Endangered Species Act
Federal Columbia River Power System
2009 Annual ESA Progress Report: Section 3

Detailed Description of Reasonable and Prudent Alternative (RPA) Action Implementation

Under Reasonable and Prudent Alternative (RPA) action 2, the Action Agencies submit an annual progress report that describes the status of implementation for the previous calendar year. Section 3 describes this progress for each RPA action. Section 4 includes a list of all projects implemented in 2009 along with their associated RPA subactions.

Contents

Tables

Figures

Hydropower Implementation Reports, RPA Actions 4–33

This document reports on actions taken during calendar year 2009. The Hydropower RPA actions are intended to be implemented over the term of the Biological Opinion (BiOp). Although many of these actions were under way or being implemented during 2008, some will be implemented later in the BiOp period. For hydro operations, actions are reported by water year (October thru September) rather than calendar year because this is more meaningful.

Table 1. Hydropower Strategy Reporting

RPA Action No.	Action	Annual Progress Report
Hydropower Strategy 1		
4	Storage Project Operations	Prepare an annual year-end review.
5	Lower Columbia and Snake River Operations	Prepare an annual year-end review.
6	In-Season Water Management	Annual progress reports will describe Federal Columbia River Power System (FCRPS) operations for the fish passage season. There is no other physical or biological monitoring or reporting.
7	Forecasting and Climate Change/Variability	Annual progress reports will include a summary of the annual forecast review and any new, pertinent climate change information or research.
8	Operational Emergencies	Annual progress reports will describe any emergency situations and actions taken per the emergency protocols. There is no other physical or biological monitoring or reporting.
9	Fish Emergencies	Annual progress reports will describe any fish emergency situations and actions taken. There is no other physical or biological monitoring or reporting.
10	Columbia River Treaty Storage	Annual progress reports will describe actions taken to provide 1 million acre-feet (maf) of storage in treaty space. There is no other physical or biological monitoring or reporting.
11	Non-Treaty Storage (NTS)	Annual progress reports will describe actions taken to refill non-treaty storage space. There is no other physical or biological monitoring or reporting.
12	Non-Treaty Long-Term Agreement	Annual progress reports will describe actions taken to develop long-term and/or annual agreements that affect lower Columbia River flows during the April through August period. There is no other physical or biological monitoring or reporting.
13	Non-Treaty Coordination with Federal Agencies, States, and Tribes	Annual progress reports will describe actions to coordinate non-treaty storage agreements. There is no other physical or biological monitoring or reporting.

Table 1. Hydropower Strategy Reporting

RPA Action No.	Action	Annual Progress Report
14	Dry Water Year Operations	Annual progress reports will describe actions taken during dry water years. There is no other physical or biological monitoring or reporting.
15	Water Quality Plan for Total Dissolved Gas and Water Temperature in the Mainstem Columbia and Snake Rivers	Annual progress reports will describe actions taken to implement Endangered Species Act (ESA) commitments. There is no other physical or biological monitoring or reporting.
16	Tributary Projects	Status of the consultations for Reclamation's tributary projects will be provided in the annual progress reports.
17	Chum Spawning Flows	Annual progress reports will describe in-season water management actions taken during the water year, which includes part of the previous calendar year.
18	Configuration and Operational Plan for Bonneville Project	Annual progress reports will describe status of the actions taken in the Configuration and Operational Plan (COP) and the results of the associated research, monitoring, and evaluation (RME).
19	Configuration and Operational Plan for The Dalles Project	Annual progress reports will describe the status of the actions taken in the COP and the results of the associated RME.
20	Configuration and Operational Plan for John Day Project	Annual progress reports will describe the status of the actions taken in the COP and the results of the associated RME.
21	Configuration and Operational Plan for McNary Project	Annual progress reports will describe the status of the actions taken in the COP and the results of the associated RME.
22	Configuration and Operational Plan for Ice Harbor Project	Annual progress reports will describe the status of the actions taken in the COP and the results of the associated RME.
23	Configuration and Operational Plan for Lower Monumental Project	Annual progress reports will describe status of the actions taken in the COP and the results of the associated RME
24	Configuration and Operational Plan for Little Goose Project	Annual progress reports will describe the status of the actions taken in the COP and the results of the associated RME.
25	Configuration and Operational Plan for Lower Granite Project	Annual progress reports will describe the status of the actions taken in the COP and the results of the associated RME.
26	Chief Joseph Dam Flow Deflector	Annual progress reports will describe the status of the flow deflector construction. Note: This construction project was completed in spring 2009.

