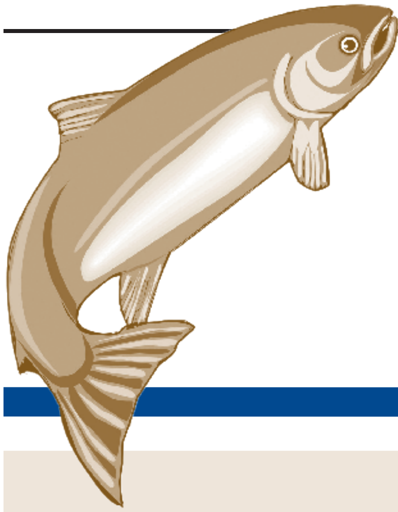

Protecting Salmon and Steelhead

Endangered Species Act
Federal Columbia River Power System
2006-2007 Progress Report

November 2009

Status of the 2004 Biological Opinion

In 2004, NOAA Fisheries issued a new Biological Opinion (BiOp) for the operation of the Federal Columbia River Power System. A subsequent legal challenge to the 2004 BiOp resulted in a court remand in October 2005. The court directed NOAA Fisheries to work with the Action Agencies and with sovereign states and tribes to develop a new BiOp. During this sovereign collaboration, the court kept the 2004 BiOp in place. In June 2006, the Action Agencies issued the first Annual Progress Report on the 2004 BiOp. This document is the final report to the region on progress under the 2004 FCRPS BiOp.

Following extensive collaboration with the sovereigns, NOAA Fisheries issued a new FCRPS BiOp in 2008. The BiOp is currently being implemented, although it is under legal challenge. A decision from the court is expected soon.

Federal agencies, states, and tribes have made considerable progress in recent years working together to recover Columbia Basin fish. While litigation continued on the 2004 National Marine Fisheries Services' (NOAA Fisheries) Biological Opinion (BiOp) on operation of the Federal Columbia River Power System (FCRPS), regional partners were restoring fish habitat, implementing hatchery reforms, controlling predators, and finding out more about the salmon life cycle and the factors that affect salmon survival. This report highlights some of the actions implemented in 2006 and 2007 by the federal Action Agencies (the U.S. Army Corps of Engineers, the Bureau of Reclamation, and the Bonneville Power Administration) under the 2004 BiOp.

Contents

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

Fish Returns and Survival

Adult Fish Returns

One way the Pacific Northwest tracks how well salmon and steelhead are doing is by comparing the numbers of adult fish that return each year to spawn. Many dams have counting stations where fish of the various species are counted as they swim up the fish ladders. In 2006, just over 1 million adult salmon and steelhead were counted as they passed Bonneville Dam, while in 2007 the count was just over 800,000; both years were below the 10-year average (Figure 1).

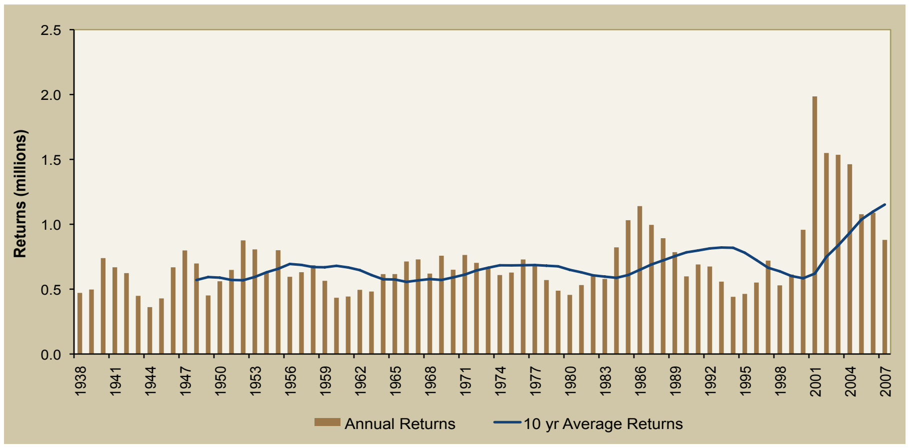

Figure 1. Adult and Jack Salmon/Steelhead Returns at Bonneville Dam.

In 2006 and 2007, return numbers were slightly to moderately below the 1997–2006 10-year average, with the exception of coho in 2006, which were slightly above average. In a typical year, about 80 percent of all returning adult salmon and steelhead are of hatchery origin (Table 1).

Adult Fish Survival through the Hydrosystem

Fish ladders on the lower Columbia and lower Snake River dams are very successful. Adult fish passage research shows that survival is about 98 percent at each dam for adult salmon and steelhead. NOAA Fisheries has found that "adult survival through the FCRPS is similar to survival under unimpounded conditions in the Snake and Columbia rivers" (NOAA Fisheries, *Passage of Juvenile and Adult Salmonids Past Columbia and Snake River Dams,* 2000).

In recent years, technological improvements have allowed better monitoring of adult passage patterns, timing, and other behavior at the dams. As a result, dam operators can adjust operations at certain dams to improve conditions for migrating fish and can monitor and track the progress of returning adults.

Juvenile Fish Survival through the Hydrosystem

Juvenile salmon and steelhead that migrate to the ocean through the Snake and Columbia rivers either migrate "in river" past the dams or are transported around the dams in barges (at times when studies show that their survival would be higher). The percentage of fish that travel in river compared to the percentage transported has ranged from approximately 45 percent to 90 percent, depending on a number of factors such as projected river flow volumes, how much spill is provided, and how well fish are attracted to juvenile fish bypass systems. Total juvenile fish survival, also known as system survival, is a combination of in-river survival and transportation survival.

Figure 2. Major Dams in the Columbia River Basin.

Table 1. Salmon and Steelhead Returns at Bonneville Dam.

Species	2006	2007	10-Year Average
Chinook – Total [1]	526,534	357,562	653,094
Spring Chinook [2]	99,366	83,252	169,254
Summer Chinook	101,874	61,568	78,587
Fall Chinook	325,294	212,742	405,253
Steelhead [3]	339,141	323,917	348,059
Sockeye [4]	37,066	24,376	62,504
Coho [5]	110,053	96,576	105,421
Chum and Pinks [6]	161	148	178
TOTALS of all species for period	1,012,955	802,579	1,169,256

Period of 10-year average: 1997–2006. All data from Fish Passage Report 2008 (U.S. Army Corps of Engineers).

[1] *Chinook data from monthly values in Table 19; includes jacks.*

[2] *Assumed Chinook run dates: spring = Jan 1–May 31; summer = June 1–July 31; fall = Aug 1–Dec 31.*

[3] *Steelhead data from monthly values in Table 22; includes hatchery and wild fish.*

[4] *Sockeye data from Table 20.*

[5] *Coho data from Table 21; includes jacks.*

[6] *Chum and pink data from Table 18.*

Approximately 98 percent of the transported juveniles survive to the point of release below Bonneville Dam. Additional "delayed mortality" may occur after the fish are released. Research is being carried out to determine the magnitude of any delayed effects and whether those effects can be minimized. For juvenile fish that migrate in river, the Action Agencies use empirical study information to develop survival estimates. As a performance standard for the FCRPS, the 2004 BiOp established juvenile survival percentages, including an average and range based on yearly water conditions, for each salmon ESU (evolutionarily significant unit) and steelhead and steelhead DPS (distinct population segment). Survival estimates for four ESUs (Snake River spring/summer Chinook salmon and steelhead and Upper Columbia spring/summer Chinook salmon and steelhead) are described below and illustrated in Figure 3.

For yearling Snake River spring/summer Chinook salmon that migrated in river from the Lower Granite Dam tailrace (the area below the dam) to the Bonneville Dam tailrace, the survival rate was about 64 percent in 2006 and 60 percent in 2007. This was slightly higher than the average in-river performance standard of 50.2 percent (38.3 to 57.7 percent range) for this ESU. This was a notable improvement from 2005, when survival was estimated at about 53 percent (Figure 4).

In-river survival for Snake River steelhead from the Lower Granite Dam tailrace to the tailrace of Bonneville Dam was 46 percent in 2006 and 39 percent in 2007. These data were not available in 2005 because of the low number of PIT tag (Passive Integrated Transponder) detections at Bonneville Dam. The 2004 BiOp's average in-river performance standard for Snake River steelhead is 30.5 percent (4.5 to 42.9 percent range).

For upper Columbia River juvenile spring/summer Chinook salmon, survival from McNary Dam to Bonneville Dam was about 71 percent in 2007— lower than survival in 2005 (76 percent), and up from 2004 (62 percent). This exceeded the 2004 BiOp average performance standard of 67.3 percent (55.1 to 74.9 percent range). These data were not available in 2006 because of the low number of PIT tag detections at Bonneville Dam.

