizing beaver dams that had previously washed out during high flow events. Stabilized beaver dams supported more natural stream dynamics, reestablished connection to the floodplain, reduced water temperature and improved groundwater exchange with the riparian area. These improvements benefit fish by providing more food and more favorable habitat conditions. Steelhead abundance increased relatively quickly after implementation of the action.

Lemhi River—Lemhi River habitat treatments in Idaho have primarily included tributary reconnection and instream flow augmentation. Based on three years of data, there was an increase in the number of Chinook salmon produced per redd, but no long term significant trend in freshwater survival over six years. Several additional years of monitoring are intended to assess changes in fish survival and growth.

Preliminary results indicate that the implemented habitat actions are improving habitat and fish growth and survival, and that further improvements in the condition of the habitat and fish growth and survival should continue to occur over time and as additional actions are implemented. For further details see Section 2 and Benefits of Tributary Habitat Improvement in the Columbia River Basin; Results of Research, Monitoring and Evaluation, 2007-2012 (2013).

Estuary Habitat Actions

Cumulative Description of Accomplishments

Undisturbed estuaries are highly variable and complex systems and are renowned for their high production of fish and other organisms. Fish from throughout the Columbia River Basin use the Columbia River estuary for varying amounts of time during all months of the year. The estuary's diverse habitats provide food and refuge for 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 that would be not be obtainable in freshwater systems. Adult salmon returning to the Columbia River also pass through the estuary as they migrate to their spawning grounds. The Action Agencies' projects in the estuary are focused on restoring this critical estuarine habitat for the benefit of listed juvenile salmon and steelhead.

Since 2008, the Action Agencies have greatly expanded their efforts in the estuary, implementing numerous "on the ground" actions, including acquisitions and restoration actions such as breaching levees to restore tidal influence. Among recent developments is the 2012 formal compilation of the Columbia Estuary Ecosystem Restoration Program (CEERP), the joint Action Agency program to prioritize, fund, and implement federal actions and research in the lower Columbia River and estuary. Regional stakeholder involvement is a key component of this program, and the Action Agencies actively work with tribal, state, and federal agency partners, as well as conservation groups, to implement on-the-ground projects in the estuary.

The CEERP documentation has three parts: 1) the Strategy Report, which outlines the program's structure and priorities; 2) the Action Plan, which contains the list of actions that the Action Agencies will implement based on the Strategy Report; and 3) the Synthesis Memorandum, which summarizes the state of the science of salmon ecology and habitat restoration in tidally influenced areas of the lower Columbia River and estuary. Together these documents provide an integrated scientific basis for the estuary program.

Habitat projects in the estuary are evaluated by a panel of regional scientists and watershed experts called the Expert Regional Technical Group (ERTG). Many ERTG members have conducted research in estuarine science and habitat restoration and bring their own expertise and other research to bear on project evaluations. The ERTG reviews the latest science and uses the findings to develop scientific criteria for assessing the biological value of habitat restoration projects in terms of Survival Benefit Units (SBUs). The Action Agencies use the results to guide funding, technical support and other resources toward projects that the science indicates have the greatest potential to improve survival of salmon and steelhead. The ERTG is the estuary equivalent of the expert panel process used to prioritize habitat projects in the tributaries. For a guide to the ERTG process, see "Science and the evaluation of habitat restoration projects in the Columbia River Estuary: The Expert Regional Technical Group Process" on www.salmonrecovery.gov.

In 2011, working with state and federal agency partners, as well as conservation groups, the Action Agencies expanded their already substantial estuary efforts, initiating and completing on-the-ground projects in the estuary and acquiring land in support of future restoration. They also continued planning and development of additional projects for future implementation. Table 3 and Figure 38 summarize the estuary habitat improvements accomplished in 2012, and cumulatively from 2007-2012 regarding floodplain and riparian area improvements. The Action Agencies have restored 3,791 acres resulting in 3.93 ocean and 1.96 stream SBUs.

Table 3. Summary of Estuary Habitat Restoration Metrics, 2008-2012

	2007-2012
Action	**Metric / Acres**
Protect riparian areas (CRE 1.3)	280.5
Restore off-channel habitat (CRE 9.4)	143.9
Restore full hydrology/access (CRE 10.1)	162
Improve hydrology/access (CRE 10.2)	51.8
Improve access (CRE 10.3)	267.1
Reduce invasive plants (CRE 15.3)	1069.3
Use dredged materials beneficially (CRE 6.3)	0
Land Acquisition (CRE 9.3)	1789.4
Total	**3791**

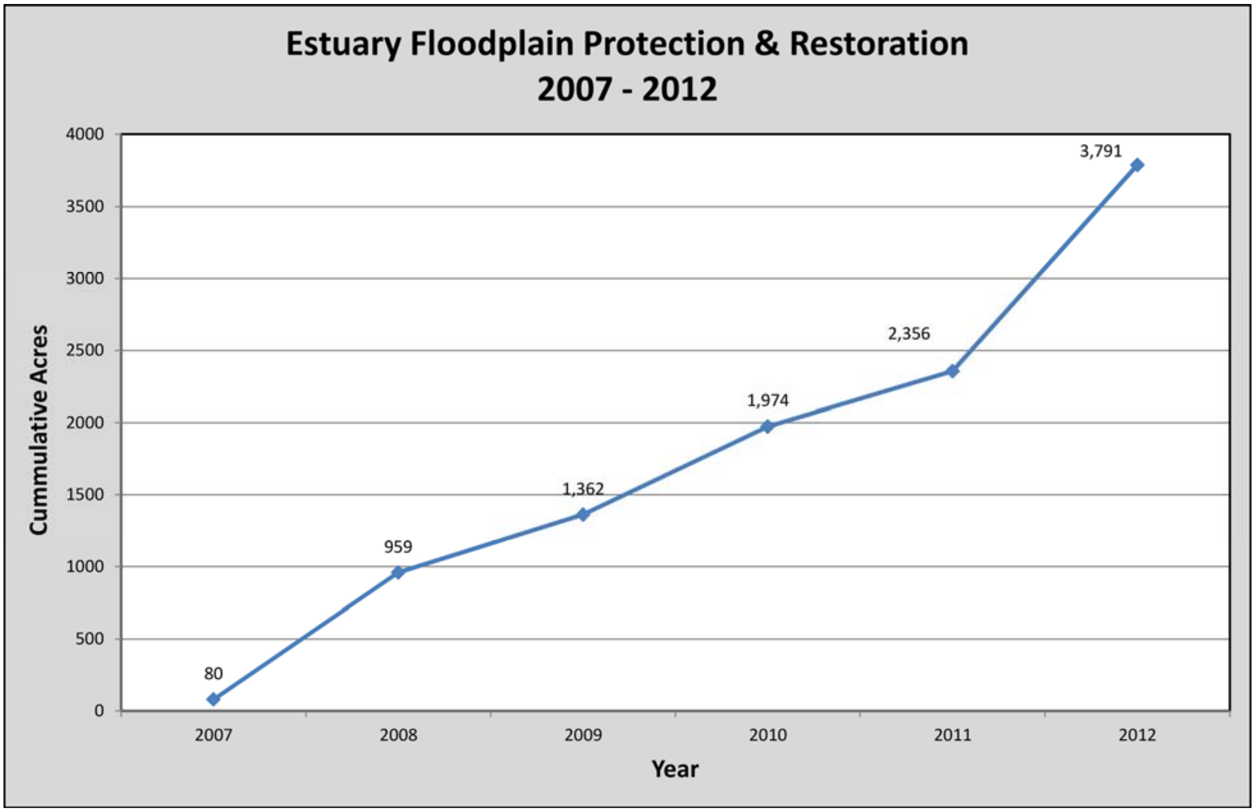


Figure 38. Summary of Estuary Habitat Restoration Metrics, 2002-2012

Improving Access to Estuarine Habitats

Floodplain reconnections are the cornerstone of the estuary habitat program. This type of action involves opening dikes and/or upgrading tide gates or culverts to allow for greater inundation of wetland sites and improved juvenile salmon and steelhead access. These reconnections also often restore sites to a more natural water temperature regime and are the basis for restoring more natural processes within the site and export of food into the larger ecosystem where other fish can benefit from it. In addition to habitat improvements behind a former barrier, floodplain reconnections are often also benefit adjacent habitats (i.e. more natural tidal channels in adjacent parcels of land).

In 2011-2012, the Action Agencies funded the Columbia River Estuary Study Taskforce (CREST) to open a dike at the Otter Point site near the town of Warrenton, Oregon. Since the dike was opened and hydraulic reconnection was restored, more than 30 acres of diked pasture are now transitioning into tidal wetland habitat for the first time in more than 100 years (Figure 39). Located near the confluence of the Lewis and Clark River and Youngs Bay and positioned within a critical transition zone to the marine environment, the Otter Point site will be available to a large range of migrating juvenile salmon, including Chinook, steelhead, coho, and chum. This feeding and rearing habitat will also enhance estuarine food web productivity as plant material and prey items are exported from the site into the mainstem.

Improving Habitat Quality for Juvenile Salmon and Steelhead

While floodplain reconnections provide a key underlying physical requirement for restoring estuarine habitats, additional actions can also enhance the quality of the habitat for juvenile salmon and steelhead. Improving certain habitat attributes (e.g. production of prey, refuge from predators) improves the system's ability to support a greater volume of juvenile fish from different ESUs that use that habitat. Actions that improve habitat quality include strategically excavating channels in firm soils, incorporating large woody debris to improve habitat complexity, and planting native wetland vegetation to help restore natural ecosystem processes more rapidly.

The Mirror Lake site is an example of a project that received additional actions to improve habitat complexity in 2010. In addition to a culvert removal that improved the quantity of habitat available to juvenile fish, the Lower Columbia Estuary Partnership (LCEP) also installed large woody debris in scour pools to provide hydraulic refugia and trap organic material. LCEP also planted native vegetation to shade streams, provide materials for beneficial beaver activity and provide food for juvenile fish -- both within the site and exported to the mainstem for juvenile fish migrating past the site. Multiple species of juvenile salmon and steelhead have been found at the site, including stocks from the interior Columbia River Basin.

Figure 39. Images at Otter Point Before the Dike Breach to Reconnect the Floodplain for Juvenile Salmonid Rearing.

Figure 40. Otter Point as High Tide Inundates the Floodplain Behind the Newly Breached Dike for the First Time in more than 100 years. More than 30 acres were opened for juvenile salmonid use at this project site.

Progress towards FCRPS BiOp Goals

The estuary restoration program has undergone significant expansion since 2007. These changes can be organized into three different periods. The early years (2007-2009) were a developmental period where the program had not yet ramped up, Action Agency investments were relatively modest, and restoration opportunities were fairly limited. A period of transition (2010-2012) followed in which the Action Agencies took a more strategic approach that included better prioritization of biological goals, regional coordination, refined planning tools, and more robust RM&E results. Currently, the program is entering a period of high output (2013-2018), characterized by a mature program where the strategy, processes, and implementation are aligned to ensure the delivery of high-value projects. Survival benefit unit (SBU) progress to date is presented in Figure 41 and illustrates how program output is changing over time, with a modest delivery of SBUs to date, but a significant increase in SBUs projected to be achieved over the remainder of the FCRPS BiOp period (2013-2018). The Action Agencies expect that by pursuing a combination of high priority projects and one or more very large and complex projects, the estuary habitat program will achieve BiOp targets for both ocean and stream-type fish.

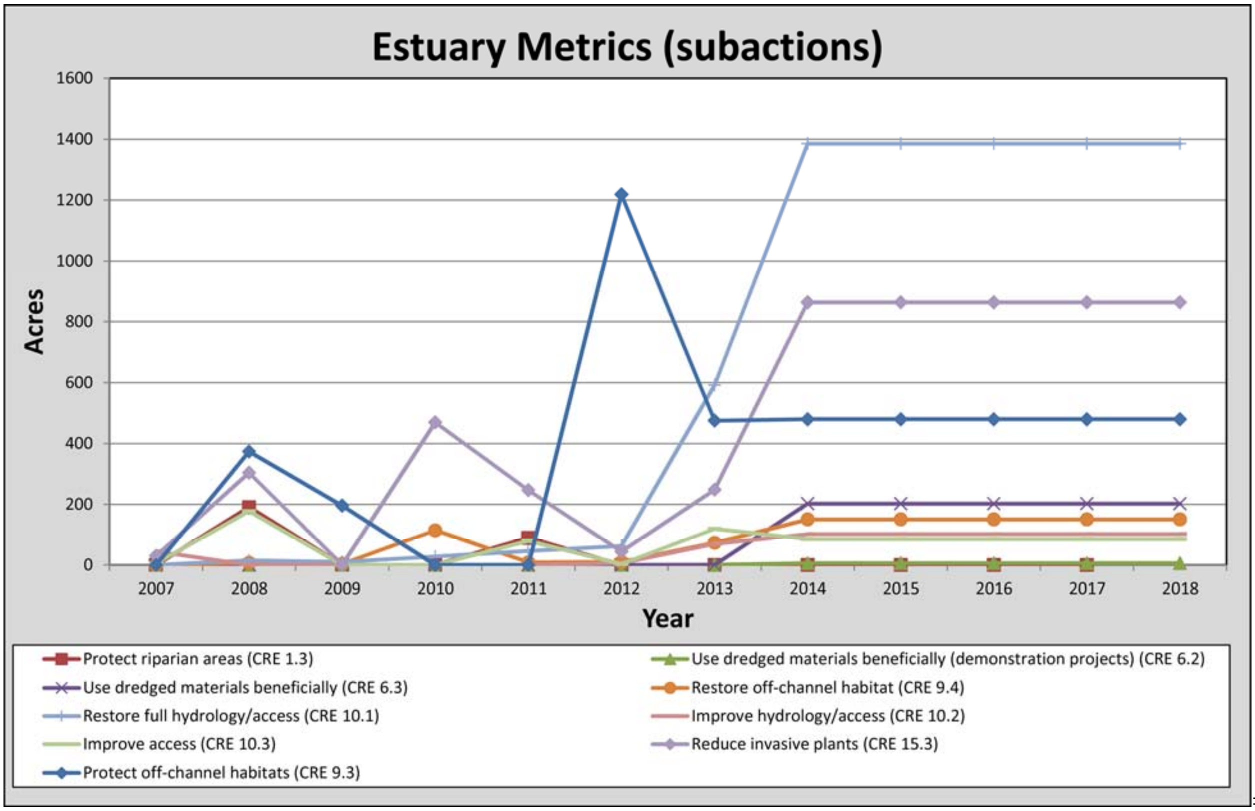


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Figure 41. Cumulative Ocean and Stream SBUs Acquired and Projected, 2000-2018.Summary of Biological Effects

Juvenile salmon and steelhead are using restored habitat. Some two-thirds of the estuary's historic wetland habitat has been lost to development, but monitoring demonstrates that fish are quickly making use of reopened and restored wetlands. Reconnecting floodplain habitat is a key element of the program, and research has found that doing so improves habitat availability and use by juvenile fish. Reconnected floodplain wetlands also produce and export macrodetritus and associated prey that fish feed on and improves thermal conditions. Research now underway will explore fish responses to estuary habitat actions at an even finer scale by examining juvenile residence time, prey availability, and other factors.