Table 1. Hydropower Strategy Reporting

RPA Action No.	Action	Annual Progress Report
27	Turbine Unit Operations	Annual progress reports are developed by Bonneville Power Administration (BPA).
Hydropower Strategy 2		
28	Columbia and Snake River Project Adult Passage Improvements	Annual progress reports will describe the status of the actions taken.
Hydropower Strategy 3		
29	Spill Operations to Improve Juvenile Passage	Spill operations are reported annually.
30	Juvenile Fish Transportation in the Columbia and Snake Rivers	Annual progress reports will provide the number of fish collected and transported in an annual report each February.
31	Configuration and Operational Plan Transportation Strategy	Annual progress reports will describe the status of the construction and operational actions and associated RME to support the transportation strategy.
Hydropower Strategy 4		
32	Fish Passage Plan	Not applicable.
Hydropower Strategy 5		
33	Snake River Steelhead Kelt Management Plan	Status of project implementation (including project milestones) through December of the previous year for all actions identified in implementation plans.

Hydropower Strategy 1 (RPA Actions 4–27)

RPA Action 4 – Storage Project Operations: *The Action Agencies will operate the FCRPS storage projects (Libby, Hungry Horse, Albeni Falls, Grand Coulee, and Dworshak projects) for flow management to aid anadromous fish. These storage project operations will be included in the Water Management Plan. These projects are operated for multiple purposes including fish and wildlife, flood control, irrigation, navigation, power, and recreation.*

The Federal Columbia River Power System (FCRPS) storage projects were operated in accordance with the 2009 Water Management Plan (WMP), at *http://www.nwd-wc.usace.army.mil/tmt/documents/wmp/2009/final/wmp_final_20081231.pdf*), which was developed in the fall 2008 with full regional coordination.[1] The 2009 operations were under court order, as in

[1] *The Regional Forum process was developed in 1995 and has been employed ever since by NOAA Fisheries and other regional entities to implement ESA provisions for protection and recovery of listed salmon species. Members of the Regional Forum include: State and Tribal sovereigns with management authority over fish and wildlife resources and water quality in the Columbia River basin; and Federal agencies with regulatory or action authority in the Columbia River, including NOAA Fisheries, USFWS, BPA, Corps, EPA, and Reclamation. Other agencies and regional interests, such as the Northwest Power and Conservation Council, the Idaho Power Company and the Mid-Columbia Public Utility Districts, may also attend. The Regional Forum consists of several technical workgroups*

2008. In accordance with the adaptive management provisions of the 2008 BiOp, the WMP was developed to meet RPA hydro actions identified in the 2008 FCRPS BiOp and the 2000 and 2006 U.S. Fish and Wildlife Service (USFWS) BiOps (USFWS 2000, 2006). The WMP incorporates operations consistent with the 2009 Spring and Summer Fish Operations Plans (FOPs) and the respective court orders. Details of the operations of the projects are shown in Figures 1 through 4 and described below. Further discussion of these operations is included in the minutes of the Technical Management Team (TMT) meeting "Annual Review of Lessons Learned 2009" at *http://www.nwd-wc.usace.army.mil/tmt/agendas/2009/1211min.pdf*