Upper Columbia River steelhead survival from McNary Dam to Bonneville Dam was about 39 percent in 2007, which was down from 54 percent in 2005. Juvenile survival of upper Columbia River steelhead was below the average 2004 BiOp performance standard of 46.8 percent (16.2 to 61.6 percent range). These data were not available in 2006 because of the limited number of PIT tag detections at Bonneville Dam.

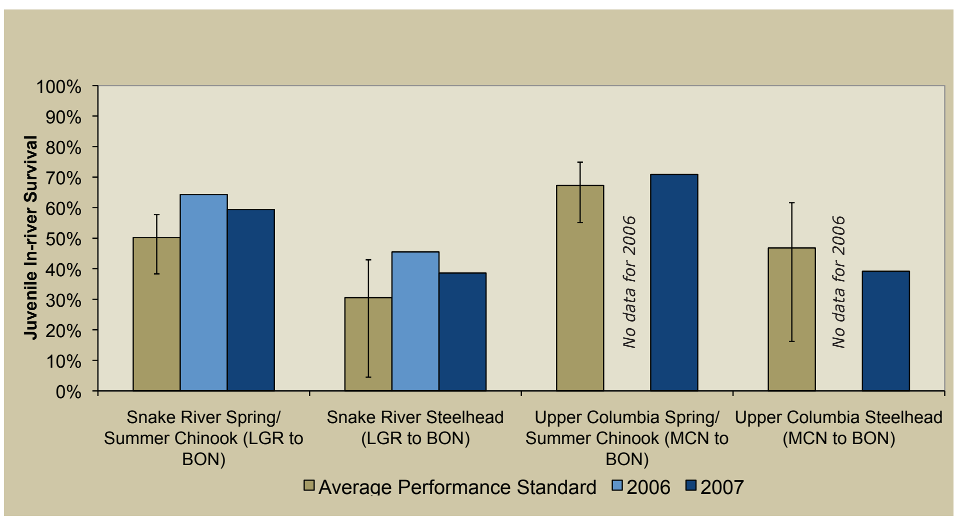

Figure 3. In-River Survival Estimates for Certain Juvenile Salmon ESUs and Steelhead DPSs between Hydropower Facilities on the Columbia and Snake Rivers.

(LGR = Lower Granite Dam, BON = Bonneville Dam, MCN = McNary Dam)

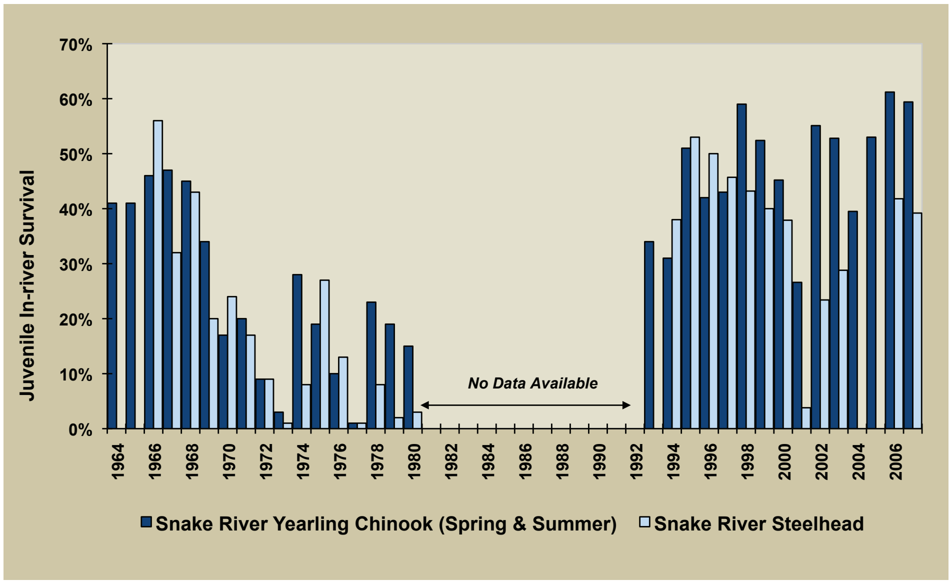

Figure 4. In-River Survival Estimates for Snake River Chinook Salmon and Steelhead.

(Steelhead estimates for 2004 and 2005 are unavailable due to lower PIT tag detection efficiency at Bonneville Dam. Survival estimates not available for 1981 through 1992.)

Hydrosystem

Hydrosystem Accomplishments

Improvements for Fish at the Dams

Most salmon and steelhead in the Columbia River Basin encounter one or more hydroelectric dams (federal and non-federal) as they migrate to and from the ocean. Juvenile and adult fish-passage systems provide various routes to help salmon and steelhead get past the dams. "Dam survival" is a combination of fish survival through three passage routes: over spillways, through bypass systems, and through turbines. All routes have been improved in recent years.

Over the past several decades, juvenile fish survival past the dams has improved dramatically. NOAA Fisheries data indicate that in-river spring/summer Chinook survival has improved to the point that it is now comparable to that of the 1960s, when there were only four dams in the lower Columbia and Snake rivers (Figure 3). For Snake River spring-summer Chinook, in-river survival through the eight dams has ranged from 30 to 60 percent over the past several years, depending on water conditions and other factors.

Juvenile fish migrate past the dams by several routes: through the turbines, through juvenile bypass systems, through surface passage structures, through spillways, or via collection and transport in barges or trucks. Turbine passage is often considered to be the least desirable juvenile bypass route, but this varies among the different projects. Turbine survival has been measured to be as low as 80 percent and as high as 95 percent or more. Bypass systems and spill are meant to divert fish away from the turbines. At many dams juvenile survival rates of 95 to 99 percent have been demonstrated through bypass systems, through surface passage structures, and through spill. In 2006–2007, the Action Agencies continued to make improvements to fish passage, and some highlights are noted here.

Spill

An important way juvenile fish migrate past the dams is through a spillway. Water is "spilled" through spillway openings rather than routed through turbines. The Final Updated Proposed Action (Action Agencies, 2004) included spring and summer spill to help juvenile salmon and steelhead pass the lower Columbia and Snake River dams when river flows are average or above.

A discussion of spill and agency efforts to manage total dissolved gas levels during spill is provided in the Water Conditions and Operations section of this report.

Juvenile Bypass Systems

Juvenile bypass systems (JBSs) at seven of the eight lower Columbia and Snake River dams guide fish away from turbines by means of submerged screens installed in front of the turbine intakes. As fish follow currents down toward the turbines, the screens guide the fish back up to channels in the dam. The fish are then either routed to the river below the dam (bypassed) or loaded into barges or trucks for transport past the remaining dams. (At The Dalles Dam, juvenile fish passage is provided by a surface sluiceway rather than by a submerged screen system.)

In 2006–2007, the U.S. Army Corps of Engineers completed design and construction of the full-flow juvenile PIT-tag monitoring facilities at Lower Monumental Dam to improve detection of migrating juveniles. Design of a juvenile PIT-tag monitoring system, dewatering structure modification, and outfall relocation for the Little Goose Dam juvenile facility was also initiated during this period. Preliminary design to modify the existing juvenile fish facilities at Lower Granite Dam for improved reliability continued. At Bonneville Dam, fish guidance improvements to the juvenile bypass system at the Second Powerhouse were completed for five of eight units. Full-flow PIT tag detection modifications for the John Day juvenile bypass flume were also completed.

Surface Passage Systems

Most juvenile salmon tend to stay in the upper 10 to 20 feet of the water column as they migrate downstream to the ocean. However, when approaching the dams, juvenile fish dive 50 to 60 feet to find passage routes such as a spillway opening or a turbine intake screen to be guided to a juvenile bypass channel. For several years, engineers and biologists have been pursuing new technologies that would provide more surface-oriented,

Bonneville Dam — Route-Specific Passage and Survival Estimates for Yearling Chinook Salmon When Spring Spillage Operations Are 100 kcfs All Day

less-stressful passage routes for juvenile fish. Surface passage has demonstrated the potential to decrease the time spent by juvenile fish in the forebay (the area just upstream of the dam face), improve juvenile fish survival, and improve water quality. Juvenile fish passing on the surface may experience smaller pressure changes and less physical trauma than fish passing through conventional spill gates or other juvenile bypass routes.