Habitat improvements benefit salmon and steelhead, even if they do not directly use the habitat. Research has demonstrated that tidal wetland habitats provide much of the prey and related food that juvenile salmon prefer as they migrate through the lower Columbia River and Estuary. All salmon and steelhead sampled in the mainstem, including stream-type, had consumed prey items commonly produced in the kind of estuary wetland habitats that the program targets for restoration. Research indicates that juveniles prefer prey items directly linked to tidal wetland habitats, further underscoring the relationship between habitat restoration and fish survival.

The larger yearling Chinook salmon are during early ocean residence, the more likely they are to survive in the ocean. Research has linked larger size and early marine growth with higher yearling Chinook salmon survival in the ocean. These size-dependent survival improvements are currently attributed to reduced predation during the first few months juveniles spend in the ocean and less starvation during their first winter in the ocean.

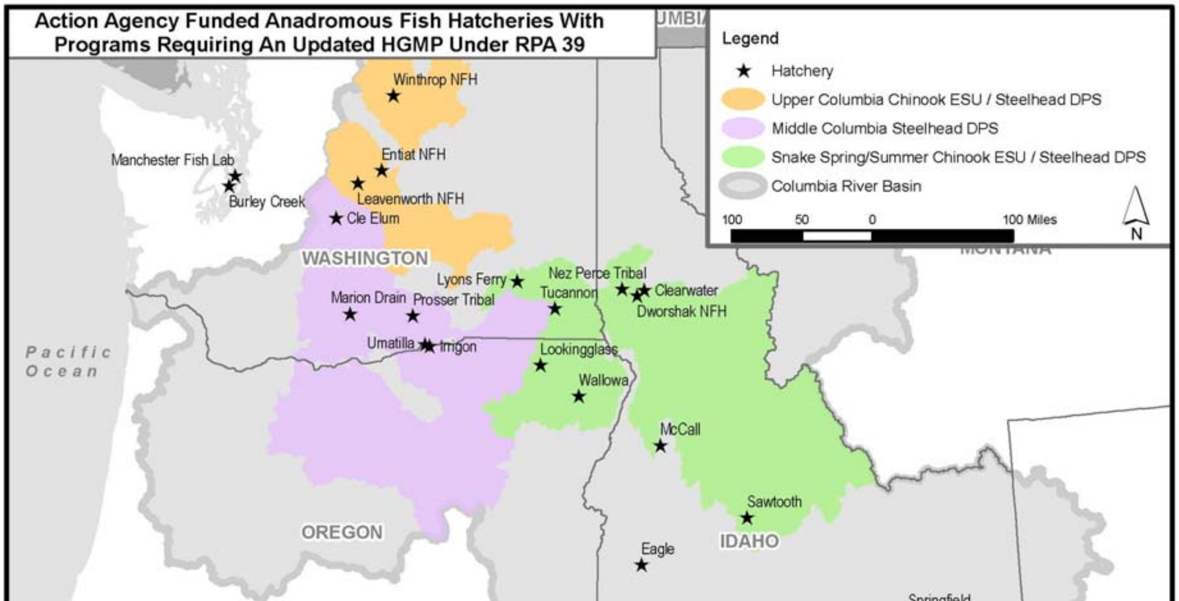
Estuary RM&E data provide the best available science and the ERTG uses this information and peer-reviewed literature to score projects based on the SBUs they will provide. The ERTG has provided input on uncertainties in the SBU process; the Action Agencies are currently considering and prioritizing these topics in estuary RM&E. Recognizing the importance of action effectiveness monitoring and research for CEERP restoration actions, a programmatic action effectiveness monitoring and research (AEMR) plan was developed in 2012 and is being implemented that prioritizes, coordinates, and communicates AEMR within the CEERP.

Hatchery Actions

Cumulative Description of Accomplishments

The Action Agencies continued to fund an extensive existing hatchery program as off-site mitigation for the federal dams, including conservation hatcheries that produce ESA-listed fish. To ensure that these programs do not impede recovery of ESA-listed salmon and steelhead, the agencies developed funding criteria for the hatchery programs in 2008 and worked with hatchery operators to prepare updated hatchery and genetic management plans (HGMPs) (Figure 42). The HGMPs identify operations and best management practices to meet production requirements, while reducing or eliminating detrimental genetic and ecological effects on listed species. The Action Agencies' strategy is to ensure that FCRPS mitigation hatchery programs aid conservation without impeding recovery of salmon ESUs or steelhead DPSs.

By the close of 2012, the Action Agencies have coordinated the development of and reviewed all 44 draft HGMPs. A total of 43 of these draft HGMPs have been revised by hatchery operators and submitted to NOAA Fisheries for review. To date, a total of 26 HGMPs have been determined by NOAA Fisheries to be sufficient for formal ESA consultation.



Region	Action Agency-Funded Hatchery Programs Requiring an HGMP	Draft HGMPs Reviewed by/Commented on by Action Agencies	Draft HGMPs Submitted to NOAA for Review-Comment	Request for Consultation Package (HGMP Letter) Submitted to NOAA	HGMPs Determined by NOAA as Sufficient for Consultation	Program Consultations Completed and Biological Opinion Issued
Upper Columbia	6	6	6	6	4	0
Middle Columbia	8	8	8	8	8	3
Snake	30	30	30	22	14	1
Total	44	44	44	36	26	4

Figure 42. Action Agency-funded Anadromous Fish Hatcheries with Hatchery Programs Requiring an Updated HGMP and ESA Consultation under BiOp RPA Action 39. The stars designate hatchery facilities, not hatchery programs. Some facilities may have just one program, others may have multiple programs.

Hatchery Reform

Significant progress has been made through 2012 on the hatchery reform measures included in the FCRPS BiOp RPA Action 40. Reform actions include improved broodstock techniques, efforts to reduce stray rates and cessation of hatchery outplanting. Examples include:

- With Action Agency support, the USFWS has enhanced use of local Methow River steelhead broodstock at the Winthrop National Fish Hatchery and made progress towards improving management of returning hatchery adults. Production from local broodstock increased from 25,000 juveniles in 2008 to 100,000 in 2012, and monitoring shows increased survival and migratory performance of the local broodstock progeny. Reclamation sponsored a series of facilitated meetings with Methow Valley stakeholders that resulted in recommendations to enhance broodstock collection and management of returning adults using existing infrastructure, increased effort, and temporary structures such as picket panel weirs. In 2012, Reclamation and USFWS developed a plan and scope of work to enable early 2013 implementation of these recommendations. A monitoring plan was developed and is being implemented to evaluate the effectiveness of these actions. Additionally, construction at Winthrop NFH removed and replaced outdated structures and installed new holding and rearing ponds.

- As a reform action for the Tucannon River steelhead supplementation program, WDFW developed a revised HGMP to eliminate releases of Lyons Ferry Hatchery steelhead in the Tucannon River and increase production of the endemic summer steelhead program. This program was partially implemented in 2010 and actions included ceasing the outplanting of Lyons Ferry Hatchery steelhead into the Tucannon River.
- As part of their review of the John Day Mitigation Program, the Corps, in conjunction with the *United States v. Oregon* Strategic Work Group, prepared an alternatives study of the program. The study evaluated mitigation production objectives, analyzed alternatives, and prepared preliminary designs and cost estimates for the most feasible alternatives. The *United States v. Oregon* parties provided comments on the study. The Corps is preparing a design report that will recommend specific adjustments to the current production program that will better support in-place, in-kind mitigation.

Other significant FCRPS hatchery reform accomplishments include cost-effective improvements in Best Management Practices and facility infrastructure at Dworshak NFH that have significantly increased the survival and production of ESA-listed hatchery summer steelhead (egg-fry, fry, juvenile, pre-smolt, and smolt life phases). These improvements, which were implemented through a coordinated effort by the hatchery operator (USFWS) and the funding agencies (Corps and BPA), include:

- New upgraded degassing towers to reduce nitrogen saturation from 107.5 percent to 98.6 percent
- Innovative management of river and reservoir water sources that significantly decreases Infectious Hematopoietic Necrosis (IHN) virus infections
- Upgrades in nursery tanks that improve fry survival
- Replacement of incubation chiller with water-to-water heat pump

Safety Net Programs

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 natural-origin stock. This hatchery program, which is carefully managed to preserve genetic diversity, annually produces fry and smolts that are released in natural habitat to migrate downstream and return from the ocean as adults. The program also produces mature adults for release into Redfish Lake to spawn naturally. Since 1999, 4,554 adults from the program have returned to Idaho's Redfish Lake or to the Sawtooth Hatchery weir on the upper Salmon River (Figure 43). In 2012, 243 adults returned to these two locations. The Action Agencies implemented research in 2009 and 2010 to investigate the source of disparity between returns to Lower Granite Dam and returns to Redfish Lake/Sawtooth Hatchery weir. The Action Agencies, along with NOAA Fisheries, are continuing to work with the region to further evaluate contributing factors.

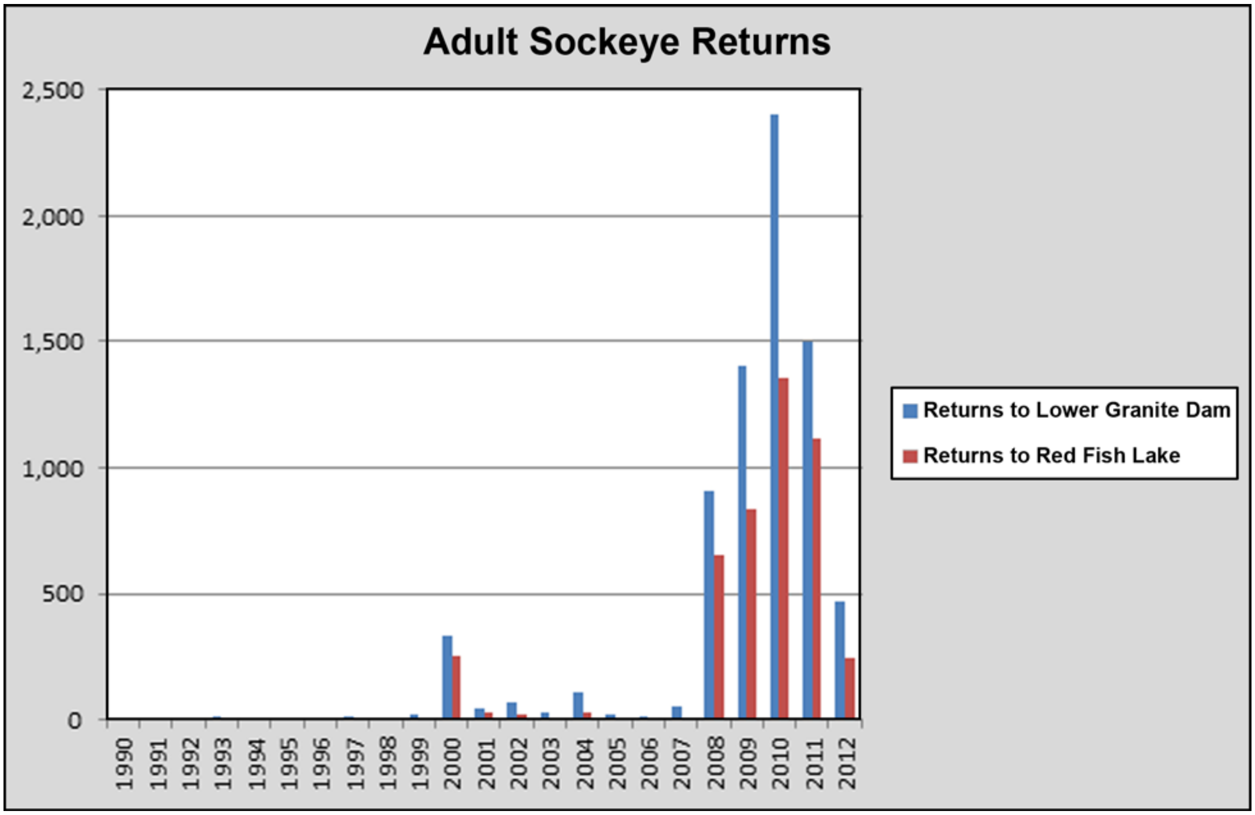


Figure 43. Adult Sockeye Salmon Returns to Lower Granite Dam and to Redfish Lake/Sawtooth Hatchery Weir on the Upper Salmon River, Idaho, 1990–2012.

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

The Action Agencies continued to fund hatchery conservation programs for salmon and steelhead to preserve and rebuild genetic resources and assist in promoting recovery of listed ESUs and DPSs. Through 2012, the Action Agencies funded:

1. Two projects to recondition upper and mid-Columbia River steelhead kelts and increase spawner abundance of these threatened DPSs.
2. Construction of a steelhead kelt reconditioning facility at Winthrop NFH.
3. Conservation programs for Snake River steelhead and Snake River sockeye.
4. A project aimed at reintroducing Columbia River chum salmon in lower Columbia River tributaries below Bonneville Dam and increasing the abundance of this threatened ESU.
5. Construction of the Chief Joseph Hatchery, with completion expected in 2013. The hatchery is anticipated to serve as the production facility for reintroducing spring Chinook in the Okanogan Basin. The purpose of this program is to reintroduce spring Chinook into rehabilitated habitat through efforts of federal, state, and tribal entities, using an Upper Columbia spring Chinook donor stock (Methow). The goal of the program is to add a fourth population to the three existing populations (Methow, Entiat, and Wenatchee) in the ESU to further reduce the extinction risk for this ESU. All Upper Columbia spring Chinook and their offspring are designated as a non-essential experimental population of Upper Columbia spring Chinook pursuant to Section 10(j) of the ESA, when found in the Okanogan River Basin or in the Columbia River adjacent to its confluence with the Okanogan River, upstream of the Chief Joseph Dam.