Dworshak Dam

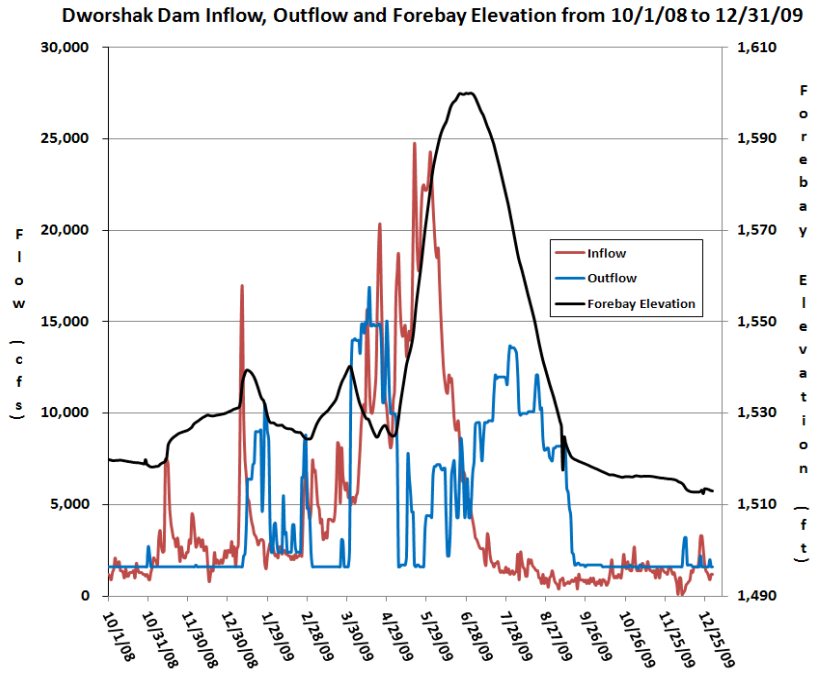

Figure 1. Dworshak Dam Inflow, Outflow, and Forebay Elevation from October 1, 2008, through December 31, 2009.

From October 2008 through early January 2009, Dworshak Dam released the minimum flow requirements of approximately 1,500 cubic feet per second (cfs), except for some minor unit testing. Dworshak Dam began January 2009 at elevation 1530.5 feet, well under flood control elevations. The project drafted to meet system and local flood control elevation targets for the end of January and February (Figure 1). The outflow was shaped daily and weekly to most efficiently meet system power requirements.

During March and through mid-April the project was operated near minimum outflow to shift system flood control to Grand Coulee Dam and to meet local flood control targets. The April 1 forecast was 2.683 thousand acre-feet (kaf), or 98 percent of average, but significant rains and rises in inflow required that the project increase to powerhouse plus spill to attempt to meet mid and end of April elevation targets. The project averaged 14,127 cfs outflow during April and was at elevation 1526.2

such as the Technical Management Team (TMT), the System Configuration Team (SCT), the Studies Review Work Group (SRWG), and the Fish Passage Operations and Maintenance (FPOM) workgroup. As used in this document, "the region" or "regional coordination" generally refers to the Regional Forum technical subgroup appropriate for the issue at hand.

feet on April 30. Dworshak Dam was operated to standard flood control criteria during the winter and spring flood control season.

The start of refill began on May 6, when Dworshak Dam began operating according to Flood Control/Refill Curve procedures. Releases from Dworshak Dam in May averaged 4,529 cfs. During portions of May project outflow was increased and adjusted at the request of the salmon managers to maintain flow objectives in the lower Snake River for salmon. The May forecast for the May to July inflow volume was 2,631 kaf, which was 98 percent of average. During April and May, the inflows averaged 10,530 cfs and 16,874 cfs, respectively. Dworshak Dam reached full levels (maximum elevation of 1,600.0 feet) on July 1.

The reservoir began drafting on July 5 to provide temperature and flow augmentation for the lower Snake River. Summer temperature management was successful, maintaining Lower Granite Dam tailwater temperatures below 68 degrees Fahrenheit for all but portions of two days, July 29 and August 1. The maximum Lower Granite Dam tailwater temperature recorded in 2009 was 68.4 degrees Fahrenheit. By August 31, the reservoir was drafted to elevation 1,535.0 feet. September operations followed the Nez Perce 200 kaf operational plan for 2009, with orderly prescribed stepdowns to a flow of about 2000 cfs on September 17, where the reservoir reached 1,520 feet.

From October to December, Dworshak Dam released minimum flows of 1,500 cfs, except during brief periods of turbine testing following normal maintenance activities. Dworshak ended December at elevation 1,513.1 feet, with flood control elevation being 1,558.2 feet.