In the period 2006–2007, two prototype surface spillway weirs were designed, constructed, and installed for the 2007 fish passage season at McNary Dam. These structures were economical, fabricated quickly, provide the opportunity to evaluate the influence of a surface passage route on the spillway, and will aid in determining the ultimate surface passage configuration at this project. Also during this period, design was completed and construction was initiated for a surface spillway weir at Lower Monumental Dam. Design of surface spillway weirs for both Little Goose Dam and John Day Dam was also initiated.

Dam sluiceways (used to remove trash and debris) can be modified to provide excellent surface bypass routes at dams.

In 2006-2007 the Corps evaluated designs for modification of the sluiceway at the Bonneville First Powerhouse to improve fish passage. In addition, design of a behavioral guidance system that guides fish to the Bonneville Second Powerhouse Corner Collector, another successful surface bypass system, was also initiated. (That guidance system was installed in 2008 and is being tested.)

Spillway Improvements

In 2006–2007, design of an extended spill wall at The Dalles Dam was initiated. Research has shown the area below the dam to have lower than desired levels of juvenile survival, possibly related to predation. The extended spillwall will help guide fish to safer areas of the river downstream of the dam. New spill patterns for the Bonneville Dam spillway were developed in 2006 to improve fish survival and reduce total dissolved gas (TDG) generation. The spillway was operated using the new patterns in 2007, and indications are that the new patterns improved fish survival and reduced total dissolved gas generation.

Tagging Fish for Research

Fish research is aided by the use of PIT tags, which are inserted into selected juvenile fish and "read" by detectors as the fish pass by. As the tag is read, data about that particular fish are fed into computers. Most of the lower Columbia and Snake River dams have juvenile PIT tag detection capability, and the tagged fish are tracked through the river system from above Lower Granite Dam to below Bonneville Dam. PIT tag detectors are also in operation in adult fish ladders at Bonneville, McNary, Ice Harbor, and Lower Granite dams, enabling researchers to track progress of the PIT-tagged fish when they return as adults.

In 2006, the Corps completed the installation of a new PIT tag detection system for the Bonneville Second Powerhouse Corner Collector, as well as a full-flow PIT tag detection for the juvenile bypass system. These two improvements have greatly increased the ability to detect PIT-tagged juvenile fish passing Bonneville Dam.

Adult Measures

PIT tag detection was installed on all Bonneville fish ladders and the McNary north shore fish ladder to track returning adult salmon that had PIT tags inserted as juveniles. In 2006, the Corps also installed bar gates, termed sea lion exclusion devices (SLEDs), on Bonneville Dam fish ladder entrances to prevent sea lions from entering and preying on adult salmon and steelhead. The transition pool at Lower Granite Dam was modified in 2006 to reduce passage delay and the proportion of adult migrants that exit the ladder via the entrance.

Fish Transportation/ Barging Program

The 2006 juvenile fish transport season was marked by river flows slightly above average—higher than river conditions noted in 2004 and 2005. The 2007 juvenile fish transport season was marked by flows well below normal in the Snake River and average river flows in the Columbia River. In 2006, the three Snake River transport projects operated under court-ordered operations, including daily spill from April 1 through August 31, with transportation of the juvenile fish collected. Spill at McNary

Dam also took place from April 4 through August 31. During the court-ordered spill period, emphasis was placed on a mix of fish transportation and in-river migration. Operations in 2007 were similar, except that spill at McNary Dam took place from April 10 through August 31.

The 2006 Lower Snake and Lower Columbia juvenile fish transport season was marked by above-average runoff, higher than the runoff noted in 2004 and 2005. The 2007 juvenile fish transport season was marked by 58 percent of normal streamflow runoff in the Snake River for the April through July period. Streamflow runoff in the Columbia River at The Dalles was 85 percent of normal for the April through August period.

In 2006, a total of 18,828,745 juvenile salmon and steelhead were collected at projects, compared to 26,440,475 in 2005. In 2006, 77 percent of those fish collected (14,490,684) were transported. Of the fish transported, 99.8 percent were transported by barge (14,466,385) and 0.2 percent (24,299) were trucked. In 2007, a total of 10,504,426 juvenile salmon and steelhead were collected at all projects. Of these, 51 percent (5,388,861) were transported; of those, 99 percent (5,342,289) were transported by barge and less than 1 percent (46,572) were trucked.

Surface Spillway Weirs in Action at McNary Dam

(Compare the flow of water over the tops of the weirs in the middle of the photo with the flow of water under the traditional spillgates on either side.)

Water Conditions and Operations

In addition to fish passage at the dams, storage reservoirs are operated to enhance fish survival. They augment river flows with water released from upstream dams to help juvenile migration and adult spawning, and to provide desired water temperatures.

The Columbia and Snake River systems have limited reservoir storage compared with other major river systems. Storage in the Columbia and Snake rivers is about 25 percent of the average runoff compared to the Colorado River, where storage is more than twice the average annual runoff. The limited stored water in the Columbia and Snake systems can be managed to make modest adjustments to river flows for fish, but it cannot improve a dry water year and a huge runoff from a wet year cannot be saved for future dry years. This means that, due to natural flows, flow objectives for juvenile fish cannot be physically achieved under many conditions or at many times of the year. River operators provide flow to help fish while also managing for flood risk. Specific operating rules (including earmarked amounts of water) are used at individual reservoirs to provide salmon flows, protect resident fish, and control floods.

Flow objectives for 2006 were 260 thousand cubic feet per second (kcfs) in the spring and 200 kcfs in the summer at McNary Dam, 100 kcfs in the spring and 54 kcfs in the summer at Lower Granite Dam, and 135 kcfs in the spring at Priest Rapids Dam. Flow objectives for 2007 were 237 kcfs in the spring and 200 kcfs in the summer for McNary Dam, 85 kcfs in the spring and 50 kcfs in the summer at Lower Granite Dam, and 135 kcfs in the spring at Priest Rapids Dam.

The Columbia River at The Dalles had 105 percent of normal streamflow runoff in 2006 (Table 2) and 58 percent of normal streamflow runoff in 2007 for the April through August period. Lower Granite had 113 percent of normal streamflow runoff in 2006 and 58 percent of normal streamflow runoff in 2007 for the April through July period (Table 3).

2006 Runoff

McNary flows during the spring started increasing in early April, dropped down in early May, and increased again in mid-May. Flows peaked in late May to around 400 kcfs at McNary and were above the flow objective of 260 kcfs from early April until late June. Flows gradually receded through the remainder of the summer fish migration season. Flows in the Snake River also increased substantially in early April and remained high through mid-June, at which time flows started receding and continued to recede through the remainder of the summer fish migration season (Table 2).

2007 Runoff

Runoff started earlier than normal in the Columbia River Basin, with runoff increasing by mid-March and peaking to around 280 kcfs at McNary by late March. In the Snake River Basin, flows remained relatively low throughout the spring, with a peak of around 100 kcfs in mid-May. The spring flow objectives vary slightly based on the forecasted runoff. Because 2007 was a dry water year, the spring flow objective was 237 kcfs at McNary and 85 kcfs at Lower Granite. Flows in the Snake and Columbia River basins gradually receded during the summer migration season (Table 3).

Table 2. 2006 Seasonal Flow Objectives and Actual Average Flows (in kcfs).

	McNary	Lower Granite	Priest Rapids
Spring			
Objective	260	100	135
Actual	326	125	191
Summer			
Objective	200	54	NA
Actual	166	38	NA

Table 3. 2007 Seasonal Flow Objectives and Actual Average Flows (in kcfs).

	McNary	Lower Granite	Priest Rapids
Spring			
Objective	237	85	135
Actual	240	61	169
Summer			
Objective	200	50	NA
Actual	163	29	NA

Water Quality

The Action Agencies measure water quality for temperature and for dissolved gas. When providing spill for fish passage, dam operators direct water through the spillways instead of through the turbines. At large dams, spilled water plunges to the river with enough force to supersaturate atmospheric gases in the water. These gases can build up to levels that are dangerous to salmon and other aquatic life. To avoid this, the Action Agencies monitor total dissolved gas levels in the river and adjust patterns and quantities of spill to stay within allowable levels. The Corps coordinates with the states of Washington and Oregon on TDG standards that allow voluntary spill for fish passage, resulting in TDG levels of up to 115 percent of saturation in dam forebays and up to 120 percent in dam tailraces. During 2006, TDG levels resulting from voluntary spill operations for fish passage exceeded state criteria on 89 of the 2,504 gauge-days (3.6 percent) during the April 3 through August 31 spill season, while for the 2007 spill season the criteria were exceeded on 93 of the 2,504 gauge-days (3.7 percent).