Progress towards FCRPS BiOp Goals: Estimating the Benefits of Hatchery Reform

NOAA Fisheries' 2008 FCRPS BiOp adopted the Action Agencies' method for quantifying the relative productivity improvements associated with certain hatchery reforms. That modeling method was described in Stier and Hinrichsen (2008)[6], which was included as an appendix to NOAA's 2008 Supplemental Comprehensive Analysis.

New information on the estimated effects of already and soon-to-be implemented hatchery reforms is included here. The tables below display estimates of the effects of both current and anticipated hatchery management actions. The changes are shown relative to the management in effect across the FCRPS BiOp's base period (roughly brood years 1980-1999). All estimates are given in terms of the change in the integrated productivity of a spawning population, e.g. the combined productivity of both natural-origin and hatchery-origin spawners in that spawning population. The FCRPS BiOp included estimates for the

[6] Stier, J. and R. Hinrichsen. 2008. A Method for Estimating Population Productivity Changes Resulting from Certain Improvements to Artificial Propagation Programs. Update to Appendix E of the "Comprehensive Analysis of the Federal Columbia River Power System and Mainstem Effects of Upper Snake and Other Tributary Actions" submitted by the Federal Action Agencies to NOAA Fisheries on August 21, 2007.

benefits of hatchery reforms for many of these populations. Therefore, the incremental improvement relative to the FCRPS BiOp estimate is also given.

Table 4. Populations for Which Hatchery Reforms are Currently Being Implemented. The method for calculating improvements is taken from Stier and Hinrichsen (2008); updated estimates of model parameters[7] are taken from a communication from staff at NOAA Fisheries.[8]

Population	Total Hatchery Reform Productivity Improvement	Hatchery Reform Productivity Improvement Relative to FCRPS BiOp	Nature of Reform Action
Catherine Creek Chinook	34%	12%	Improved hatchery broodstock (non-local to local)
Upper Grande Ronde Chinook	35%	11.5%	Improved hatchery broodstock (non-local to local)
Lostine R. Chinook	15%	11.4%	Reduction in straying (new weir for pHOS[9] management)
Minam R. Chinook	23%	1%	Management measures to reduce pHOS
Wenaha R. Chinook	41%	2%	Management measures to reduce pHOS
Entiat R. Chinook	10.9%	10.9%	Termination of spring Chinook hatchery program and reduction in straying from Chelan PUD hatchery program

[7] *The parameters of interest are the past and future relative reproductive effectiveness of the hatchery-origin spawners in a given spawning population, and the past and future proportions of hatchery-origin fish in that spawning population.*

[8] *The column labeled "total hatchery reform productivity improvement" refers to the estimated hatchery reform productivity improvement based on the most recent available information. The column labeled "hatchery reform productivity improvement relative to FCRPS BiOp" refers to the hatchery reform productivity improvement over and above the improvement that was estimated in the 2008 FCRPS BiOp. For example, the FCRPS BiOp estimated a 20% productivity improvement for Catherine Creek spring Chinook salmon resulting from already implemented hatchery reform actions. However, recent information from a relative reproductive success study funded by BPA indicates that there has actually been a 34% productivity improvement. Since these improvements are expressed as multipliers in the BiOp analysis, the incremental improvement is 11.6%, rounded to 12% for convenience (1.34/1.2).*

[9] *pHOS = proportion of hatchery-origin spawners*

Table 5. Populations for Which Hatchery Reforms are Indicated in Hatchery Genetic Management Plans Submitted to NOAA Fisheries for ESA Consultation. Hatchery reforms expected to be implemented by 2014-2016. The method for calculating improvements is the same as described for the table above.

Population	Total Hatchery Reform Productivity Improvement	Hatchery Reform Productivity Improvement Relative to FCRPS BiOp[10]	Nature of Reform Action
Imnaha R. Chinook	29%	29%	Reduction in straying (new weir for pHOS management)
Methow R. Chinook	5.5%	5.5%	Reduction in straying (improved imprinting/homing practices)
Wenatchee R. Steelhead	81%	13%	Improved broodstock and reduction in straying at Winthrop NFH
Entiat R. Steelhead	29%	58%	Cessation of hatchery outplanting practices
Methow R.Steelhead	162%	124%	Improved broodstock and reduction in straying
Okanogan R. Steelhead	34%	0%	Improved broodstock and reduction in straying

Harvest

Harvest impacts on ESA-listed fish species in the Columbia River Basin are managed primarily through states, tribes, and federal agencies other than the Action Agencies, and are addressed in separate BiOps. The Action Agencies have supported the identification and implementation of approaches or conservation measures to reduce the effects of harvest on ESA-listed species and/or increase the precision of enumeration of impacts. In 2012 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 funded an analytical investigation into harvest managers' sampling regime and estimation model to assess whether improved methodologies could provide more precise estimates, especially with the use of PIT technology.

[10] *For the "low hatchery" estimate.*

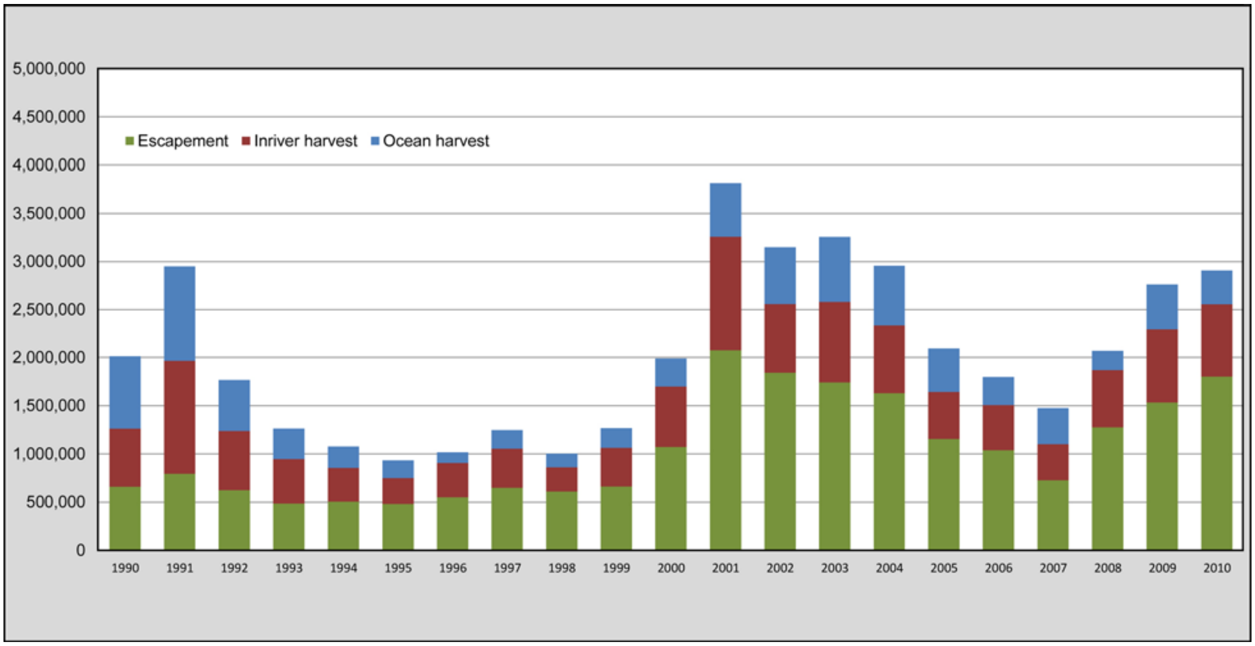


Figure 44. Escapement from Fisheries, In-river harvests, and Harvest Related Mortalities at Sea of Columbia River Salmon and Steelhead, 1990-2010. Figure Adapted from ISAB 2009 Review of the Fish & Wildlife Program (2013).

The Northwest Power and Conservation Council's Independent Scientific Advisory Board recently compiled figures combining escapement with ocean and river harvest, as shown in Figure 44. This provides a complete picture of fish that reach the river and those harvested before they do. Escapement increased substantially beginning in 2000. Harvest includes treaty and non-treaty fisheries, Ocean harvests include Columbia-bound Chinook and coho salmon and non-landed mortalities in commercial and sport fisheries from Southeast Alaska through California.

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 mid-Columbia region, but at lower numbers. Reducing avian predation of juvenile salmon and steelhead would result in increased adult returns. However, both Caspian terns and double-crested cormorants are protected under the Migratory Bird Treaty Act of 1918 (MBTA), which complicates the Action Agencies' ability to reduce the impact of these birds on the ESA-listed salmon and steelhead. Some types of management actions must be coordinated and approved by the US Fish & Wildlife Service (USFWS), which administers the MBTA.

Among fish, northern pikeminnow are voracious consumers of juvenile salmon and steelhead. Predation by introduced fish species such as smallmouth bass and walleye is also a concern. California and Steller sea lions are known to consume substantial numbers of adult spring Chinook salmon and winter steelhead below Bonneville Dam, and they injure many fish that pass upstream. Under the FCRPS BiOp, however, the Action Agencies' efforts to manage predation by sea lions are limited to non-lethal deterrent actions at Bonneville Dam. 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. Programs to redistribute Caspian terns currently nesting in the estuary, deter and block sea lions from Bonneville Dam fish ladders, and reduce the northern pikeminnow population through a sport-reward program have been successful in decreasing the loss of adult and juvenile salmon to predation. In 2012, the Action Agencies continued these efforts to control specific predators and improve survival of juvenile fish.

Avian Predation Accomplishments Since 2008

Avian Predation Management at Corps Projects

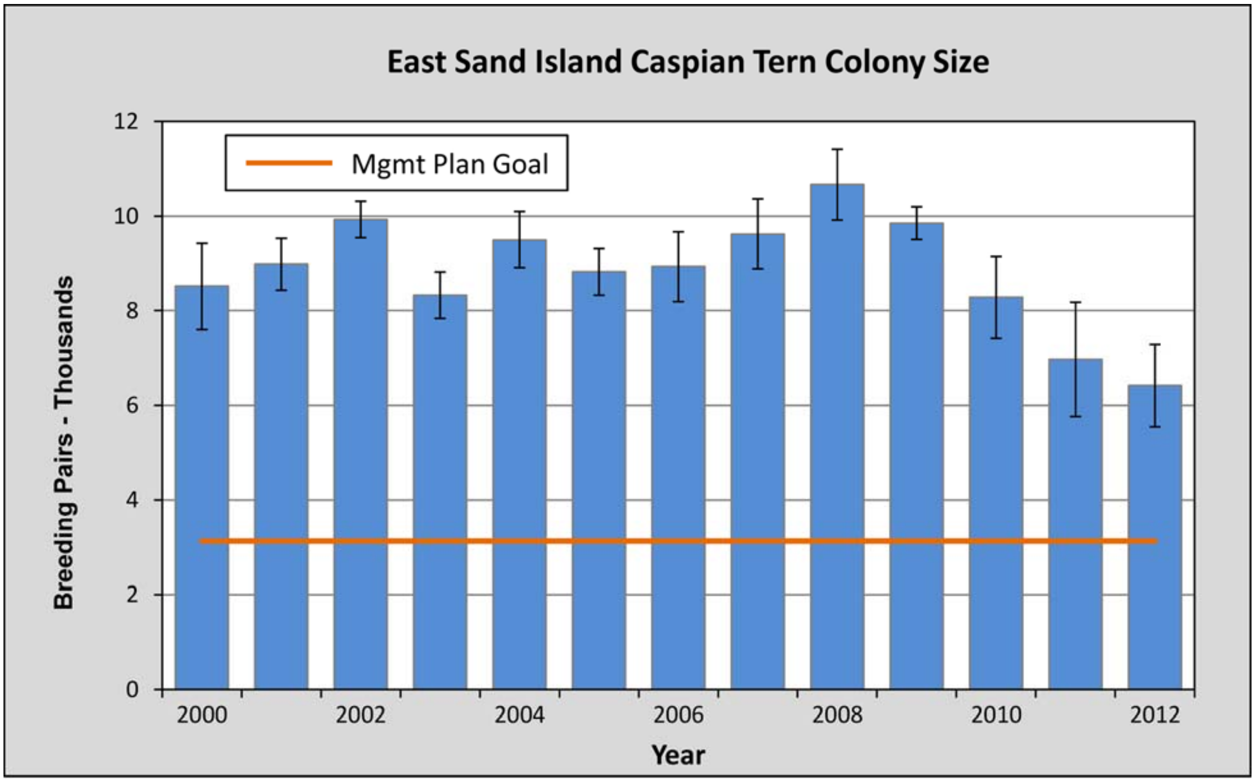
In 2008 through 2012, the Corps sought to minimize avian predation, mostly by gulls, at lower Columbia and Snake River dams through a combination of line arrays over tailraces, water cannon at bypass system outfalls, and active hazing. These were maintained and operated in accordance with the yearly, regionally-coordinated Fish Passage Plan. Line arrays at John Day and The Dalles dams were modified or replaced in 2010 and 2011, respectively, to deal with predation issues resulting in part from passage improvements made at those dams. Results indicate that gull predation at those dams dropped from 124,000 in 2010 to 22,000 in 2011.

Caspian Terns at East Sand Island

The Action Agencies also addressed the Caspian tern colony on East Sand Island (ESI) in the Columbia River estuary. The goal for the Caspian tern program is the construction of alternative nesting habitat sufficient to allow the reduction of Caspian tern nesting habitat on ESI to 1.5 to 2.0 acres, with the objective of reducing the number of nesting pairs to 3,125.

The tern colony in the estuary was first located on Rice Island; it was redistributed to East Sand Island beginning in 2000 in an effort to shift the terns' diet away from juvenile salmon toward a more diverse diet of predominantly marine fish species (at Rice Island, juvenile salmon comprised 75 to 90 percent of the terns' diet). In 2006, the Corps and the USFWS adopted the jointly-developed Caspian Tern Management Plan. The basis of that plan was the development of alternative nesting islands in areas outside of the Columbia River Basin, with nesting habitat on East Sand Island being reduced at a 1:2 ratio as alternative habitat was created. Implementation of that plan began in 2008 with the construction of an island in Fern Ridge Reservoir near Eugene, Oregon. Through 2012, the Corps has created nine nesting islands with 8.3 acres of habitat. While not all of this habitat is available every year, it has allowed the reduction of tern nesting habitat on East Sand Island from 6.0 acres in 2008 to 1.5 acres in 2012. The Corps is pursuing construction of an additional island in San Francisco Bay. That island, if construction becomes possible, will allow a further reduction on East Sand Islands to 1.0 acre, the minimum area considered in the Management Plan.