Libby Dam

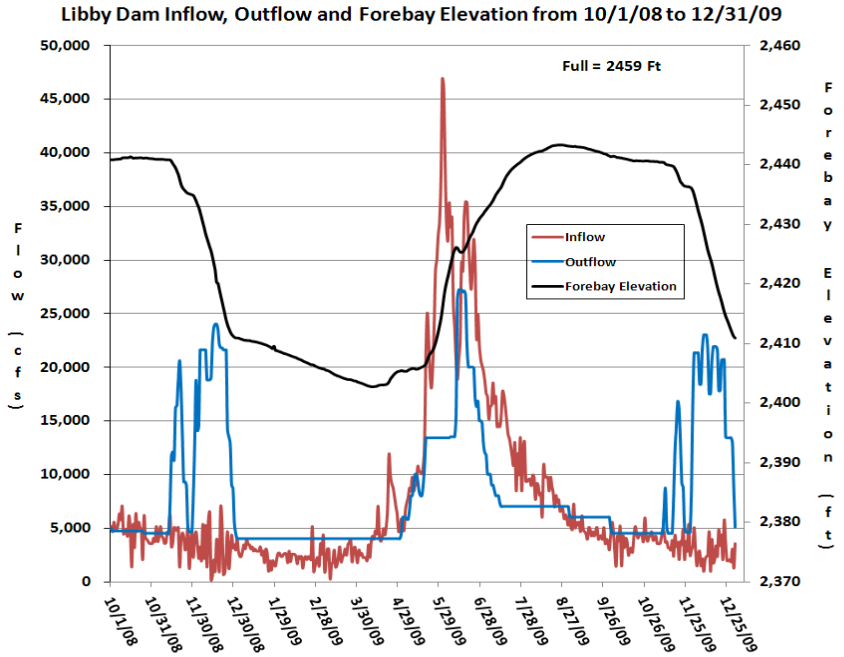

Figure 2. Libby Dam Inflow, Outflow, and Forebay Elevation from October 1, 2008, through December 31, 2009.

After meeting an end of December 2008 flood control elevation target of 2411.0 feet, from January through April 2009, Libby Dam released the minimum flow of 4,000 cfs (Figure 2).

Libby Dam operated consistent with the variable outflow flood control procedures (VARQ) that were incorporated into RPA action 4 of the 2008 BiOp. The start of refill was declared on April 27, with outflows averaging 10,100 cfs for all of May. The project was then operated to provide tiered augmentation volumes for listed Kootenai River white sturgeon to achieve habitat attributes for

sturgeon spawning/recruitment shaped through coordination with the regional Technical Management Team (TMT) and consistent with the 2008 BiOp RPA action regarding May, June, and July operations. The May forecast for the April through August inflow volume was 5,209 kaf, which set the sturgeon volume at 0.8 million acre-feet (maf) and established the tiered bull trout minimum flows from the end of the sturgeon pulse through August 31 at 7,000 cfs. The sturgeon pulse started June 10. The sturgeon volume was exhausted on July 12. The pulse included seven days at Libby Dam's full powerhouse and an additional five days above 20,000 cfs on the descending limb. Libby Dam reached a maximum elevation of 2,444.3 feet on August 24 and did not refill. The actual April through August water supply volume was 4400 kaf, much drier than forecasted.

After the sturgeon pulse Libby Dam ramped down to a minimum bull trout flow of 7,000 cfs for July and August. In September, Libby Dam operated to the minimum bull trout flow of 6,000 cfs.

From October to December 2009, Libby Dam was regulated to meet the projected end-of-December target elevation, to optimize for power any draft to meet the December flood control target, and to limit any fluctuations by operating to the ramping rates in the 2006 USFWS BiOp. The project followed the end-of-December variable flood control draft based on the December early season forecast. This forecast was 6,544 kaf for the April through August inflow volume forecast. This forecast set the end-of-December flood control target at 2,411 feet. Actual elevation on December 31 was 2,410.9 feet. Throughout 2009, Libby Dam avoided spill and did not exceed the Montana state total dissolved gas standard of 110 percent. In accordance with the 2008 BiOp, Libby Dam was also regulated consistently with the Columbia River Treaty, the International Joint Commission, and the 1938 Order on Kootenay Lake.