To help cool the lower Snake River during the summer, cold water is released from Dworshak Dam on the Clearwater River from early July through mid-September. The benefit of these cold-water releases was apparent as the agencies monitored temperatures at Lower Granite Dam. In 2006, temperatures measured at the Lower Granite tailwater gauge were managed so that approximately 15 percent of the time (223 hours) they were above 68°F during July and August, when temperature issues are most common, with a maximum temperature of 69.5°F. In 2007, temperatures at the Lower Granite tailwater gauge were managed so that approximately 2.1 percent of the time (31 hours) they were above 68°F during July and August, with a maximum temperature of 68.7°F. For a more thorough discussion of how water quality was managed in 2006 and 2007, see the annual "TDG and Temperature Report" links at *www.nwd-wc.usace.army.mil/TMT/wqwebpage/mainpage.htm.*

"Flow deflectors" are in place at the lower Snake and Columbia River mainstem projects and are used to reduce TDG levels by changing the flow direction of water at the bottom of the spillway. The construction of flow deflectors at Chief Joseph Dam began in 2006 and continued in 2007. Completion of the flow deflectors (in 2008) should significantly reduce TDG levels in the mid-Columbia River through coordinated operation of Grand Coulee and Chief Joseph dams.

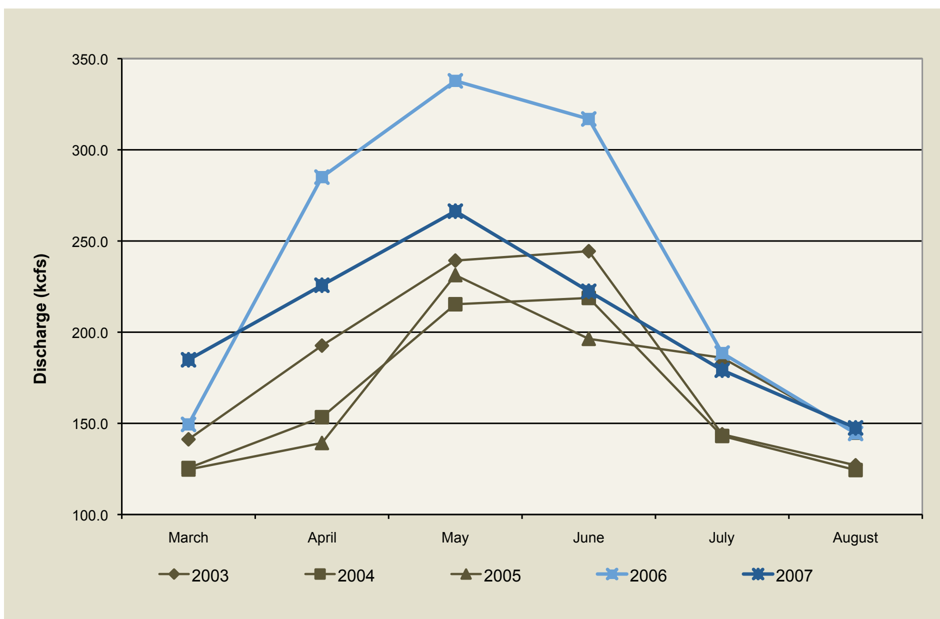

Figure 5. **The amounts and timing of runoff in the Columbia and Snake River systems vary significantly from year to year. This is due both to variations in annual precipitation and the fact that reservoir storage is limited in these systems.**

Predator Management

There are four species that consume large numbers of salmonids and are a major cause of mortality for fish listed under the federal Endangered Species Act (ESA) in the Columbia River system. Caspian terns and double-crested cormorants have enjoyed population increases over the last two decades in the Columbia River estuary and are present in lesser numbers in the mid-Columbia region. Among fish, northern pikeminnow are voracious consumers of juvenile salmonids. California sea lions are known to consume large numbers of adult Chinook salmon and steelhead below Bonneville Dam, while Steller sea lions and harbor seals consume smaller amounts. In 2006-2007, the Action Agencies continued efforts to address specific predation issues and improve survival of salmonids in the Columbia River system.

Caspian Terns and Double-Crested Cormorants

Caspian terns and double-crested cormorants consume large numbers of juvenile salmonids and are a major cause of mortality of ESA-listed fish. The 1999–2001 effort to redistribute Caspian terns from Rice Island, in the Columbia River estuary, to East Sand Island, nearer to the ocean, was successful. As intended, the relocation shifted the terns' diets away from juvenile salmonids (75 to 90 percent at Rice Island) toward a more diverse diet of predominantly marine fish species.

Caspian terns nesting on East Sand Island consumed approximately 5.5 million young salmon in 2007, compared to the estimated 15 million they consumed in 1999.

In 2006 and 2007, the East Sand Island tern colony consumed 5.4 and 5.5 million juvenile salmonids, respectively. The average number of juveniles consumed by Caspian terns from 2001 to 2007 was 5.1 million per year. In comparison, in 1999, the colony consumed 15 million fish when located at Rice Island. The number of Caspian tern pairs on East Sand Island increased from an estimated 8,929 pairs in 2006 to 9,623 pairs in 2007. The average number of pairs on East Sand Island from 2001 to 2007 was 9,159.

In 2005, the U.S. Fish and Wildlife Service (USFWS), the Corps, and NOAA Fisheries jointly prepared a Final Environmental Impact Statement (EIS) for Caspian tern management to reduce predation of juvenile salmonids in the Columbia River estuary. In November 2006, USFWS and the Corps signed Records of Decision regarding the alternative selected from among those examined in the EIS. The selected alternative recommends that two-thirds of the Caspian terns be redistributed to alternate sites in Oregon and California *(see http://www.nwp.usace.army.mil/pm/e/en_plan_avian.asp)*. The first contract for construction of alternative habitat was awarded in December 2007 for construction of a 1-acre island at Fern Ridge Lake near Eugene, Oregon. Further island construction efforts are slated for 2008: Crump Lake (1 acre) and East Link Unit at Summer Lake (0.5 acre). Additional islands will be constructed in subsequent years. Habitat acreage on East Sand Island for Caspian terns will be reduced at a ratio of 1 acre of reduction for every 2 acres of alternative habitat developed, with an ultimate objective of 1.0 to 1.5 acres of nesting habitat remaining. Habitat reduction on East Sand Island will occur prior to the breeding season that follows habitat development at alternative locations.

The agencies are also considering management actions to address a greatly increased population of double-crested cormorants in the Columbia River estuary. The cormorant nesting population on East Sand Island increased from around 100 pairs in 1989 to about 13,771 breeding pairs in 2007. The average number of pairs for 1999-2007 was 10,555, ranging from 6,561 pairs in 1999 to 13,771 pairs in 2007. Salmonids generally make up only a small percentage of the cormorants' diet, averaging 9.3 percent from 1999 to 2007 (range of 2 to 25 percent). The number of juvenile salmonids consumed by cormorants averaged 6.8 million fish for 2003-2007, with a range of from 2.9 to 10 million juveniles per year. Consumption of juvenile salmonids in 2006 and 2007 was 10.3 and 9.2 million, respectively, the highest levels for the recorded period. Combined, the terns and cormorants consumed an estimated 15.7 million juvenile salmonids in the estuary in 2006 and 14.7 million in 2007.

In 2007, the Action Agencies initiated discussions on further cormorant research to obtain baseline information on the western region population of double-crested cormorants that could be used to develop a draft EIS. The draft EIS would explore whether management of the double-crested cormorant population at East Sand Island is warranted. At the same time, it would explore potential management scenarios to address this population. It was anticipated that research efforts would be initiated in 2008 and carried forth in subsequent years with a draft EIS initiated in late 2009 or 2010.