Tern numbers on East Sand Island have not decreased as rapidly as nesting area has; the birds have compensated to a degree by building their nests closer together. However, the reduction has still been substantial, falling from a high of more than 10,600 pairs in 2008 to an estimated 6,400 pairs in 2012 (Figure 45). However, consumption of smolts decreased to a lesser degree; the high of more than 6.6 million smolts in 2008 decreased to about 4.9 million in 2012 (Figure 45).



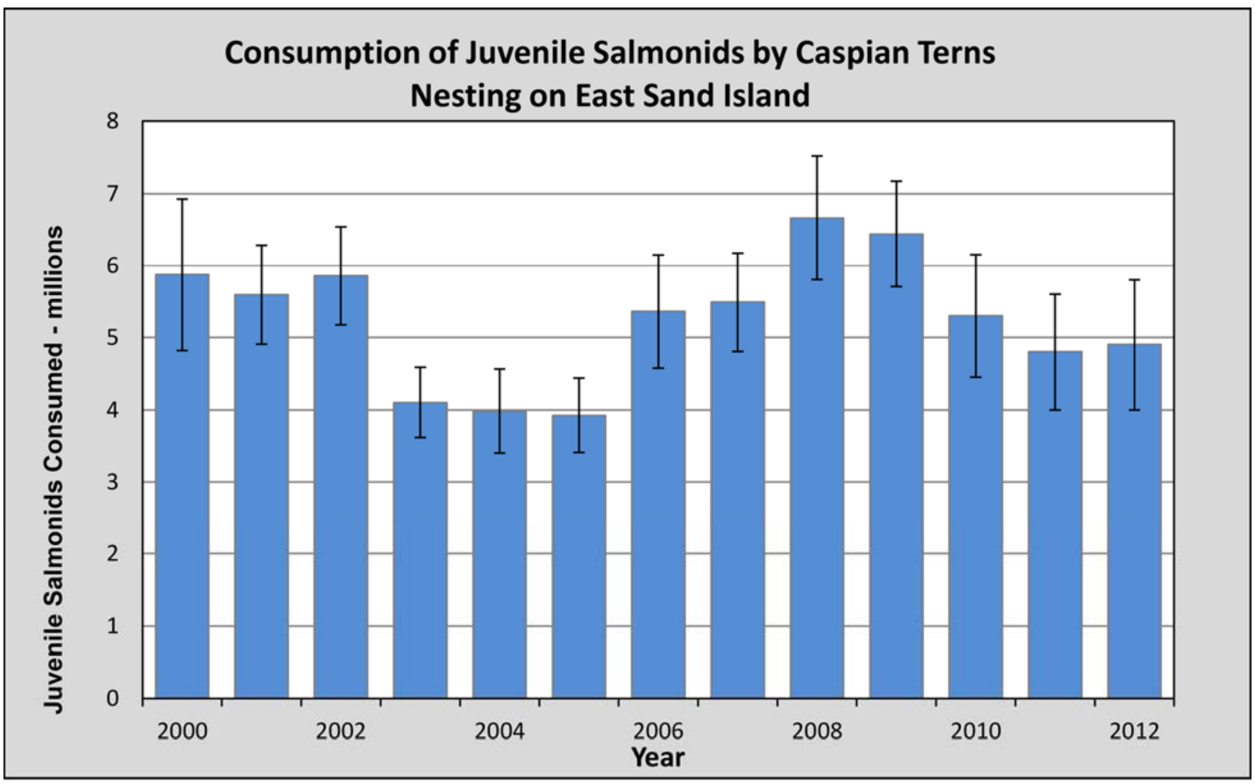


Figure 45. East Sand Island Caspian Tern Abundance and Salmonid Smolt Consumption, 2000-2012. 2012 numbers are preliminary and are subject to change.

Double-Crested Cormorants at East Sand Island

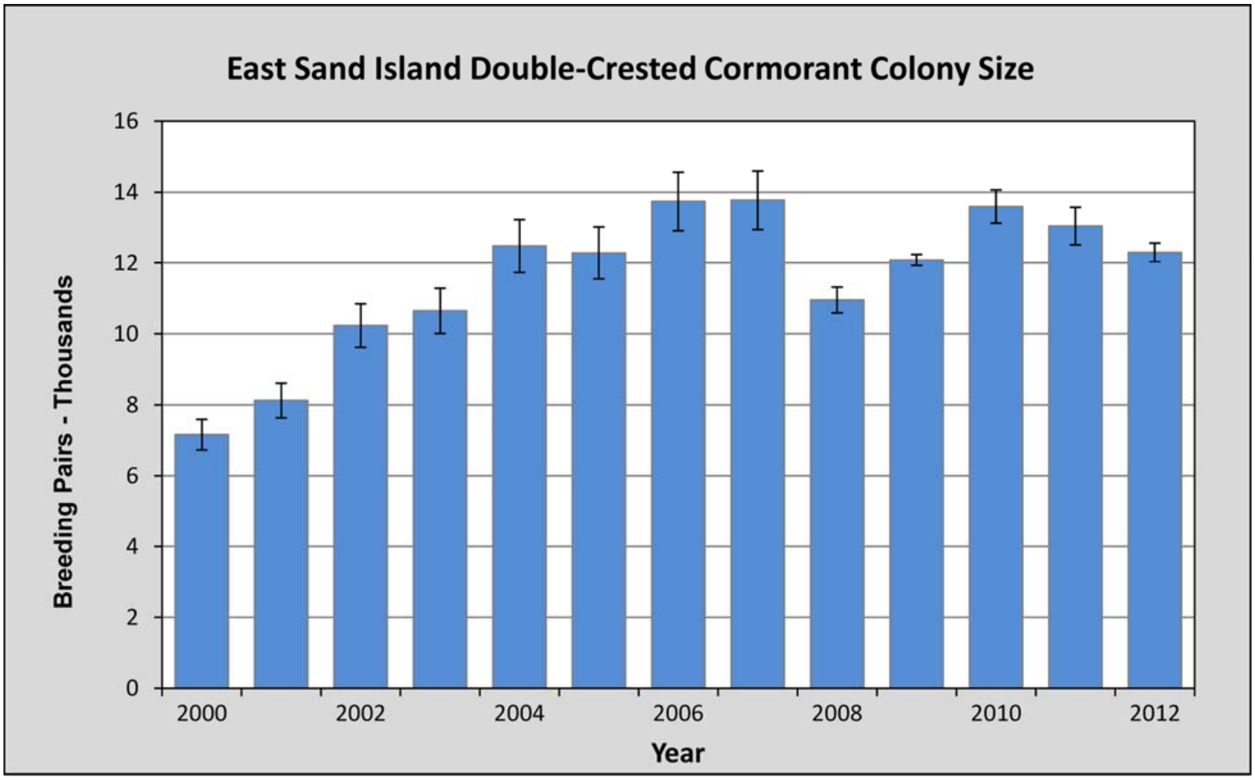
East Sand Island is home to the largest double-crested cormorant colony in western North America. The size of that colony increased considerably from 2000 to 2006, and since then has remained relatively constant at around 13,000 nesting pairs (Figure 46). However, consumption of juvenile salmon and steelhead has increased considerably since 2008, reaching a new estimate of more than 20 million, more than the estimated consumption by Caspian terns.

The program goal for the ESI double-crested cormorant predation management program is the development of a cormorant management plan encompassing additional research, development of a conceptual management plan and implementation of warranted actions on East Sand Island. The Corps, again working with the USFWS, is developing a double-crested cormorant management plan to address this issue. In 2012, the Corps determined that implementation of an effective cormorant management plan would require preparation of an EIS, and began the initial steps in preparing that document. Notice of the EIS was published in the Federal Register, and several public scoping meetings were held in November 2012. The expected date of release of the draft EIS is August 2013. Completion of the final EIS and preparation of a Record of Decision are scheduled for 2014, and implementation of identified management actions is expected to begin in 2015.

Inland Avian Predation Management

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

The program goal for the inland avian predation program is development of a management plan for Caspian terns, double-crested cormorants, and other species as warranted, for Corps-owned lands not immediately adjacent to Corps dams. (Management of avian predation at Corps dam and reservoir projects is described under “Avian Predation Management at Corps Projects” above.) Long-term management actions are being developed through regional input. Completion of the plan, along with implementation of identified management actions, is expected later in 2013.



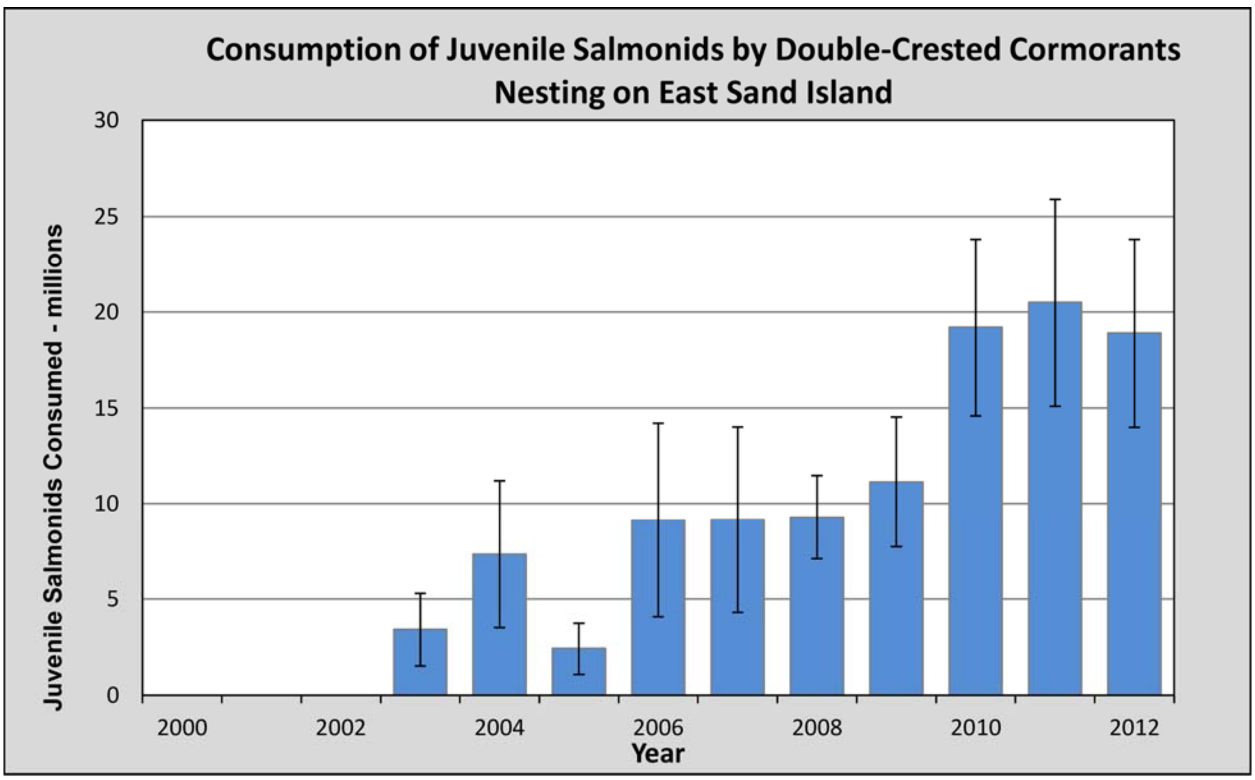


Figure 46. East Sand Island Double-crested Cormorant Abundance and Salmonid Smolt Consumption, 2003 – 2012. Consumption estimates for 2000-2002 are not available. Consumption estimate for 2012 not available in time for inclusion in this document.

Northern Pikeminnow Management Accomplishments Since 2008

Large northern pikeminnow are voracious consumers of juvenile salmon. Since 1990, BPA has funded the Northern Pikeminnow Management Program (NPMP) to reduce the numbers of larger pikeminnow and improve survival of juvenile salmon. Program goals of the Northern Pikeminnow Management Program are to achieve 1) an annual exploitation rate of 10 to 20 percent on northern pikeminnow 250mm or longer; 2) annually evaluate if inter or intra-specific compensation is occurring; and 3) quantify the benefits of cumulative removals to date.

The NPMP relies on private-sector fishing efforts to provide the majority of the catch of northern pikeminnow. Since 2005, BPA has increased the tiered monetary reward for the catch of this predator to achieve and maintain a higher exploitation rate to boost the biological benefit of the program. Since 2008 the exploitation rate for fish 11 inches and larger has been above 15% in all but one year (2009- 12.9%). 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 5,474 northern pikeminnow were caught at those locations in 2012. This represents a 38-percent increase in catch from 2011.

In 2012, the exploitation rate on northern pikeminnow was a notable 16.1 percent. This rate was based on a numerical catch of 157,846 from the sport reward fisheries.

Cumulatively, the NPMP has removed close to 3.65 million pikeminnow from the Columbia River Basin since 1990. Evaluation indicates that as a result of implementation of these actions pikeminnow predation on juvenile salmon has declined 38 percent in that time, saving 4 to 6 million juvenile salmon annually that otherwise would have been eaten by this predator.

Pinniped Management Accomplishments Since 2008

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

Program goals for the 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 salmonids and other fish; and 4) evaluating the effectiveness of hazing and other deterrent measures.

Corps biologists began gathering data on sea lion presence and predation at the dam in 2001. By 2003 the number counted had grown to more than 100. Not all sea lions counted were at the dam at the same time; usually about 30 were present on any one day. From

2002 through 2007, most of the pinnipeds present were California sea lions. Beginning in 2008, Steller sea lions, which are listed as threatened under the ESA, began arriving in larger numbers. By 2012, the total number of Steller sea lions seen at the Bonneville Dam tailrace was greater than the number of California sea lions seen (Figure 47).