Grand Coulee Dam

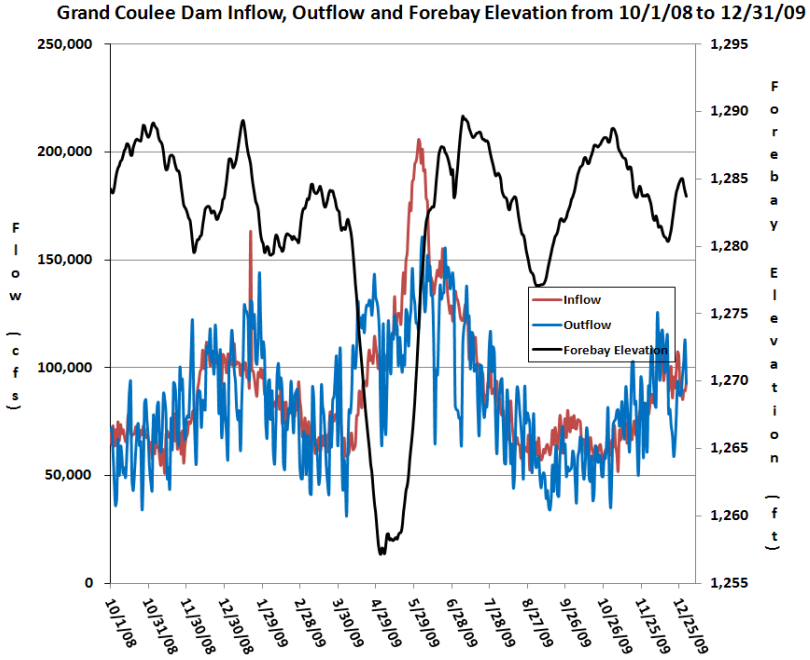

Figure 3. Grand Coulee Dam Inflow, Outflow, and Forebay Elevation from October 1, 2008, through December 31, 2009.

Grand Coulee Dam was operated during November and December 2008 to help support chum spawning below Bonneville Dam and maintain the chum redd protection tailwater below Bonneville Dam of 11.5 feet through the winter 2009 (Figure 3). Also during this period, Grand Coulee Dam was operated to help support the Vernita Bar protection flows of 60 thousand cubic feet per second (kcfs). The project was operated using standard flood criteria, which included accepting a 134 kaf shift of flood control space from Dworshak Dam on March 31. Water supply forecasts for the basin above

Grand Coulee Dam during the April to September period were at 93 percent of average in January, 88 percent of average in March, 92 percent of average in April, and 87 percent of average in June. Grand Coulee Dam reached the March 31 flood control elevation of 1281.6 feet. However, in early April, it became apparent that it would be difficult to maintain the Vernita Bar protection flows of 60 kcfs and also reach the April 10 elevation objective of 1281.9 feet. The issue was discussed at TMT, and it was decided to maintain the Vernita Bar protection flows. It was estimated that maintaining the Vernita Bar flows may draft Grand Coulee Dam about 1-2 feet below the 1281.9 feet April 10 objective. An additional complicating factor was the large increase in the Northwest River Forecast Center's (NWRFC) Water Supply Forecast (WSF) from March to April at The Dalles Dam. The April final forecast increased about 8 maf (9 percent) from the March final forecast resulting in Grand Coulee Dam's April 30 flood control elevation dropping 24 feet to elevation 1257.7 feet (from March's forecast of 1281.7 feet). The April 15 flood control elevation decreased 9 feet from 1282 feet to 1273 feet. To achieve the new April 15 and April 30 flood control elevations, Grand Coulee Dam began drafting to the new flood control elevations starting on April 9. Grand Coulee Dam's maximum elevation on April 10 was 1280.4 feet.

Because of the relatively high flood control elevations at Grand Coulee Dam, drum gate maintenance was not performed and was deferred during 2009.