Northern Pikeminnow

Since 1990, BPA has funded the Northern Pikeminnow Management Program (NPMP) to reduce the numbers of these voracious consumers of juvenile salmon and improve survival of juvenile salmon. In 2004, BPA increased the "sport reward" for catching this predator, and the number removed rose by 25 percent over prior years. This increased reward was made permanent in 2005 to sustain the higher catches. The result was the highest harvest rate of pikeminnow observed since program inception. The NPMP has removed more than 3.3 million northern pikeminnow from the Columbia River since 1990. In 2006, almost 234,000 were

(continued on page 12)

Accomplishments to Date

What are our goals and strategies?	What are our key initiatives?	What have we accomplished?
HYDROSYSTEM		
Increase the survival rates of fish passing through mainstem dams: • Configure dam facilities to improve juvenile and adult fish passage survival • Manage water to improve juvenile and adult fish survival • Operate and maintain fish passage facilities to improve fish survival	• Operate and maintain adult fish ladders and other fish facilities • Guide juvenile fish away from turbines • Improve passage routes through the dams for juvenile fish • Manage available water to improve conditions for migrating fish • Transport juvenile fish in trucks or barges past dams in a "spread-the-risk" approach • Track migrating fish with Passive Integrated Transponder (PIT) detection systems	<u>Lower Granite Dam</u> • Modified "transition pool" (part of adult fishway) to reduce passage delays <u>Lower Monumental Dam</u> • Constructed PIT-tag detection system for juvenile bypass system (JBS) • Started construction of surface spillway weir <u>McNary Dam</u> • Constructed and installed two surface spillway weirs • Installed PIT-tag detectors on north fish ladder <u>John Day Dam</u> • Modified JBS PIT-tag system to full-flow detector <u>Bonneville Dam</u> • Developed a new spill release pattern to decrease generation of dissolved gas • Installed PIT-tag detectors on all fish ladders • Constructed and installed SLEDS—sea lion exclusion devices—on entrances to fish ladders • Completed JBS fish guidance screen improvements on five units • Installed full-flow PIT-tag detector at Powerhouse 2 corner collector surface passage system • Completed installation of full-flow PIT-tag detection system for Powerhouse 2 JBS • Transported juvenile fish around dams—14.5 million transported in 2006, 5.3 million transported in 2007
PREDATOR CONTROL		
Reduce the number of juvenile fish consumed by predators: • Redistribute avian predators • Reduce fish predation	• Provide alternative Caspian tern habitat in the Western Region to encourage redistribution (begin in 2008, complete around 2012) • Gradually reduce tern habitat in the Columbia River estuary, after alternative habitat is provided in other locations; reduce annual juvenile salmonid consumption by Caspian terns in the estuary to approximately 2.5 million fish • Provide incentives to reduce the number of large northern pikeminnow in the Columbia River • Address presence of sea lions at Bonneville Dam • Initiate further baseline research and development of a future draft EIS to determine whether double-crested cormorant management is warranted	• Designed and contracted for construction of alternative Caspian tern habitat in Fern Ridge reservoir • In 2006, almost 234,000 northern pikeminnow were caught under the NPMP "sports reward" program, reducing predation by 25 percent. In 2007, the catch was less than 193,000, but this reflects a predation reduction of 37 percent. • Evaluated the effectiveness of various techniques to discourage sea lion presence below Bonneville Dam • Constructed and installed sea lion exclusion devices (SLEDs) on entrances to fish ladders • Monitored sea lion predation below Bonneville Dam

Accomplishments to Date

What are our goals and strategies?	What are our key initiatives?	What have we accomplished?
HABITAT		
Improve tributary and/or estuary habitat used by salmon for spawning or rearing: • Protect and improve tributary habitat based on biological needs and prioritized actions • Improve juvenile and adult fish survival in estuary habitat	• Increase streamflow through water acquisitions • Address entrainment through screening • Provide fish passage and access • Improve mainstem and side channel habitat conditions • Protect and enhance riparian conditions • Improve water quality • Acquire, protect, and restore off-channel habitat • Restore tidal influence and improve hydrologic flushing • Restore floodplain reconnection by removing or breaching dikes or installing fish-friendly tide gates • Remove invasive plants and weeds; replant native vegetation • Protect and restore emergent wetland habitat and riparian forest habitat • Restore channel structure and function • Develop and implement a piling and pile dike removal program	Tributary • Secured more than 375 cubic feet per second (cfs) of water in tributaries in 2006 and 2007; maintained another 230 cfs that were secured since 2000 • Fish screens and associated improvements were completed at 23 sites in 2006 and 2007 to reduce entrainment of fish into irrigation canals • About 120 barriers or obstructions were removed in 2006 and 2007 to restore access to more than 500 miles of tributary habitat • Treated more than 40 miles of streams to increase channel complexity in 2006 and 2007 • Protected almost 20,000 acres of riparian habitat Estuary • Restored 25 acres of tidal estuarine habitat • Removed fish passage barriers, providing access to an additional 2 miles of estuary habitat • Restored 15 acres of native hardwood riparian forest; stabilized 9,000 continuous linear feet of eroding riverbank; planted and inter-planted 190 acres of riparian forest; maintaining restored plant communities on 235 acres and site preparation for planting 15 acres in the estuary • Reconnected 45 acres of estuary floodplain
HATCHERIES		
Use hatcheries to address biological priorities of salmon: • Implement safety-net programs to avoid extinction • Reduce potentially harmful effects of artificial production	• Intervene with artificial production techniques to avoid extinction of fish populations facing a high risk of extinction • Modify hatchery practices or facilities if needed	• Continued funding of safety-net hatchery programs, reducing the extinction risk of populations of Snake River sockeye, spring/summer Chinook, fall Chinook and steelhead, and middle and lower Columbia steelhead • Funded the final phase of draft Hatchery Genetic Management Plans; as these plans are reviewed and approved by NOAA Fisheries, they may be used to identify and prioritize facilities and practices for reform
RESEARCH, MONITORING, AND EVALUATION		
Assess and maximize performance of actions: • Monitor status of salmon • Assess the effects of actions on salmon • Address and resolve areas of uncertainty	• Monitor status of fish within the hydrosystem corridor • Contribute information for use in a regionally developed network of monitoring and assessment programs • Integrate status monitoring with action effectiveness and critical uncertainty research strategies • Implement pilot studies to determine the success or effectiveness of actions to improve fish survival • Coordinate with regional RME efforts to maximize the amount and quality of data, given limited resources	• Monitored juvenile and adult fish passing through the system of Columbia and Snake River dams; improved accuracy of fish counting • Conducted studies to determine and confirm the benefits of actions implemented in the hydrosystem, tributaries, and estuary, and at hatcheries • Evaluated the survival and adult return rates of transported juvenile salmon compared to fish that migrate in the river • Performed studies of limiting factors on juvenile fish production • Monitored and evaluated juvenile salmon use of the estuary and ocean plume • Implemented studies to determine the spawning effectiveness of hatchery fish • Funded development of a comprehensive marking strategy to improve monitoring of hatchery-origin fish and assess the status of wild fish in natural spawning areas

(continued from page 9)

Northern Pikeminnow, a Voracious Consumer of Juvenile Salmon

caught under the sport reward program, reducing predation by 25 percent; in 2007, the catch was less than 193,000, but this reflects a predation reduction of 37 percent. Evaluation indicates that, as a result of the pikeminnow management program, 4 to 6 million juvenile salmonids per year have avoided being consumed by pikeminnow.

Sea Lions at Bonneville

In recent years, California sea lions, which are protected by the Marine Mammal Protection Act (MMPA), have been observed swimming more than 140 miles up the Columbia River to Bonneville Dam to prey on adult Chinook salmon, steelhead, and other anadromous fishes. Generally arriving from mid- to late February and leaving by the first week in June, these male sea lions eat to gain weight in preparation for the summer mating season. Corps biologists began gathering data on sea lion presence and predation at the dam in 2001, when six California sea lions were documented. In 2002 (the first full season of monitoring), 30 sea lions were counted.

By 2006, the minimum estimated number of pinnipeds (California sea lions and Steller sea lions) reached 85, and in 2007, the number was 80 or more. Not all of these animals were at the dam at the same time; estimated peak daily abundance reached 46 in 2006 and 54 in 2007. Although the total number of sea lions appeared to stabilize, the overall presence of sea lions continued to increase. Some sea lions came earlier each year and many stayed at the dam throughout the spring rather than moving back and forth between the dam and the mouth of the Columbia River.

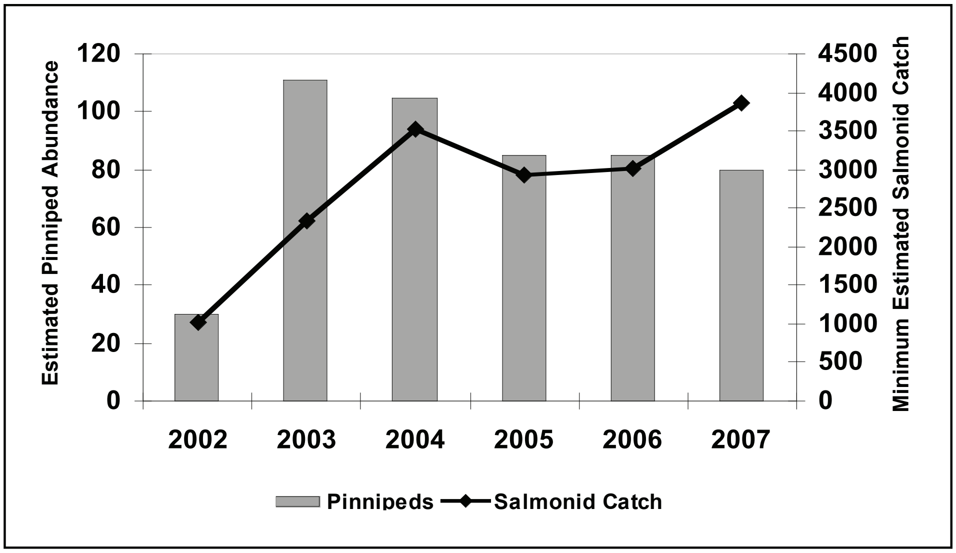

Figure 6. Estimated Minimum Number of Adult Salmonids Consumed by Pinnipeds and Estimated Total Number of Pinnipeds Seen at Bonneville Dam, January 1 to May 31 in the 6-year period of 2002 to 2007.