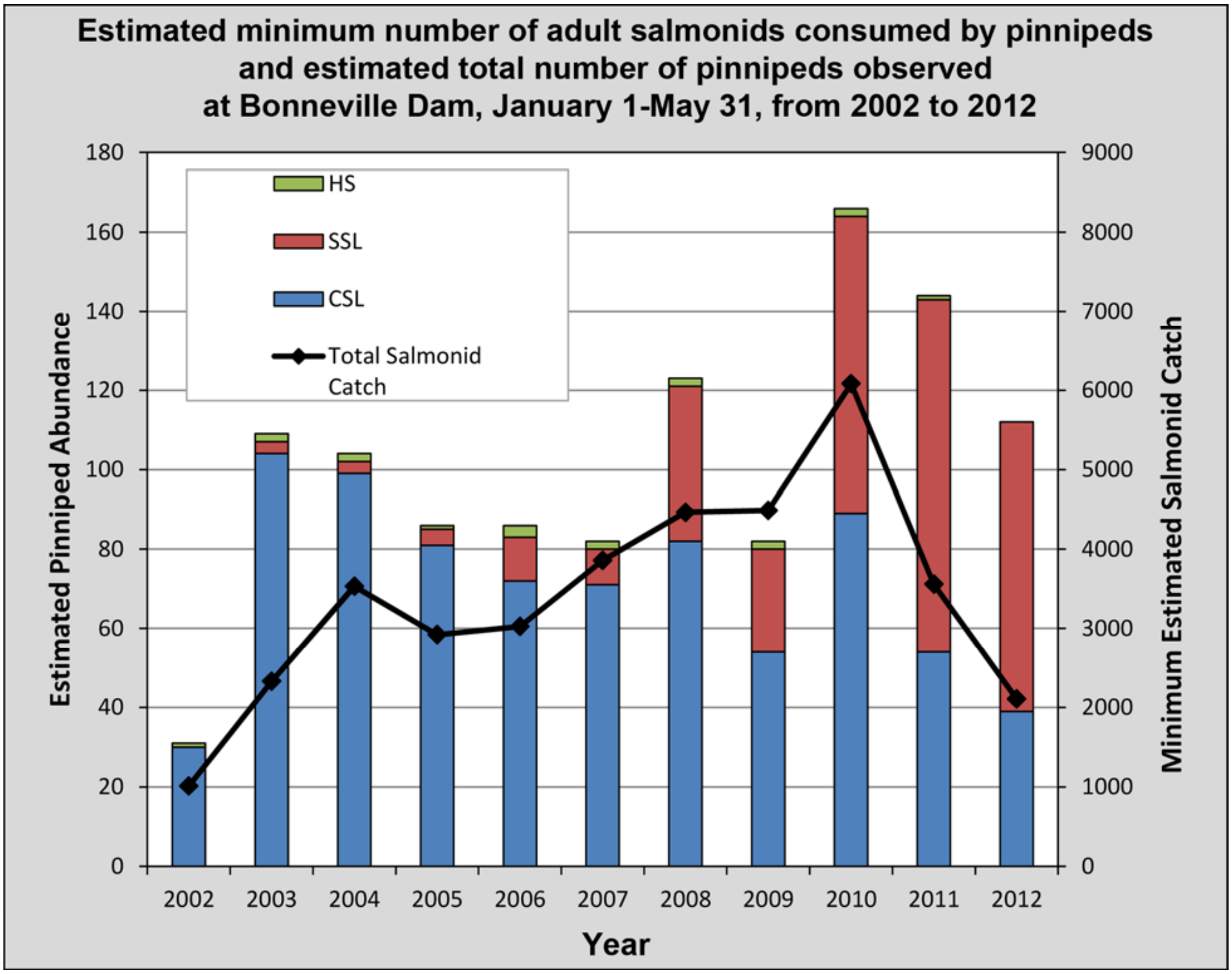


Figure 47. Estimated Minimum Number of Adult Salmonids Consumed by Pinnipeds and Estimated Total Number of Pinnipeds Observed at Bonneville Dam, January 1–May 31, from 2002 to 2012. Note: In 2005, regular observations did not start until March 18. Pinnipeds observed included California sea lions, Steller sea lions, and harbor seals. HS = harbor seals, SSL = Steller sea lions, CSL = California sea lions.

The number of fish eaten by sea lions increased every year from 2006 to 2010, but it decreased substantially in 2011 and 2012 (Table 6). In 2010, the expanded consumption estimate was 6,081 adult salmon and steelhead that would otherwise have passed Bonneville Dam from January 1 through May 31 ("expanded" estimates correct for the fact that observers are not present at all locations at all times). The 2011 expanded catch estimate for the Bonneville Dam tailrace observation area dropped to 3,557, or about 1.6 percent of the adult salmonid run at Bonneville Dam from January 1 through May 31, 2011.

In 2012, the expanded estimate dropped still further to 2,107, or about 1.2 percent of the January 1 – May 31 run. This is the lowest percentage since 2003 (Figure 47).

Table 6. Summary of Estimated Catch of Salmonids by Pinnipeds at Bonneville Dam, 2002–12.

Year	Bonneville Dam Salmonid Passage (Jan. 1–May 31)			Expanded Salmonid Catch Estimate		Adjusted Salmonid Catch Estimate	
		Observed Catch	% of Run (1/1 to 5/31)	Estimated Catch	% of Run (1/1 to 5/31)	Estimated Catch	% of Run (1/1 to 5/31)
2002	281,785	448	0.2%	1,010	0.4%	—	—
2003	217,943	1,538	0.7%	2,329	1.1%	—	—
2004	186,770	1,324	0.7%	3,533	1.9%	—	—
2005	81,252	2,659	3.1%	2,920	3.5%	—	—
2006	105,063	2,718	2.5%	3,023	2.8%	3,401	3.1%
2007	88,476	3,569	3.9%	3,859	4.2%	4,355	4.7%
2008	147,534	4,243	2.8%	4,466	2.9%	4,927	3.2%
2009	186,060	2,960	1.6%	4,489	2.4%	4,960	2.7%
2010	267,194	3,910	1.4%	6,081	2.2%	6,321	2.4%
2011	223,380	2,186	1.0%	3,557	1.6%	3,970	1.8%
2012	171,665	1,227	0.7%	2,107	1.2%	2,360	1.4%

During 2008 through 2012, the Corps implemented and evaluated a variety of sea lion deterrents, from physical barriers to non-lethal harassment. Since 2006, the Corps has contracted with the U.S. Department of Agriculture (USDA) Wildlife Services to harass sea lions away from fishways and other dam structures. Dam-based harassment by USDA agents 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.

From 2006-10, the Corps evaluated the effectiveness of acoustic devices at deterring sea lion predation on salmon near fishways. The acoustic devices, which emit a 205-decibel sound in the 15-kilohertz range, were installed underwater near primary fishway entrances and operated annually. They proved ineffective at deterring sea lions and were removed before the 2011 season.

From 2008 through 2012, the Action Agencies supported boat-based harassment conducted by the Columbia River Inter-tribal Fish Commission (CRITFC), the Oregon Department of Fish and Wildlife (ODFW), and Washington Department of Fish and Wildlife (WDFW). Boat-based harassment occurred annually from March through May. Boats operated from the Bonneville Dam tailrace at river mile (RM) 146 downstream to navigation marker 85 (RM 139). The Corps granted access to the Bonneville Dam boat restricted zone (BRZ) 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 BRZ after adult salmonid passage exceeded 1,000 fish per day. Corps biologists coordinated with USDA agents and boat-based crews from ODFW, WDFW, and CRITFC on all sea lion harassment activities at Bonneville Dam to ensure safety and increase the effectiveness of harassment efforts.

Overall, the Action Agencies have assisted efforts by NOAA and the states to better manage predation by marine mammals and current results are promising.

Research, Monitoring, and Evaluation

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

RM&E is implemented through various programs: the NPCC Fish and Wildlife Program (BPA), the Corps' Anadromous Fish Evaluation Program, and Reclamation's technical assistance activities. The programs are coordinated with RM&E activities of other regional agencies. The Action Agencies work closely with state, federal, and tribal aquatic habitat and ESA-listed salmon and steelhead monitoring programs, the Columbia Basin Fish and Wildlife Authority, and state and tribal constituents through a forum called the Pacific Northwest Aquatic Monitoring Partnership.

The Action Agencies have implemented several RM&E strategies and associated actions with regard to fish population status, hydro, tributary habitat, estuary/ocean, harvest, hatchery, predation, and regional coordination and data management. Work implemented and key lessons learned relative to all-H implementation is summarized below. More detailed action and project descriptions, and lessons learned, can be found in CE Section 2.

Fish Population Status Monitoring

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

What Was Implemented in 2008-2012

- The Action Agencies continued to monitor the status of ESA-listed fish and enhance the existing status monitoring performed by regional fish management agencies through implementation of approximately 50 projects. This effort reflects a regional strategy to monitor a minimum of one population per each MPG for each listed species.
- This monitoring program continued to be enhanced through further expansion of a regional PIT-tag array network in tributaries to support spawner abundance surveys. In addition, an expansion of juvenile trapping and surveys was implemented for key populations to improve both fish status monitoring and habitat effectiveness studies.
- Genetic stock identification techniques were used to establish population baselines and help to identify the origin or parentage of untagged Snake River Chinook and steelhead. Also, a non-invasive and non-lethal parental-based genetic tagging pilot validated the proof of concept to use genetics to support population run reconstruction for hatchery or natural origin fish.
- Monitoring precision was improved for key populations.
- Population spawner abundance estimates for Snake River B-run Steelhead were conducted for the first time to improve information on fish status.

Table 7. Proportion of Index Populations Within Each ESU that Show an Increase in Average Natural Origin Spawner Abundance and that Show an Increase in the Proportion of Natural-origin Spawners Between 2004-2007 and 2008-2012. Only populations with at least three years of data in 2004-2007 and three years of data within 2008-2012 were considered. Populations represent the number of index populations within the ESU that were considered and % change represents the average percent change in natural-origin spawner abundance between 2004-2007 and 2008-2012.

ESU / DPS	FCRPS BiOp Populations	Populations with Decreased Percent Hatchery-Origin Spawners (pHOS)	Populations with Increased Natural-Origin Spawner Abundance	% Average Change of Natural-Origin Spawner Abundance
Snake River Spring/Summer-run Chinook Salmon ESU	19	65%	87%	64%
Upper Columbia River Spring-run Chinook Salmon ESU	3	67%	100%	63%
Snake River Basin Steelhead DPS	3	67%	100%	32%
Middle Columbia River Steelhead DPS	14	64%	86%	57%
Upper Columbia River Steelhead DPS	4	100%	100%	96%
Total	**43**	**70%**	**89%**	**63%**

What Was Learned from 2008-2012 Project Results

- Sponsors reported significant increases in natural-origin adult spawners and reduction of hatchery-origin spawners for many populations across the basin, improving natural-origin spawning viability for these species. This information is validated in Table 7.
- Adult abundance of natural origin spawners increased for 89 percent of key target populations by an average factor of 63 percent while the hatchery proportion of spawners decreased for 70 percent of the key FCRPS BiOp target population (Table 7).
- Total adult fish returns to Bonneville Dam of listed and unlisted salmonids during the implementation period from 2008-2012 included some of the highest numbers since counting began in 1938.
- Adult salmonid spawner abundance is trending in a positive direction, away from adult AMIP triggers.
- It appears likely that there is not a substantial genetic distinction between Snake River A-run and B-run steelhead, which may have implications for FCRPS BiOp and other management decisions. This finding resulted from new genetic typing of all steelhead broodstock. The information will improve B-run steelhead pedigree analysis, which provides a baseline for potential future genetic assessments that may be used by NOAA Fisheries to re-evaluate population targets.
- Marking of hatchery fish has increased and genetic markers for hatchery-origin identification have been identified.
- Refer to the Hydropower and Tributary Habitat RM&E section for information related to how adult and juvenile abundance and survival monitoring informed RM&E for the FCRPS BiOp.
- Neither the AMIP Early Warning Indicators nor the Significant Decline triggers were tripped for any ESU, and preliminary data has salmon and steelhead survival and abundance trending away from triggers.

Observations and Adaptive Management Modifications to Improve Status Monitoring

- New Snake River steelhead population genetic analysis shows no distinctions between A-run and B-run designations. Therefore, the Action Agencies recommend NOAA Fisheries reconsiders existing FCRPS BiOp requirements and targets for B-run steelhead.
- Refer to the Hydropower and Tributary RM&E section for information related to how adult and juvenile abundance and survival monitoring informed the FCRPS BiOp.

Hydro RM&E

A broad array of status monitoring, action effectiveness, and critical uncertainty research and monitoring studies was conducted in 2008 through 2012 to assess hydro action performance and inform planning and adaptive management. Some of these investigations have been ongoing for years, preceding the FCRPS BiOp. They are pivotal for informing management decisions involving critical FCRPS operation issues and the effects on listed ESUs.

What Was Implemented in 2008-2012

- Testing compliance with performance standards, including juvenile survival passing individual dams.
- Describing migration characteristics (timing, abundance indices, etc.) and condition of juvenile fish as they migrate through the FCRPS.
- Upgrading the PIT-Tag Information System (PTAGIS) with advanced software, new detector installations at strategic sites, and the development of improved detection systems.
- Maintaining a long-term historical time series (decades) of FCRPS performance by estimating juvenile survival from point of entry through the FCRPS, each year. These data are used to detect changes in fish responses to the reconfiguration and operation of the FCRPS, and provide data to calibrate COMPASS.
- Monitoring adult survival during upstream migration to determine if survival targets are being achieved, and if not, where in the system losses from straying, harvest, or passage mortality may be occurring.
- Evaluating and fine-tuning spill magnitude, patterns, and duration to enhance dam passage survival of juveniles, while containing negative impacts to water quality and adult passage.
- Evaluating surface flow outlets as a means to improve juvenile passage and survival. This involved conducting hydraulic model studies and then field testing to confirm hypothesized survival improvements.
- Measuring passage distributions of overwintering steelhead and kelts passing through surface passage routes and turbines at Bonneville, The Dalles, and McNary dams. Kelt survival was estimated at FCRPS dams and river reaches in 2012.
- Exploring the role of transportation for spring and summer migrating populations in maximizing adult fish return rates to the Columbia River. Specific evaluations focused on release location and timing, and effects of juvenile fish transportation on adult fish stray rates.
- Refining COMPASS by incorporating the most current passage and survival data for the FCRPS. This tool is an important platform used in prospective risk assessments.
- Exploring passage conditions that may result in latent mortality beyond Bonneville Dam.

- Assessing the feasibility of PIT-tagging Snake River sockeye for use in passage studies. Transport evaluations are currently underway.

What Was Learned from 2008-2012 Project Results

- Performance standard tests to date confirmed that actions aimed at improving survival for juvenile fish passing FCPRS mainstem dams are achieving survival improvements that were predicted in the FCRPS BiOp. Collectively, results through 2012 indicate that the combined actions of spill, surface passage spill, and screened powerhouse bypass systems can be optimized at each site to achieve the FCRPS BiOp juvenile fish dam survival standards of 96 percent for spring and 93 percent for summer migrants. In addition, results of tagging effect studies, improved statistical study design, and recent dam survival data have demonstrated that robust absolute survival estimates can be obtained at FCRPS dams.
- In-river survival for PIT-tagged yearling Chinook and steelhead migrating from Lower Granite Dam to Bonneville Dam was estimated annually. Historical patterns of in-river survival calculated and reported by NOAA Fisheries indicate that the mainstem actions implemented under the FCRPS BiOp have been effective at maintaining high survival through the FCRPS. In-river smolt survival today is roughly comparable to levels estimated during the 1960s when fewer dams comprised the FCRPS.
- Surface passage spill is more effective and efficient than conventional spill in attracting fish and optimizing fish survival. It provides both reduced delay in the forebay and increased overall survival. At Bonneville Dam, new spill patterns and volumes were developed and resulted in an increase in subyearling Chinook survival. At The Dalles Dam an 800-foot long spill wall was constructed to improve tailrace egress and provide safe conveyance for juvenile fish. Results from 2010-12 performance standard testing indicated a marked improvement over the pre-spill wall configuration in dam survival of both spring and summer migrants.
- Monitoring adult passage survival with PIT-tagged fish has indicated that over the last five years, some stocks that previously met adult passage survival targets specified in the FCRPS BiOp are no longer meeting them. Snake River steelhead and spring-summer Chinook missed the targets in recent years, but Snake River fall Chinook and upper Columbia River stocks are achieving the targets. The reasons for the shortfall for some ESUs are not yet known, but the improved and expanded PIT-tag detection system should improve our understanding of the problem and suggest solutions. Possible issues include impaired adult passage from high downstream flows and spill, adult fall back, unaccounted harvest and other factors.
- Results of research conducted from 2008-2012 continue to show that transportation generally a benefits Snake River spring Chinook salmon and steelhead; geometric mean transport SARs from Lower Granite Dam were 15 to 68 percent greater than non-detected in-river migrant SARs and 37 to 101 percent higher than bypass SARs. The only exception may be natural-origin Chinook that, based on Comparative Survival Study (CSS) assessments, survive at equivalent rates whether transported

or left in-river to migrate through the FCRPS. Preliminary results of Snake River sockeye and fall Chinook salmon transport studies suggest that transport may be beneficial, and at minimum, is not harmful to these species. Evaluations of transport release timing and location concluded that benefits accrued from more distant release locations were negated by increased stray rates of returning adults. The management practice of delaying smolt transport until early May is beneficial to natural-origin spring Chinook, but detrimental to natural steelhead and hatchery spring Chinook.

- The multi-agency, decade-long study to identify the preferred passage strategies for summer-migrating Snake River fall Chinook is just yielding preliminary results. Their complex life history has made this a challenging endeavor. A substantial portion of returning adults displayed a reservoir-type life history, spending their first summer and winter in Snake River reservoirs. The central management issue is whether in-river migration or transport is the preferred passage strategy during the summer season, or if a spread-the-risk approach is warranted.
- The term hydro latent mortality has been used to label apparent delayed effects associated with in-river hydro migratory experience that do not manifest until after passage below Bonneville dam. Some analyses indicate that screen-bypassed smolts may have some hydro associated latent mortality since they return at lower rates than smolts that evade such structures (i.e., passing through spill or turbine routes). However, this finding is confounded by the selectivity of bypass systems for smaller or poor condition fish which would naturally have lower return rates than larger or better condition fish that have avoided the bypass system route of passage. The Independent Scientific Advisory Board released a report on April 6, 2007 saying that the panel concluded that the hydrosystem "causes some fish to experience latent mortality, but strongly advises against continuing to try to measure absolute latent mortality. Latent mortality relative to a damless reference is not measurable."
- Summer spill benefits depend upon the timing of spill in relation to the timing of migration.

Observations and Adaptive Management Modifications to Improve Hydrosystem Operations

- Performance standard tests to date are confirming that actions aimed at improving survival for juvenile fish passing FCPRS mainstem dams are achieving survival improvements that were predicted in the FCRPS BiOp. These test results will be used to finalize the configuration and operation of dams that have met the standard, and focus on areas where more improvement is needed.
- Optimizing spill for fish passage involves balancing the following factors: a) identification of minimum gate openings for safe conveyance of juveniles, b) development of spill amounts and patterns that minimize juvenile fish exposure to predators, c) enabling upstream migrating adult fish to find ladder entrances quickly, and d) not exceeding TDG standards.

- Surface flow outlets at spillways require training spill from adjacent spillway and powerhouse outlets to provide good downstream egress conditions. Training spill should be optimized for fish passage by minimizing eddy formation and improving juvenile survival.
- The mechanisms responsible for low adult passage survival of some ESUs in the FCRPS are an ongoing critical uncertainty. Installation of PIT-tag detectors in The Dalles Dam ladders will enhance the spatial resolution of adult fish inter-dam loss estimates in the lower Columbia River. This, in combination with the ability to detect adults entering major tributaries, is expected to better pinpoint the zone and mechanism explaining the loss. The sampling of fisheries for PIT-tagged adults is an important facet of this monitoring effort. Once mechanisms are identified, remedial actions (e.g. possible spill adjustments) can be formulated if appropriate.
- Following the completion of the collaborative fall Chinook passage study in the next few years, the Action Agencies will work with other agencies to formulate a passage strategy for summer-migrating Snake River fall Chinook. Transportation provides a survival benefit for Snake River spring Chinook and steelhead, and it should continue to be used for these fish until monitoring shows otherwise. Optimizing spring transport operations in the Snake River is complicated since the ESUs and their natural-origin and hatchery components respond differently.

Tributary Habitat RM&E

Information to support habitat action planning and assessment needs was collected in 2008 through 2012, with ongoing and expanded efforts in status and trend monitoring, action effectiveness research, and analytical approaches. Status and trend monitoring supports identification and assessment of ecological concerns (habitat limiting factors), and development of relationships between habitat condition and fish productivity and capacity. Action effectiveness monitoring and research helps to refine information regarding the beneficial effect of habitat actions on fish populations and habitat conditions at both the local (project) level and the broader watershed level – and to identify the most effective actions to enhance fish survival.

Given the ramp up of longer term RM&E studies for the FCRPS BiOp, the AAs and NOAA Fisheries are well staged with Intensively Monitored Watershed action effectiveness studies, fish status and habitat status data, and project monitoring anticipated to further expand scientific information about tributary habitat restoration projects' relationship to fish abundance and survival by the end of the BiOp term in 2018. This staging is documented in the "*Columbia Basin Tributary Habitat Improvement: A Framework for Research, Monitoring and Evaluation*".

The Columbia Habitat Monitoring Program (CHaMP); the U.S. Forest Service's PACFISH/INFISH Biological Opinion (PIBO) Program; and the Okanogan Basin Monitoring and Evaluation Program (OBMEP) continued to assess multiple parameters of habitat status and trends in nine subbasins for at least 15 salmon populations. Tributary habitat conditions and ecological concerns were evaluated through several state-of-the-art "intensively monitored watersheds" (IMW), which provided data to quantify the relationships between habitat conditions and fish productivity. In addition, the effects of different types of habitat improvements on local habitat conditions and fish responses were evaluated at the project level.

What Was Implemented in 2008-2012

- Habitat status and trend monitoring coverage continued via the second year of implementation of the CHaMP Program. The CHaMP Program was able to successfully implement the planned study design and then report on results from the first year of data collection. Second-year results were provided during a workshop in November 2012.
- Habitat action effectiveness studies continued through assessments of large-scale IMWs. The effectiveness of restoration treatments relative to fish population response at the watershed and reach scales was evaluated through several IMWs (Asotin Creek, Upper Middle Fork John Day River, Bridge Creek, Grande Ronde River, lower Columbia River tributaries, Potlatch River, Lemhi River, Entiat River, Okanogan River, and Methow River).
- Fish-habitat relationships were developed to improve the advancement and parameterization of habitat models. These relationships are being used as key components of population-specific life-cycle models that support the AMIP contingency and adaptive management assessments. In addition, substantial progress was made on the development of life-cycle and aquatic productivity models to analyze habitat treatments in the Methow River Basin.
- Project level action effectiveness monitoring was implemented for many habitat actions being implemented under the BiOp. This monitoring of local, reach scale habitat and fish conditions documented the benefits of actions such as passage improvements, in-stream improvements, reconnection of side channels, flow augmentation and controls on grazing.

What Was Learned from 2008-2012 Results

- Habitat improvements promote increased fish survival on large and small scales, where survival increases as habitat actions improve conditions for fish. This validates the fundamental connection between fish and habitat and underscores the role of habitat in strengthening fish populations.
- Habitat actions create improvements for fish, with the clearest benefits from barrier removals, reconnection of side channels and other habitat actions that correct physical and biological impediments.
- Salmon and steelhead have quickly returned to reopened habitat, spawned in greater numbers in restored reaches and increased in abundance following treatment.
- The RM&E program can accurately measure environmental changes from tributary habitat improvements and resulting increases in fish survival, reporting them in formats that inform managers and improve project design.

- At the project level, habitat actions implemented correctly improved physical habitat and resulted in positive salmonid responses (increased reach-scale juvenile abundance and survival). Actions such as barrier removals, floodplain restoration, and instream habitat improvements resulted in positive effects that were easily detected in the short term. Off-channel and floodplain habitat improvements were rapidly utilized by salmon and steelhead and are expected to ameliorate climate change effects on peak flows, low flows, and stream temperatures. Habitat actions such as riparian improvements and sediment reductions show beneficial effects, but require longer periods to detect changes and are sensitive to site conditions, natural disturbances, and herbivores. Acquisition and protection projects are key tools for protecting high quality habitat and securing lands for restoration.
- At the watershed or population level, several habitat metrics are correlated with fish size and parr-to-smolt survival. This means that monitoring programs are measuring habitat metrics that are important to fish survival and productivity. In addition, correlative studies indicate that parr-to-smolt survival increases as the number of habitat actions increase within a population.
- All of the IMWs are now underway and several have completed pre-project monitoring that provides a wealth of information on conditions prior to habitat improvement project implementation. In many cases, post-project monitoring has begun and is planned to continue through the FCRPS BiOp period. Thus the program is well staged to provide scientific information about project effectiveness at the population level by 2018. The Methow IMW results to date confirm that lack of protective cover is limiting salmon productivity; many of the habitat improvement projects underway in the Methow are addressing this limiting factor.
- The habitat status and trend monitoring programs are successfully providing information on ecological concerns at different spatial scales (reach, watershed, and population scales). These results were available to the Expert Panels to help identify ecological concerns. In many cases, the results from habitat monitoring confirmed assumptions made by the experts before they had empirical data.
- The Integrated Status and Effectiveness Monitoring Program (ISEMP), CHaMP, and the IMWs have revealed fish-habitat relationships that are being used to develop and parameterize models. Initial work indicates that habitat metrics related to fish performance differ between Chinook salmon and steelhead. These relationships are continuing to be used by the NOAA Fisheries Life-Cycle Modeling Group to develop population-specific life-cycle models.

Observations and Adaptive Management Modifications to Improve Tributary Habitat Projects

- The habitat program implementation structure, which consists of biologically targeted projects, assessment of habitat quality improvements, use of Expert Panels, and independent scientific review, continues to improve year-by-year through information gained from RM&E. Information accumulating through the RM&E programs is actively being made available both to the Expert Panels and to the watershed planning groups that help identify and prioritize habitat improvement projects. Thus over time, as the science on the benefits of habitat projects improves, both the projects and the benefits of the projects will continue to evolve as was expected by the adaptive management framework of the FCRPS BiOp.

- The correlation between habitat actions and survival indicates that continuing the habitat program will improve juvenile salmon and steelhead survival and productivity. The exact nature of these correlations is the subject of the RM&E work that is underway. Habitat actions that improve connectivity, stream flows, and off-channel and floodplain conditions will buffer against climate change effects on peak flows, low flows, and stream temperatures. Beaver dam support structures show great promise in restoring habitat diversity in degraded and entrenched streams.
- The tributary habitat RM&E effort that is underway is large in scope and targeted at the FCRPS BiOp issues. These increased RM&E efforts include increased fish population status and trend monitoring covering 42 key fish populations in 24 sub-basins/watersheds; habitat status and trend monitoring in 11 sub-basins/watersheds under the CHaMP, OBMEP, and PIBO programs; nine Intensively Monitored Watershed studies to evaluate fish-habitat relationships and a revised project level habitat action effectiveness program targeting key BiOp populations throughout the Columbia River Basin. Results are currently available for many basins; even more data and syntheses will become available within the next five years as RM&E already planned and underway produces new information and habitat monitoring is expanded to include additional populations. Thus the Action Agencies and NOAA Fisheries will have improved information in the future regarding tributary habitat actions.

Estuary and Ocean RM&E

The Action Agencies strategize, prioritize, plan, and implement lower Columbia River estuary actions through the Columbia Estuary Ecosystem Restoration Program (CEERP) and its adaptive management framework.

What Was Implemented in 2008-2012

- Estuary/Ocean RM&E monitored and evaluated fish performance in the lower Columbia River estuary and plume, fish migration characteristics and habitat conditions, the effectiveness of restoration actions, and critical uncertainties.
- Ten major RM&E projects were conducted in the estuary (7) and ocean (3) during 2008-2012, including: Salmonid Survival and Behavior, Historic and Current Habitat Linkages, Ecosystem Monitoring, Tidal Freshwater Research, Contribution of Tidal Fluvial Habitats, Salmon Benefits, Cumulative Effects, Ocean Survival of Juvenile Salmonids, Canada-USA Salmon Shelf Survival, and Coastal Ocean Acoustic Salmon Tracking. This effort followed the 2008 programmatic RM&E plan titled *Research, Monitoring, and Evaluation for the Federal Columbia River Estuary Program*.

What Was Learned from 2008-2012 Project Results

- The Columbia River estuary, plume and the ocean provide a continuum of salmonid habitats from tidal freshwater to estuarine water to the plume and nearshore ocean water. Juvenile salmon feed heavily on insects and amphipods produced in wetlands and their gut contents are generally high, even for many salmonids in the main stem, which contributes to growth and survival. Growth rates derived from various methods indicate salmon are benefitting from wetland habitats.