The amount of salmon and steelhead eaten by sea lions increased from 2006 to 2007, from 2.8 percent of the total January 1 through May 31 salmon run in 2006 (3,023 fish) to a peak of 4.2 percent in 2007 (3,859 fish) (Figure 6); (2007 had a smaller spring salmon run than 2006, so the estimated predation impact was greater than in 2006). These predation estimates were essentially minimum estimates, based on surface observations taken at the three major tailrace areas of the dam (Powerhouse One [PH1], Powerhouse Two [PH2], and the spillway). For more information, see *http://www.nwd-wc.usace.army.mil/tmt/documents/fish/05-07_Pinniped_Report_Final.pdf*.

By 2005, a few sea lions had learned how to find and enter the dam fish ladders. In 2006, the Corps installed sea lion exclusion devices (SLEDs) at the main entrances to the dam fishways. These individual gates are designed to exclude sea lions but allow fish passage. Similar barriers and stab plates were installed

A California sea lion catches a steelhead at Bonneville Dam.

at floating orifice gates along the PH2 adult fish collection channel. California sea lion C404 was the only one able to get around the barriers (he was observed jumping over floating orifice gates at PH2).

In 2006 and 2007, the Action Agencies contracted with the Columbia River Inter-Tribal Fish Commission (CRITFC) and U.S. Department of Agriculture (USDA) Wildlife Services to join the Oregon Department of Fish and Wildlife (ODFW) and the Washington Department of Fish and Wildlife (WDFW) in conducting monitoring and non-lethal harassment efforts to deter marine mammal predation downstream of the dam. A variety of harassment techniques were used, including above-water pyrotechnics, underwater acoustics, rubber bullets, and rubber-tipped arrows. Results from a 2006 test by Corps biologists indicated that these tools were ineffective in reducing total predation and pinniped presence, although sea lions did demonstrate some hazing avoidance behavior. In 2007, ODFW and WDFW attempted to reduce pinniped predation by trapping and relocating sea lions. However, most of the sea lions trapped and subsequently released on the Oregon coast returned to the dam before the end of the observation season.

In 2006, the states of Oregon, Washington, and Idaho applied to NOAA Fisheries for authorization under the MMPA to lethally remove or permanently relocate nuisance sea lions found at the dam. NOAA Fisheries created a Pinniped-Fishery Interaction Task Force to address this request, and in late 2007, the task force released its report in favor of the states' request.

Habitat Protection and Improvement Actions

Recognizing that the Columbia River tributaries and estuary provide important habitats to salmon during their various life stages, the Action Agencies coordinate with federal, state, tribal, and local partners to promote improvements in aquatic ecosystems. The Action Agencies are increasing the amount of water in streams, retrofitting or installing fish screens at water diversions to keep fish safely out of irrigation canals, removing barriers to fish passage, improving channel complexity by reconnecting side channels, increasing floodplain function, improving instream habitat conditions, and acquiring easements or other protective interests for riparian areas along tributaries.

In 2006 and 2007, the Action Agencies continued to expand their efforts to improve habitat by addressing factors that limit the survival of targeted salmon and steelhead. In the estuary, the Action Agencies seek to acquire ownership or development rights to areas of relatively undisturbed habitat, and to areas that are degraded but are good candidates for restoration.

Tributary Protection and Improvement

In tributary subbasins, the Action Agencies removed barriers, screened diversions, improved instream habitat, and leased more instream flows to address a number of factors that limit the abundance, productivity, diversity, and distribution of Snake River spring/summer Chinook, Upper Columbia River spring Chinook, Snake River steelhead, Upper Columbia River steelhead, and Mid-Columbia River steelhead. Because biological improvements associated with actions implemented to address limiting factors are difficult to measure and take time to quantify, the Action Agencies sponsor and coordinate research, monitoring, and evaluation within a larger regional framework to evaluate and quantify these biological benefits. The Action Agencies also pursued long-term survival improvements through conservation easements, leases, and land acquisitions.

Streamflow Improvements

The Action Agencies, using mechanisms such as water acquisition agreements and efficiency improvements, increased the water quantity in certain tributaries that provide important spawning and rearing habitat for ESA-listed fish.

BPA has supported efforts to obtain tributary flows using water acquisitions. Through a cooperative funding agreement with BPA, the National Fish and Wildlife Foundation operates the Columbia Basin Water Transactions Program (CBWTP). The program supports voluntary and innovative grassroots water transactions to improve flows to Columbia Basin tributary streams and rivers, working in accordance with state water law. In 2006 and 2007, the CBWTP completed 74 voluntary transactions around the region, each addressing a significant opportunity to restore instream flows. More than 170 transactions have been completed since the inception of the water transactions program in 2002.

In 2006, the CBWTP secured 256 cubic feet per second (cfs) of streamflows throughout tributaries in the Columbia Basin, with more than 200 cfs focused on ESA-listed fish. In 2007, the CBWTP secured another 232 cfs of streamflows, with more than 175 cfs for ESA-listed fish.

A good example of progress made under the water transactions program comes from BPA-supported transactions by the Washington Water Trust along the North Fork Teanaway River, among the most productive habitats for steelhead in the upper Yakima River Basin. Anadromous fish in this tributary have suffered from low streamflows and passage barriers. In the past decade, short-term water leases have helped provide a source of revenue for farmers and ranchers who needed to refurbish irrigation systems after past floods. The goodwill and momentum generated by those agreements has begun to translate into a shift toward longer term transactions. In 2006, with CBWTP support, the Washington Water Trust contracted with landowners to extend

East Fork Salmon Fish Screen EF-15 (Before).
The original fish screen was oriented perpendicular to flow and did not meet NOAA Fisheries criteria. Also, fish could swim past the screen at high river flows.

East Fork Salmon Fish Screen EF-15 (After).
The new vertical plate, point-of-diversion fish screen prevents fish from swimming into the canal at high and low flows. Also, unlike conventional fish screens located in the canal away from the river, fish passing a point-of-diversion screen never leave the river because the screen is built directly on the river at the canal inlet.

its lease of 102 acre-feet until 2023. With eight projects along 13 miles of the mainstem and North Fork Teanaway River, the Washington Water Trust has increased flows by up to 5.5 cfs, a biologically significant boost for the basin's fishery.

For more information about the water transactions program, see the CBWTP's 2006 and the 2007 Annual Report Summaries at *http://cbwtp.org/jsp/cbwtp/news/Publications.jsp*.

Fish Screen Improvements

In many agricultural areas, irrigation diversions are known to impede fish passage or entrain fish in irrigation canals. The Action Agencies have installed structures such as lay-flat stanchions and diversion pumps so that water can be diverted for irrigation without obstructing passage. Fish screens have also been installed or retrofitted at water diversions to prevent entrainment into irrigation canals or other inappropriate habitats.

In 2006 and 2007, improvements at 23 water diversions were completed in the Entiat, Hood, John Day, Methow, Salmon River, and Wenatchee watersheds. These diversion improvements reduced fish mortality and provided immediate survival benefits for ESA-listed fish.

One example is the replacement of the fish screen at an irrigation diversion on the East Fork Salmon River near Challis, Idaho (known as EF-15). The Bureau of Reclamation and BPA collaborated with the landowner, Custer County Soil and Water Conservation District, and Idaho Department of Fish and Game (IDFG) on this project.

When the gravel push-up dam, which blocked fish passage under low-flow conditions, was replaced with an engineered rock ramp (that provides fish passage at all flow conditions), the screen was replaced, too. The new structure is a two-bay, vertical-plate, point-of-diversion screen. The mesh of the plate is porous enough to pass water for irrigation, but small enough to prevent tiny fish from passing through it. Mechanical wipers, powered by a paddlewheel in the canal downstream from the screen, prevent collection of debris that could interfere with screen operation. A point-of-diversion screen provides another benefit compared to conventional screens, which often are located down the diversion canal and some distance away from the river. Such conventional screens require a return pipe to carry fish from the screen back to the river, which can be up to hundreds of feet away. A point-of-diversion screen, such as the one at EF-15, does not need a return pipe because it is located directly on the river at the canal inlet. Therefore, fish never leave the river.