- Juvenile salmonids are using restored habitat. Some two-thirds of the estuary's historic wetland habitat has been lost to development, but monitoring demonstrates that fish are quickly making use of reopened and restored wetlands. Reconnecting floodplain habitat is a key element of the program, and research has found that doing so improves habitat availability and use by juvenile fish. Different life-history types of Chinook salmon are found year-round throughout the habitats sampled and enter the sea at all sizes. Species and stocks (especially of Chinook salmon) have distinct migration periods and migration peaks that depend on location in the system.
- Reconnected floodplain wetlands also produce and export macrodetritus and associated prey that fish feed on. It also improves thermal conditions. Research now underway will explore fish responses to estuary habitat actions at an even finer scale by examining salmonid residence time, prey availability, and other factors. For example, the residence time of salmon in wetland habitats varies by life-history stage, location, and season, but it is clear that some salmon remain in or near wetland channel locations for weeks to months. Larger fall Chinook salmon generally move downstream at a faster rate than smaller fish.
- **Habitat improvements benefit salmonids, even if they do not directly use the habitat.** Research has found that tidal wetland habitats provide important prey and related food resources to juvenile salmonids in the Columbia River and Estuary regardless of whether they occupy those habitats. Salmonids sampled in the mainstem, including stream-type salmonids, had consumed prey items produced in the kind of estuary wetland habitats that the program targets for restoration. Research indicates that juvenile salmonids prefer prey items directly linked to tidal wetland habitats, further underscoring the relationship between habitat restoration and fish survival.
- **The larger yearling Chinook salmon are during early ocean residence, the more likely they are to survive in the ocean.** Mortality during the first winter in the ocean can be substantial (80-90%). Research has linked larger size and early marine growth with higher yearling Chinook salmon survival in the ocean. These size-dependent survival improvements are currently attributed to reduced predation during the first few months juveniles spend in the ocean and less starvation during their first winter in the ocean. Ocean studies have also shown that that juvenile salmon survival is set within the first year of marine residency and is partially related to food-web structure and growth conditions in the plume and coastal ocean. Salmonid species interact with the ocean environment differently. Juvenile salmon entering the ocean rapidly shift to a diet of primarily fish and krill and preferentially feed on taxa rich in essential fatty acids. Inter-annual variation in the quantity and

type of prey available to juvenile salmon in the nearshore environment appears to influence the relative survival of Columbia River salmon populations.

- Action effectiveness studies show that in many cases hydrologic reconnections increase opportunity for fish access to shallow-water habitats (e.g., Crims Island, Julia Butler Hansen Refuge, Kandoll Farm). Information to date suggests that dike breaches are more effective at restoring juvenile salmonid access to habitats than tide gate retrofits. The lines-of-evidence assessment for cumulative effects revealed that juvenile salmon benefit from tidal wetland reconnection by increased presence, residence, access to prey, and feeding; historically reconnected sites in the lower Columbia River estuary are available to juvenile salmon; juvenile salmonid response to habitat restoration in the lower Columbia River estuary is mixed; ecosystem processes respond quickly to habitat restoration; wetlands produce plants and prey that are consumed by juvenile salmon; organic matter from restored sites can be exported >7 km to the main-stem river; and stomachs of Chinook salmon and steelhead near rkm 15 are substantially more full than fish exiting the hydropower system. These benefits from the lower Columbia River estuary are expected to improve juvenile salmon early ocean survival.
- The lower Columbia River estuary provides a transition zone from freshwater to seawater that is critical to prepare fish for entry into the ocean. The data support the premise that improved conditions in lower Columbia River estuary ecosystems support improved probability of survival during the first few weeks in the plume and nearshore ocean. Tidal wetlands in the lower Columbia River estuary currently support juvenile salmonids, including interior basin salmonids. This effect would be expected to increase over time as existing restoration projects mature and new ones are implemented.
- In studies of spatial structure and diversity, Columbia River Chinook salmon stocks are not uniformly distributed in space or time, but they exhibit characteristic patterns of migration and habitat use. All genetic stock groups of Chinook salmon frequent shallow habitats of the lower and mid-estuary, but lower Columbia River fall Chinook are most abundant. Greater proportions of upper Columbia River summer/fall, Willamette River spring, and interior (i.e., Snake River, Deschutes River) fall Chinook stocks are represented in upper estuary reaches.
- For Chinook salmon, the proportion of hatchery-marked fish has increased in recent years and hatchery-reared fish dominate most main-stem sampling sites. However, the many smaller fish found in shallow-water habitats are unmarked and are likely wild fish, indicating that unmarked fish use shallow tidal freshwater to a greater extent than marked fish. This finding is consistent with previous work that has shown that shallow-water areas are particularly important to native life-history types and many of the small juvenile salmon rearing in shallow wetland areas are wild spawned.
- Yearling Chinook size and early marine growth is positively correlated with adult returns. Despite relatively stable production from Columbia River Basin hatcheries every year, salmon return rates vary by ESU.

- Results suggest that juvenile salmon survival is set within the first year of marine residency and is partially related to food-web structure and growth conditions in the plume and coastal ocean, but salmonid species interact with the ocean environment differently. Juvenile salmon entering the ocean rapidly shift to a diet of primarily fish and krill and preferentially feed on taxa rich in essential fatty acids. Inter-annual variation in the quantity and type of prey available to juvenile salmon appears to influence the relative survival of Columbia River salmon populations.
- Mortality during the first winter in the ocean can be substantial (80-90%), Emerging information suggests that during sustained high flow events in May and June, marine forage fish may have difficulty entering the Columbia River estuary, meaning that juvenile salmonids would comprise a higher proportion of some avian diets.

Observations and Adaptive Management Modifications to Improve FCRPS BiOp Performance

This section contains the key lessons learned and adaptive management components for actions in the estuary/ocean.

Estuary

- Estuary RM&E data provide the best available science and the Expert Regional Technical Group (ERTG) uses this information and peer-reviewed literature to score projects to assign SBUs. The ERTG has provided input on uncertainties in the SBU process; the Action Agencies are currently considering and prioritizing these topics in estuary RM&E. Recognizing the importance of action effectiveness monitoring and research for CEERP restoration actions, a programmatic action effectiveness monitoring and research (AEMR) plan was developed in 2012 and is being implemented that prioritizes, coordinates, and communicates AEMR within the CEERP.
- Research, Monitoring and Evaluation results and feedback from the ERTG have also helped affirm several important restoration principles that will further strengthen the habitat program. For example, dollar-for-dollar, larger projects with more acreage provide greater benefits for fish because they are more secure, accessible, and have greater carrying capacity. In addition, projects closer to the main stem are more accessible to fish than those farther away, restoring remnant channels is better than excavating new ones and natural processes are preferable to engineered ones.
- Information indicates that habitat restoration activities in the lower Columbia River and estuary are having a cumulative beneficial effect on juvenile salmonids, including those from interior basin populations. This effect would be expected to increase over time as existing restoration actions mature and new ones are instituted. This assessment supports continued CEERP implementation. Restoration projects, focused on floodplain habitats, have increased and are showing a positive effect on site-scale and ecosystem-scale habitat conditions and processes.
- Protecting, restoring, and enhancing the wetland habitat upon which these fish depend will help restore life-history diversity to Columbia River salmon populations.

Habitat diversity is associated with life history diversity. Restoring a diversity of lower Columbia River estuary habitats should contribute to increased life history diversity for natural-origin salmon populations basin wide, improving resilience and potentially overall abundance.

- Habitat opportunity appears to be a major limitation to salmon performance, because many potential habitats are simply unavailable due to migration barriers such as dikes, levees, dilapidated tide gates, and plugged culverts. Therefore, CEERP actions to increase habitat opportunities will be prioritized, especially those that fully reconnect wetlands to the main stem river.
- The primary direct, onsite beneficiaries of the restoration of main-stem wetland habitats will be subyearling Chinook salmon. However, restoration of wetland habitats also has offsite benefits for a wide variety juvenile salmon migrating in main and off-channel areas because of export of organic materials, nutrients, and prey resources from onsite to offsite areas. Restoration of lower Columbia River estuary wetlands should therefore continue to be implemented for the benefit of multiple Columbia Basin populations.
- Tidal wetlands in the lower Columbia River estuary support juvenile salmonids, and this effect would be expected to increase over time as existing restoration projects mature and new ones are implemented.
- Habitat restoration will also help mitigate potential climate change impacts in the form of in-river flow dynamics and volumes, increases in water temperature, and sea-level rise. Floodplain reconnections to restore natural ecosystem processes could be expected to help ameliorate the effects of climate change.

Ocean

- Long-term datasets on ocean conditions and Chinook and coho size and abundance can be used for harvest management, run forecasting, and life cycle modeling. Different populations of Columbia River salmon migrate at different times and speeds, and migration rates of interior Columbia River yearling Chinook during their first months at sea are higher during years of poor ocean conditions. This suggests that juveniles may modify their migratory behavior based on ocean conditions.
- Although work is still ongoing, results to date suggest that much of the variability in overall survival from the smolt-to-adult life stage (SAR) of multiple Columbia River Basin salmonids is a function of ocean conditions. In particular, for a number of species and population groups, the early ocean residence is a critical period.

Harvest RM&E

Harvest investigations linked to FCRPS interests included coded-wire and PIT tagging and recovery operations to assess the survival, straying, and harvest rates of returning adult salmonids in the ocean and hydrosystem. In addition, genetic stock identification techniques were improved and selective fishing methods and gear were evaluated. Much of this information goes beyond the immediate needs and obligation of the FCRPS. The NPCC Tagging Forum is currently examining the FCRPS nexus for some of the following work.

What Was Implemented in 2008-2012

Since the early 1980s, the Action Agencies have funded coded-wire tag recovery and stock identification in ocean and in-river fisheries to support adult return and harvest estimates, as well as to determine run timing and stray rates of hatchery fish by stock, rearing facility, release treatment, and location. Coded-wire tag insertion occurred at state hatcheries in Oregon, Washington, and Idaho; Mitchell Act hatcheries; and several tribal hatcheries. Tag recovery efforts were funded in sport, commercial, and tribal fisheries; at hatcheries; and via spawning ground surveys in tributaries in Oregon, Washington, and Idaho.

Multiple BPA projects studied salmonid genetics to advance Chinook and steelhead stock identification that enables managers to trace natural and hatchery-origin Chinook or steelhead back to their stock of origin in dam or mainstem sampling programs and in ocean fisheries. Parentage Based Tagging (PBT) technologies have been developed to identify the specific hatchery stock and age of sampled hatchery fish. Additionally, Genetic Stock Identification (GSI) techniques utilizing single nucleotide polymorphism (SNP) technology have been developed to segregate natural-origin runs of Snake River Spring/Summer Chinook and Snake River Steelhead by stock of origin.

In addition, partners continue to investigate alternative and modified fishing gear to selectively harvest hatchery-origin Chinook while better protecting natural-origin Chinook returning to spawning grounds in the Columbia and Okanogan Rivers. A variety of live capture gears (e.g. purse seine, beach seine, tangle net, hoop net, dip net, weir, Merwin trap) have been tested for their catch efficiency and effect on fish (condition, mortality). These gear improvements can strengthen the viability and fitness of naturally-produced Chinook populations by ensuring that natural-origin fish are minimally affected by live capture gear as they migrate upstream to spawning grounds.

What Was Learned from 2008-2012 Project Results

- Genetic monitoring techniques advanced significantly, especially in identifying markers associated with adaptive traits such as anadromy and those used to distinguish hatchery from natural-origin fish. These improved techniques will allow partners to more easily distinguish hatchery from natural-origin fish and detect patterns and differences in fish behavior and performance throughout the Fish and Wildlife H’s.
- Harvest managers collected PIT-tag data from commercial and recreational catches beginning in 2011, which allowed harvest managers to monitor catch stock composition, impacts by gear, and improve interrogation techniques. This data and PIT-tag technology assists with determining run timing at Bonneville and harvest management in the future.
- High flows in the Similkameen & Okanogan Rivers in the late spring to early summer of 2011 led to a brief, late thermal barrier that resulted in decreased select harvest rates (1,156 salmonids) for the Colville Confederated Tribe (CCT). The thermal

barrier typically enables the CCT to harvest large numbers of Chinook and sockeye in the Wells pool below the mouth of the Okanogan River. Therefore in high flow years, CCT could anticipate lower harvest rates in the Similkameen & Okanogan Rivers.

- CCT found summer/fall Chinook and steelhead mortalities were lowest for fish captured in the purse and beach seines (immediate release survivals of 100 and 99 percent, respectively), compared to traditional hoop, dip, and tangle nets (80 percent immediate release survivals). In the future, purse and beach seines will be the preferred live harvest gear types used in CCT selective fisheries. Longer-term post-release research is planned to assess long-term survival and spawning success. The purse seine method also serves as a tool for broodstock collection and managing hatchery fish on spawning grounds.
- Multiple BPA projects have studied salmonid genetics to advance Chinook and steelhead stock identification so that any or natural or hatchery-origin Chinook or steelhead can be traced to its stock of origin through sampling programs. PBT technologies have been developed to identify the specific hatchery stock and age of sampled hatchery fish. Additionally, GSI techniques utilizing SNPs technology have been developed to segregate natural-origin runs of Snake River Spring/Summer Chinook and Snake River steelhead by stock of origin.

Related Observations and Adaptive Management Modifications to Improve FCRPS BiOp Performance

- In the future, purse and beach seines will be the preferred live harvest gear types used in CCT selective fisheries and longer-term post-release research is planned to assess long-term survival and spawning success. The purse seine method also serves as a tool for broodstock collection and managing hatchery fish on spawning grounds. The transfer of fishing and gear technology may be feasible for other fishing areas within the Columbia River Basin as well.
- Improved genetic technology will allow partners to more easily distinguish hatchery from natural-origin fish and detect patterns in fish behavior and performance, regardless of whether hatchery fish are marked.

Hatchery RM&E

A large number of hatchery program effectiveness and critical uncertainty research projects were implemented in 2008-2012. RM&E for hatchery effectiveness has increased within the last few years to include expanded genetic studies, PIT tagging (and detection) in numerous tributaries, kelt reconditioning research, and additional studies in the Methow and Deschutes rivers. This monitoring and research helps assess the effect of hatchery programs on naturally produced population viability, general effectiveness of hatchery programs, and the benefits of hatchery reform. Relative Reproductive Success (RRS) studies, comparing the reproductive success of hatchery-origin fish to the reproductive success of natural-origin fish, continue to provide a key indicator for hatchery program effectiveness in conserving or increasing natural populations.