Fish Passage Improvements

The Action Agencies improve fish passage by removing obstructions that block access to spawning and rearing habitat. These obstructions include water diversions, culverts and other migration barriers. The Action Agencies increase access to high-quality spawning and rearing habitat by supporting projects to remove obstructions and reconnect streams with floodplains and side channels.

In 2006 and 2007, the agencies funded the removal or improvement of more than 120 barriers or obstructions to fish, providing access to more than 500 miles of tributary fish habitat.

An example of improved fish passage is replacement of the Fulton Diversion Dam on the Chewuch River near Winthrop, Washington. The existing boulder push-up diversion dam blocked fish passage at low streamflows and caused mortality to downstream-migrating juveniles. The push-up dam was replaced with an engineered rock ramp (also called a "roughened channel"). The rock ramp mimics the natural gradient of a stream channel but builds enough elevation for the diversion of water. A grouted channel concentrates streamflow along the centerline of the rock ramp to provide adult and juvenile fish passage under low-flow conditions. On this project, BPA and the Bureau of Reclamation collaborated with local landowners, the Fulton Canal Company, WDFW, and Washington State Salmon Recovery Funding Board.

Fulton Diversion Dam (Before).
The boulder push-up dam was a barrier to fish passage.

Fulton Diversion Dam (After).
Low streamflow is concentrated down the center of the completed rock ramp.

Channel Complexity Improvement

The Action Agencies work to improve channel complexity by reconnecting side channels, increasing floodplain function, and improving instream habitat conditions. Side-channel reconnection projects increase off-channel spawning and rearing habitat. Where feasible, projects to increase floodplain function rely on natural river processes to create and maintain instream habitat. In channels that lack variety, other instream improvement projects involve adding wood and rock structures to provide fish with resting areas and protection from predators. The Action Agencies treated more than 40 miles of streams in 2006 and 2007.

Channel complexity improvements often involve a wide array of stakeholder interests. The Bureau of Reclamation has pioneered an assessment process with local partners in the Mid-Columbia and Upper Columbia regions that incorporates physical and biological information and analysis as a basis for identifying, prioritizing, and implementing stream habitat improvement projects. These assessments are scaled from coarse to finer scales of resolution to focus human and capital resources on areas with the most potential to achieve the greatest biological results and filter out areas with less potential. Examples of these assessments can be found at *http://www.usbr.gov/pn/programs/fcrps/thp/index.html*.

The Milne Project on the Entiat River in north-central Washington is an example of a channel complexity project. The project included installation of five rock barbs, one diversion barb structure with sluice-gate, thirteen large logs with root wads, and six boulder clusters with five boulders each. The diversion barb is used to convey water to an irrigation ditch and replaces a push-up dam that had been created annually. The sluice-gate was installed to reduce disturbance of fish by heavy equipment that formerly operated in the river to clear sediment that would accumulate in the irrigation ditch. Logs, root wads and boulder clusters provide cover from predators, slow river velocity, and promote formation of deep resting pools. Project partners included private landowners, the Entiat Watershed

Planning Unit, U.S. Forest Service (USFS), USFWS, Washington State Salmon Recovery Funding Board, and the Chelan County Public Utility District Tributary Fund.

Riparian Protection and Enhancement

As a longer term strategy to improve fish survival, the Action Agencies protect and enhance fish habitat by acquiring easements or other protective interests in land, treating and fencing riparian areas, and stabilizing stream banks.

In 2006 and 2007, the agencies funded the protection of more than 300 miles of anadromous fish habitat in 13 subbasins. Counting actions implemented or secured in prior years, more than 1,300 miles of habitat have been secured. These important fish habitats will continue to provide fish survival improvements for many years.

In 2006 and 2007, in an effort to permanently protect high-quality habitat in areas of strategic significance for fish, BPA cooperated with other entities to continue the Columbia Basin Riparian Easement Pilot to complement the water transaction program. The Methow Conservancy in the Columbia Cascade province of north-central Washington worked to secure additional easements with BPA funding.

In 2006, the Methow Conservancy purchased an easement permanently limiting future development on a 141-acre parcel of wetlands and forest with 1.5 miles of shoreline along the Methow River, several miles northwest of Winthrop, Washington. Permanent protection for this ecologically significant landscape secures one of the most productive stretches of salmon redds in the valley, along with two spring-fed ponds that connect to the Methow, supplying constant year-round flows that help keep temperatures in the river amenable for endangered spring Chinook salmon and steelhead. The Action Agencies continue to use this easement program to work cooperatively with others to protect important riparian areas.

Estuary Protection and Improvement

In the Columbia River estuary, the Action Agencies funded projects that protect and enhance shallow-water habitats and research that improves our understanding of estuary habitat. Estuary habitats provide refuge, foraging, and rearing areas for juvenile salmon as they migrate and make their transition from freshwater to saltwater. The estuary habitat projects funded by the Action Agencies focus primarily on protecting and increasing the distribution of high-quality habitat for all ESUs.

On the Methow River, this riparian area is protected by the Heath conservation easement and will help the river function in its dynamic, natural state.

In 2006 and 2007, BPA funded implementation of multiple projects in cooperation with the Lower Columbia River Estuary Partnership (LCREP), local watershed councils, Columbia River Estuary Study Taskforce (CREST), USFS, and others. In addition, BPA is funding LCREP and others in developing an ecosystem classification system based on hydrogeomorphology. The classification system uses a variety of spatial data sets — including hydrologic, geomorphic, bathymetric, land cover, and other comprehensive data — to delineate ecosystem structure. This information will be used in project development, prioritization, and selection. Efforts are ongoing and the classification system should be completed in 2011.

In 2006, BPA funded a passage restoration project in Alder Creek, a tributary to North Fork Scappoose Creek in the Scappoose Bay Watershed. The focus of this project was the removal of three culverts that blocked fish passage. Removing those barriers provided access to an additional 2 miles of habitat. Additional restoration efforts included enhancing riparian habitat in the project area by planting native species of trees and shrubs, and placing large woody debris in the channel to provide streambed stability, create additional habitat complexity, and retain existing pools.

BPA also funded the restoration on the Scappoose Bay Bottomlands near Warren, Oregon. Riparian planting was completed on both the Hogan Ranch and the Scappoose Creek sites, where more than 5,000 plants and live cuttings were installed. Riparian fencing was installed on both sites and 2 miles of Scappoose Creek was treated for non-native plant species.

In 2006, BPA also funded a dike breach on the Lewis and Clark River (Columbia River RM 12.8, near Astoria). This project restored the tidal connection between the estuary and roughly 25 acres of essential wetland habitat. In doing so, the project increased the hydrologic connection between the Lewis and Clark River and its floodplain, restored access to historical rearing habitat for juvenile salmonids, increased critical flood storage and sediment retention, and re-established historical plant community structure. This

Fort Clatsop Floodplain Reconnection Project (Before)

Fort Clatsop Floodplain Reconnection Project (After)

will benefit salmonids and wildlife within the Youngs Bay Watershed.

In 2006 and 2007, the Action Agencies continued to fund restoration efforts at the Sandy River Delta. These efforts are an important part of the larger effort to restore all of the major pre-settlement habitats across the entire USFS ownership at the Sandy River Delta. This work builds on work done during 2005 and focuses on the riparian fringe area along the new Sandy and old (original) Sandy River channels. The goal of the restoration actions for this project was to improve habitat for salmonids migrating and sheltering in the Columbia and Sandy River systems and to improve water quality. In 2006, this project restored 15 acres of diverse native hardwood riparian forest and stabilized approximately 9,000 contiguous linear feet of eroding riverbank along the Sandy River. Accomplishments in 2007 included planting and inter-planting 190 acres of riparian forest, maintaining restored plant communities on 235 acres, and site preparation for planting 15 acres.

In 2007, BPA funded restoration efforts at Fort Clatsop. This project resulted in the reconnection of 45 acres of floodplain with the Lewis and Clark River. Reconnection was established by replacing a non-functioning tide gate with a bridge. The bridge was designed to maximize tidal hydrologic connectivity between the 45 acres of diked pasture and the river. Funds were dedicated to the time and materials necessary to design and install the bridge.

Hatcheries

The Action Agencies continued to fund production hatchery programs to meet mitigation and treaty expectations and safety-net programs to reduce the extinction risk of at-risk populations of ESA-listed Snake River sockeye salmon, Snake River spring/summer Chinook salmon, and middle and lower Columbia River steelhead.