What Was Implemented in 2008-2012

- Hatchery projects effectively monitored status and trend (e.g., abundance, life history characteristics) of natural and hatchery-origin populations to determine if project goals and objectives were being met.
- RRS studies comparing hatchery-origin fish to natural-origin fish continued to be assessed for Wenatchee River spring Chinook salmon; Grande Ronde River, Catherine Creek, and Lostine River Chinook salmon; and steelhead populations in the Methow and Deschutes rivers, and Abernathy Creek. Projects for steelhead RRS were completed for Hood River and Forks Creek. Because the potential effects of lower RRS of hatchery-origin fish spawning in the wild is somewhat dependent on the percentage of hatchery spawners, additional information about the interactions of hatchery and natural-origin fish on the spawning grounds could have management implications.
- PBT genetic tracking methodology for Snake River Chinook and steelhead was started in FY 2010 to gather information that will be assist in more accurately assessing abundance for individual streams, determining fish origin (natural versus hatchery), and evaluating hatchery effectiveness for streams and programs upstream of Lower Granite Dam.
- Hatchery reform actions in the Methow River (transition to local broodstock) and Tucannon River (transition to local broodstock) were continued. In related studies, information continues to be collected regarding growth rates of hatchery fish and the subsequent effect on precocial (early maturity) rates of fish.
- Genetic information continued to be collected to support parental based tagging efforts which contributes to understanding trends in diversity for hatchery and natural-origin fish.
- Research in the upper Columbia River (CCT and YN) and the Snake River (Nez Perce Tribe) basins on using steelhead kelts to improve productivity continued to develop in a positive direction.

What Was Learned from 2008-2012 Project Results

- Many hatchery projects are showing near-term success in returning more fish to the targeted stream than if the fish were left to spawn naturally. This information is an important step in understanding the success of a hatchery supplementation program (i.e., are more fish returning from hatchery intervention than if the fish spawned naturally).
- Many programs (e.g., Grande Ronde River spring/summer Chinook) have shown that survival of natural-origin emigrants to downstream detection sites (e.g., Lower Granite Dam) does not differ significantly from hatchery-origin fish. However, several projects (e.g., Grande Ronde and Lostine river spring/summer Chinook) have shown that natural-origin fish have significantly higher rates of SAR survival than hatchery-origin counterparts. Thus, there appears to be a survival difference between hatchery and natural-origin fish once they pass the first point of detection.

The mechanisms for this difference are still not clear, although actions that may increase SARs (i.e., overwinter acclimation or reducing precocial male development) are prudent if feasible.

- Many hatchery programs show significant differences between natural and hatchery-origin adult mean brood-year age-class structure. Younger age class structure of hatchery fish could reduce reproductive potential of the targeted population through reduced fecundity, smaller egg size, and reduced competitive advantage on the spawning grounds.
- Research on hatchery rearing techniques for steelhead have revealed that smolts reared for two years survived to the first point of detection at significantly higher rates than smolts raised for one year (a standard hatchery practice). This finding may have strong implications for rearing practices for steelhead by changing the fundamental rearing strategies, from broodstock collection (collecting at a different time of year [e.g., closer to spawning]) to cultural practices (e.g., having multiple year classes of fish in the hatchery at any one time).
- On-going research indicates that growth rates of hatchery fish may affect the rate of precocial development and expression (approaching 50 percent of the male fish released in some programs). High rates of precocial development could reduce reproductive potential and bias SAR estimates.
- Monitoring for many programs (e.g., Wenatchee River spring Chinook, Deschutes River steelhead) has shown that hatchery-origin fish can make up a large percentage of a spawning population. RRS research for steelhead (e.g. Abernathy Creek, Hood River, and Forks Creek) indicates a decrease in reproductive success of hatchery fish in comparison to natural-origin fish. The research results for Chinook salmon are mixed. For example, for Wenatchee River spring Chinook salmon, results have shown RRS of hatchery-origin fish to be approximately 50 percent, while in other projects (Johnson Creek and Lostine River) RRS is closer (> 85 percent) to that of natural-origin fish.
- Monitoring of population abundance, productivity, and life history characteristics in the John Day River Basin continues to be important because there are no hatchery fish released in that basin. Monitoring information from John Day Basin can be utilized as a reference for comparison to basins with hatchery programs to assess the effects hatchery fish on natural-populations.
- The use of reconditioned kelts to support ESA listed natural-origin steelhead continues to be studied in various streams throughout the mid- and upper Columbia and Snake River basins. Results have shown that fish can be successfully reconditioned and released onto the spawning grounds. These studies will be continuing.
- Research by Chelan PUD found that yearling summer Chinook salmon reared in partial water reuse circular tanks showed increased outmigration relative to yearlings reared in standard flow-through raceways. Partial water reuse also provided an effective approach to minimizing water use.

Observations and Adaptive Management Modifications to Improve Hatchery Operations

- The spring Chinook captive propagation program (e.g. Catherine Creek, Lostine River, etc.) and the sockeye program (Upper Snake River) have successfully maintained ESA-listed populations in captivity, and they have provided returning adults supporting broodstock and restoration objectives.
- Successful hatchery reform and interventions targeted at reducing mortality in a key stage of their life history are supporting greater steelhead and Chinook returns to targeted streams.
- The completed HGMPs and the ongoing ESA consultation process on Action Agency hatchery programs includes measures supported by research findings to minimize or mitigate adverse effects. Management actions supported by current research findings include:
    - Manage the percentage of hatchery-origin fish on the spawning grounds and increase the percentage of natural-origin fish in hatchery program broodstocks to reduce genetic risk.
    - Continue to develop supplementation programs to avoid long-term effects on the productivity of the natural component of populations.
    - Modify hatchery management factors such as the length of rearing time and/or growth rates to reduce early maturity (precocious development) and possibly increase SARs for hatchery fish.
    - Maintain or increase management efforts to increase the survival of steelhead kelts to support the genetic and demographic diversity of populations.
- Continued monitoring of hatchery projects ensures timely analyses and reporting of trends in abundance and productivity of hatchery- and natural-origin fish to allow for better evaluation of hatchery effectiveness

Predation and Non-Indigenous Species RM&E

Predation RM&E 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 salmonids and predator management projects also continued to include monitoring components to assess action effectiveness.

What Was Implemented in 2008-2012

- Continued effectiveness evaluation of predation management actions were implemented as a component of most predator management projects.
- Stock assessments for double-crested cormorants (DCC) were completed in 2009-2010.

- Northern pikeminnow RM&E 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.
- The Action Agencies continued to fund research and monitoring on shad interactions with non-indigenous predators (small mouth bass and walleye) to understand the effect of those interactions on predator over-wintering survival. The concern is that shad may act as a prey base to sustain juvenile salmonid predator populations into the fall or buffer juvenile fall Chinook salmon as they are outmigrating.

What Was Learned from 2008-2012 Project Results

- The Caspian tern nesting habitat goal for East Sand Island has been reached. However, the tern colony size at East Sand Island in 2012 was approximately double the desired 3,125 breeding pairs, a result of terns nesting at unexpectedly high density. It appears that additional nesting habitat reduction will be required to bring the colony size down to the desired level. Consumption of juvenile salmonids by Caspian terns dropped considerably in 2011. Total nesting failure, resulting from the effects of both harsh weather and eagle and gull predation on adult birds and eggs, was a major factor in this reduced consumption.
- Human disturbance appears to be a viable option for effectively preventing cormorant nesting on East Sand Island. However, the effectiveness of habitat enhancement and social attraction techniques to establish new double-crested cormorant colonies outside the Columbia River Basin remains under evaluation.
- Preliminary results indicate that a combination of hazing and improved avian line arrays in the tailraces at The Dalles and John Day dams helped reduced estimated avian predation, primarily by gulls.
- Removal of northern pikeminnnow is not resulting in increased abundance nor predation pressure on juvenile salmonids by other non-native fish predators (smallmouth bass, walleye). However, the diets of some non-native predators (e.g. smallmouth bass, walleye) do contain high proportions of juvenile shad during the mid-late fall of the year. Studies have not detected channel catfish (another non-native fish predator) consuming juvenile shad into the fall, so management actions are likely to focus on smallmouth bass and walleye. This mature management program is achieving the desired goal of reducing predation on juvenile salmonids by 3 to 6 million smolts annually.
- In 2011, the number of adult salmonids consumed by pinnipeds (3,557 adult salmonids in the Bonneville tailrace) was the lowest since 2006, despite increased take by Steller sea lions that comprised a record 16 percent of total pinniped consumption. This trend suggests that lethal removal of California sea lions may be having a measurable effect on decreasing the overall pinniped consumption of adult salmonids returning to spawn.

- The Corps and other federal, state, and tribal agencies implemented a variety of sea lion deterrents at Bonneville Dam. Physical barriers, called SLEDs, installed at all primary fishway entrances and floating orifice gate (FOG) barriers continue to be an effective tool to prevent sea lions from entering fishways.

Observations and Adaptive Management Modifications to Improve Predator Control

- Predation continues to be a serious issue for the survival of both juvenile and adult salmon and steelhead so measures in the FCRPS BiOp continue to be important. Emphasis on predation by double crested cormorants and non-indigenous fishes are a research priority for the Action Agencies. This research will inform management decisions.
- The amount of fish eaten by sea lions at Bonneville Dam decreased substantially in 2011 and 2012, with the estimated catch of adult salmon and steelhead dropping from 6,081 in 2010 to 2,107 in 2012. However, the expected reductions from efforts by the states to remove California sea lions may be offset to some degree by increases in Steller sea lion abundance.
- The increases in numbers of double-crested cormorant nesting pairs and smolt consumption in 2011 and 2012 are of heightened concern. Development of cormorant management plans is moving forward that will include methods for reducing consumption of juvenile salmon.
- Predation by northern pikeminnow is being successfully controlled, with significant ongoing salmon survival benefits. Examination of predation by non-native species, such as shad, walleye, and bass, is underway with projects initiated in 2010. Management of non-native species predation in waters that fall under the jurisdiction of different states, such as the mainstem Columbia and Snake rivers, may conflict with some state management of exotic warm-water game species (walleye, largemouth and smallmouth bass, northern pike, catfish, etc.) for sport fisheries. The Action Agencies note the recent consideration by the Washington Fish and Wildlife Commission to remove the daily catch limit for channel catfish and the daily catch and size limits for bass and walleye in portions of the Columbia and Snake rivers to reduce impacts on listed salmon and steelhead stocks. The Action Agencies will proceed with sensitivity to other management jurisdictions through well-designed basic research within this topic area.

Regional Coordination: Data Management and Implementation Monitoring

This strategy primarily supports monitoring and evaluation of the FCRPS BiOp and does not provide lessons learned with regard to how to manage the primary H-strategies of the FCRPS BiOp. Refer to Section 2 of the Comprehensive Evaluation for more lessons learned with regard to management of RM&E RPAs and the 2014-2018 Implementation Plan for information related to adaptive management of actions to support these strategies.

Observations and Adaptive Management Modifications to Achieve FCRPS BiOp Strategies

Annual reporting of RM&E results was improved by BPA (consistent with recommendations by the NPCC and ISRP) through improved communication of RPA requirements through the Taurus tool at *www.cbfish.org* and creation of electronic reporting templates for the FCRPS BiOp RPAs.

Working with the Region

Columbia Basin Fish Accords

Historical, long term agreements like those with the Fish Accord Partners-–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 strengthen the successful planning and implementation of actions under the FCRPS BiOp, especially tributary and estuary habitat actions. These partnerships help accomplish "on-the-ground" implementation of actions that are beneficial to listed fish. Between 2008 and 2012, the Fish Accord Partners, focusing BiOp priorities, have:

- protected 14,136 acre-feet of water for Columbia Basin streams;
- improved 4,691 acres of habitat to address factors that limit fish survival, e.g. riparian vegetation enhancement;
- made 932 miles of habitat accessible, important for spawning and rearing; and
- improved 96 miles of stream complexity by installing features and enhancing channels to protect and feed fish.

Regional Forum

The Regional Forum process was developed in 1995 and has been employed since by National Marine Fisheries Service (NOAA Fisheries) 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 action authority in the Columbia River, including NOAA Fisheries, USFWS, BPA, Corps, Environmental Protection Agency, and Reclamation. Other agencies and regional interests, such as the NPCC, the Idaho Power Company and the Mid-Columbia Public Utility Districts, may also attend. The Regional Forum consists of several technical workgroups, comprised of Action Agency representatives, such as the TMT, the System Configuration Team (SCT), the Studies Review Work Group (SRWG), and the Fish Passage Operations and Maintenance (FPOM) workgroup. As used in this document, "the region" or "regional coordination" generally refers to the Regional Forum technical subgroup appropriate for the issue at hand.

Regional Implementation Oversight Group

The RIOG was established in 2008 to provide high-level policy review for the Columbia River Basin—to discuss and coordinate implementation of the FCRPS BiOp. It is a prime example of a reactive forum that has evolved over time to a proactive, solution oriented focus; the RIOG is the successor of the Policy Working Group formed in 2005 to address court concerns and collaborate on the development of the FCRPS BiOp. The RIOG involves Federal, State, and Tribal agencies with the common aim of salmon protection. The group encourages collaboration, accountability, and transparency for FCRPS BiOp implementation. The RIOG structure includes technical subgroups (e.g., the Technical Management Team) to support regional review. Currently, this forum 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. Over the last five years, the RIOG has reviewed many Action Agency activities for implementation including, but not limited to, contingency plans, spill and transport operations, annual progress reports, modeling, and habitat improvement actions.

Northwest Power and Conservation Council's 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 funding and must be taken into account by all Federal agencies that manage, operate, or regulate hydropower dams in the basin. The program includes independent science review processes that apply to BPA funded projects. The NPCC's amended program (finalized in 2009) can be found at: http://www.nwcouncil.org/library/2009/2009-09/Default.asp.

Conclusions

The financial, technical and personnel resources directed by the Action Agencies in support of the FCRPS BiOp are unparalleled in the Pacific Northwest and in the nation. The scale of these myriad activities involves hundreds of millions of dollars annually and hundreds of entities and individuals to plan, prioritize, implement, monitor, and evaluate on-the-ground projects that benefit steelhead and salmon. Relationships developed among the Action Agencies and local, state, tribal, and other federal partners, have resulted in actions, BiOp progress, and biological and environmental results that help advance recovery. Thanks to this unprecedented collaboration, cooperation, and accomplishment, the Action Agencies can report that implementation of the 2008 BiOp remains on track. Hydrosystem improvements and operations are in place and working, juvenile salmon dam passage survival is meeting or on track to meet aggressive hydro performance standards, hundreds of tributary and estuary habitat actions have been implemented and are improving habitat and benefitting salmon, hatchery reform is underway, predator control actions are being implemented, and RM&E is providing sound science with which to track action effectiveness.

Based on solid performance in the first five years of FCRPS BiOp implementation, the Action Agencies are confident that the FCRPS BiOp goals will be reached by 2018.

Ensuring sufficient abundance of salmon and steelhead to sustain health natural stocks is a challenge that reaches well beyond the federal hydrosystem. Other human and natural impacts must also be addressed by a wide range of regional parties to accomplish ESA objectives. The progress made to date is the result of years of concerted effort and collaboration between the Action Agencies, other federal agencies, states, and tribes, local governments, and private parties.