One of those programs, the Snake River Sockeye Salmon Captive Broodstock Program, preserves this critically imperiled species. The program has produced hundreds of thousands of progeny from remnants of the wild stock. The progeny are raised in carefully managed hatcheries and released into their natural habitats as adults to spawn or as juveniles to migrate downstream. Since 1999, 355 adults from the program have returned to Redfish Lake in the upper Salmon River subbasin, 900 miles from the ocean.

In 2006, BPA funded modifications to the IDFG Eagle Fish Hatchery to facilitate the production of additional sockeye salmon broodstock and increase smolt production for the program.

BPA also executed a contract to fund improvements at the ODFW's Oxbow Fish Hatchery to accommodate additional sockeye salmon smolt rearing capacity.

In 2007, BPA executed a contract with IDFG to conduct pre-acquisition activities to secure an additional sockeye salmon hatchery site. Once secured, this initiative is intended to boost production to between 500,000 and 1 million sockeye smolts.

Modifications at the NOAA Fisheries Burley Creek Hatchery (near Burley, Washington), ODFW Oxbow Fish Hatchery, and IDFG Eagle Hatchery improved the security of the safety-net program and facilitated the production of additional broodstock adults and eggs to meet an interim target of 150,000 sockeye salmon smolt.

In 2007, the Action Agencies completed expansion of the adult collection facility at Lower Granite Dam, which allows it to handle up to 6,000 adult fall Chinook salmon annually. The expansion will reduce genetic risks to the threatened

Figure 7. Action Agency Funded Anadromous Fish Hatcheries, Including Anadromous/Resident Fish Safety-Net Hatcheries.

run by allowing more out-of-basin fall Chinook salmon to be trapped and removed, and it will improve the hatchery program integration between natural-origin and hatchery-origin Snake River fall Chinook salmon.

The Action Agencies also funded the final stages of development of draft Hatchery Genetic Management Plans (HGMPs) to identify hatchery reform actions that would reduce the negative impacts of hatchery operations on ESA-listed stocks. In January 2006, all HGMPs completed to date were forwarded to NOAA Fisheries for review and approval. The HGMPs are expected to help NOAA Fisheries, hatchery operators, and the Action Agencies identify priority hatchery reform actions that would contribute to the recovery of listed stocks.

Research, Monitoring, and Evaluation

The Action Agencies implement a research, monitoring, and evaluation (RM&E) program that evaluates the performance of management actions in the All H action environments — hydropower, hatcheries, harvest, and habitat. The RM&E program is implemented in coordination with the Northwest Power and Conservation Council's Fish and Wildlife Program, the Corps' Anadromous Fisheries Evaluation Program (AFEP), Reclamation's technical assistance activities, and RM&E activities of other agencies. The Action Agencies continue to work closely with the Pacific Northwest Aquatic Monitoring Partnership (PNAMP) — a forum for coordinating state, federal, and tribal aquatic habitat and ESA-listed salmonid monitoring programs — to collaboratively advance a regionally coordinated approach to fish monitoring. In 2005, a PNAMP charter was signed by 19 state, tribal, federal, and regional entities. The Action Agencies provide a substantial portion of the PNAMP funding, as well as the majority of funding for two PNAMP entities: the Columbia Basin Fish and Wildlife Authority (CBFWA) and the Columbia River Intertribal Fish Commission (CRITFC).

Status and Trend Monitoring

Status monitoring was used to assess the condition or change (trend) in fish populations and/or watershed health relative to required performance standards. In 2006–2007, the Action Agencies continued to implement status monitoring of listed ESUs. This included, for example, monitoring in the Upper Columbia, John Day, and Salmon River tributary subbasins to further advance the methods and information for assessing fish status and environmental conditions. The Action Agencies funded the collection of daily adult and juvenile fish passage data at eight sites through the mainstem Snake and Columbia rivers, enabling statistical and analytical support for real-time hydrosystem operational decisions and providing critical information needed to determine and track the status of ESA populations and their environment. This status-monitoring information was used to conduct population level, hydrosystem, and offsite mitigation performance tests identified in the 2004 BiOp.

Action Effectiveness Monitoring

Action effectiveness studies establish cause-and-effect or inferential relationships between management actions and fish populations or fish habitat conditions in a quantitatively rigorous approach. Action effectiveness research supports performance evaluations and mitigation planning, and informs adaptive management decisions. The Action Agencies are using these assessment tools to evaluate the management actions and suggest alternative future actions in an adaptive management framework.

In 2006–2007, the Action Agencies funded studies of the effectiveness of certain hydrosystem, predator control, tributary habitat, estuary, hatchery, and harvest-related management actions. In the hydrosystem, studies of the effectiveness of the juvenile fish transportation program and hydro project passage measures were conducted. The Action Agencies also funded studies to evaluate the effectiveness of the Northern Pikeminnow Management Program. For habitat actions, studies of the cumulative effects of estuary habitat restoration actions on juvenile salmon survival and tributary pilot studies in the Wenatchee, John Day, and Methow subbasins continued. BPA also continued to fund the monitoring and evaluation of its safety-net hatchery programs.

Sockeye Salmon in Full Red

Critical Uncertainties Research

Critical uncertainties research addresses areas of uncertainty in biological evaluations of the survival conditions and the needed survival improvements for specific fish stocks. The Action Agencies continued to invest in research in 2006–2007 to resolve key uncertainties and improve analytical methods for population status assessments and survival improvement. Subjects of key critical uncertainties research implementation included the following:

- Population dynamics and the importance of ocean entry timing
- Delayed mortality related to hydrosystem passage
- Relationship of estuary habitat to salmon production

Regional Coordination on RM&E

Regional coordination remained a critical aspect of the RME program in 2006–2007. Participation and funding of the PNAMP and the Northwest Environmental Data-Network (NED) were key components of this coordination work. This included participating in the PNAMP fish population work group to plan and publish the *Salmonid Field Protocols Handbook* (American Fisheries Service, 2006) and initial work on developing a regional fish monitoring strategy, as well as development of a compendium. Coordination efforts on hydro RM&E occurred through the AFEP project development and review process. The Northwest Power and Conservation Council's (NPCC) Fish and Wildlife Program RM&E efforts included substantial regional coordination through the NPCC project proposal-and-review process; this included review by the Independent Scientific Review Panel (ISRP). Other significant regional coordination efforts occurred through the NOAA Fisheries' Regional Forum, LCREP, Federal Caucus RM&E work groups, tributary status and action effectiveness pilot project work groups, and the Upper Columbia Regional Technical Team.

Conclusion

Working with the Region for Recovery

Ensuring sufficient abundance of salmon and steelhead to sustain healthy natural stocks is a challenge that reaches beyond the federal hydrosystem. Recovery will require years of concerted effort from federal agencies, states, and tribes, as well as local governments and private parties. Actions in hydro, habitat, hatcheries, harvest, and predation management will all be necessary. The Action Agencies look forward to working with the region's sovereigns on the implementation of the new BiOps in a continuation of the collaboration that has led to these proposed actions. The technical and scientific contributions of those entities over the past 2 years have led to a better understanding and appreciation of what the fish need. It has helped the agencies fashion a comprehensive suite of actions and commitments that are expected to contribute to recovery for Columbia River Basin salmon and steelhead over the next decade and to lay the foundation for the greater recovery effort in the region. To learn more about this new strategy for listed fish, go to *www.salmonrecovery.gov*.

Additional Resources

Complete citations for in-text references can be found in the *2008 Annual Progress Report*. Additional sources of information on the web regarding regional salmon recovery efforts include:

- Website links and more information on federal agency efforts for salmon and steelhead: *www.salmonrecovery.gov*
- Columbia River Inter-Tribal Fish Commission: *www.critfc.org*
- Columbia Basin Fish and Wildlife Authority: *www.cbfwa.org*
- Columbia Basin Water Transactions Program (CBWTP): *www.cbwtp.org*
- Idaho Office of Species Conservation: *www.species.idaho.gov*
- Northwest Power and Conservation Council: *www.nwcouncil.org*
- Oregon Watershed Enhancement Board: *www.oregon.gov/OWEB/index.shtml*
- Pacific Coastal Salmon Recovery Fund: *www.nwr.noaa.gov/Salmon-Recovery-Planning/PCSRF/*
- Pacific Northwest Aquatic Monitoring Partnership (PNAMP): *www.pnamp.org*
- Bureau of Reclamation shows some completed tributary habitat projects at: *www.usbr.gov/pn/programs/fcrps/thp/index.html*
- Washington Salmon Recovery Office: *www.governor.wa.gov/gsro/default.htm*