During the refill, there were periods of high flows and elevated TDG throughout the system because of forced spill. To minimize downstream spill and TDG production in the Columbia River, operations were coordinated through the TMT and in accordance with the 2009 Total Dissolved Gas Management Plan (*http://www.nwd-wc.usace.army.mil/tmt/documents/wmp/2009/final/app4.pdf*). Grand Coulee Dam began refill in mid-May and achieved elevation 1290 feet on July 6, as coordinated through the TMT, and then began drafting for summer flow augmentation. The August 31 elevation target for Grand Coulee Dam was elevation 1277.8 feet, which included 0.2 feet that was released under the Lake Roosevelt Incremental Storage Release Project. Grand Coulee Dam drafted to elevation 1277.5 feet on August 31. Pumping was reduced to Banks Lake during August, and Banks Lake reached an elevation of 1564.68 feet on August 31.

Hungry Horse Dam

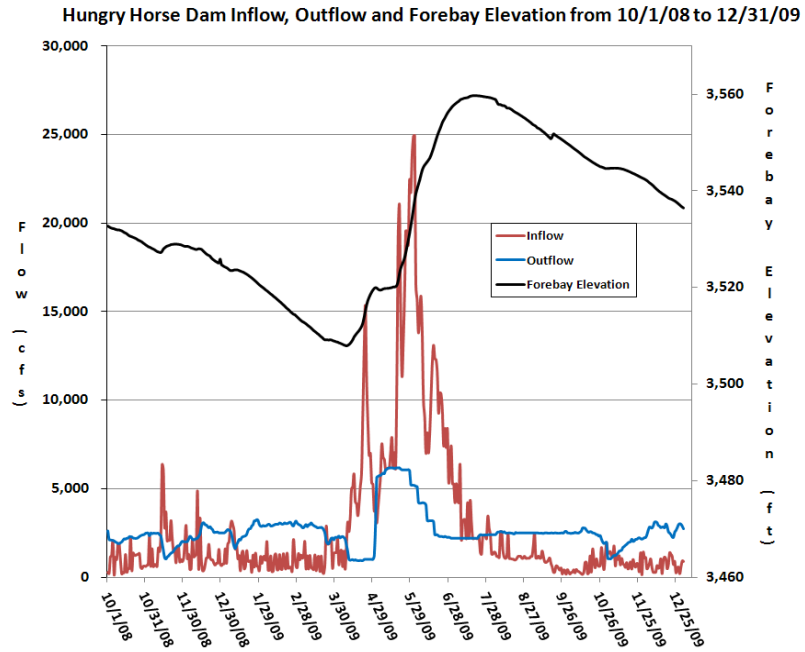

Figure 4. Hungry Horse Dam Inflow, Outflow and Forebay Elevation from October 1, 2008, through December 31, 2009.

Hungry Horse Dam was operated through fall 2008 and throughout 2009 to maintain the minimum flow requirements of 3,500 cfs at Columbia Falls and 900 cfs in the South Fork Flathead River (Figure 4). Minimum flows were for Endangered Species Act (ESA)-listed bull trout and were calculated from a sliding scale based on the Hungry Horse Dam inflow volume forecast. Hungry Horse Dam operations in 2009 followed VARQ flood control procedures. The water supply forecast for Hungry Horse Dam inflow from May to September was at 99 percent of average in January and 99 percent of average by May. Hungry Horse Dam was drafted to elevation 3508.75 feet by April 10 for minimum flow requirements at Columbia Falls. The April 10 elevation objective was 3538.4 feet. Flows were increased to approximately 6 kcfs by May 1 to target refill and to shape the discharges into the spring migration period. Discharges were gradually stepped down during late May and June to fill the reservoir as much as possible and to transition to the forecasted summer flow. During refill and throughout the 2009 water year, Hungry Horse Dam was operated to avoid spill and to limit TDG production in the South Fork of the Flathead River to below Montana's standard of 110 percent. Hungry Horse Dam was operated using the ramping rates as prescribed in the 2000 BiOp (FWS 2000). Hungry Horse Dam refilled to elevation 3559.15 feet on July 19 and then began drafting for summer flow augmentation.

Hungry Horse Dam was operated to provide a stable flow operation during the summer flow augmentation period while targeting a September 30 elevation of 3550 feet. The average flow from July through September was 2.4 kcfs, and Hungry Horse Dam reached elevation 3549.7 feet on September 30.

Albeni Falls Dam

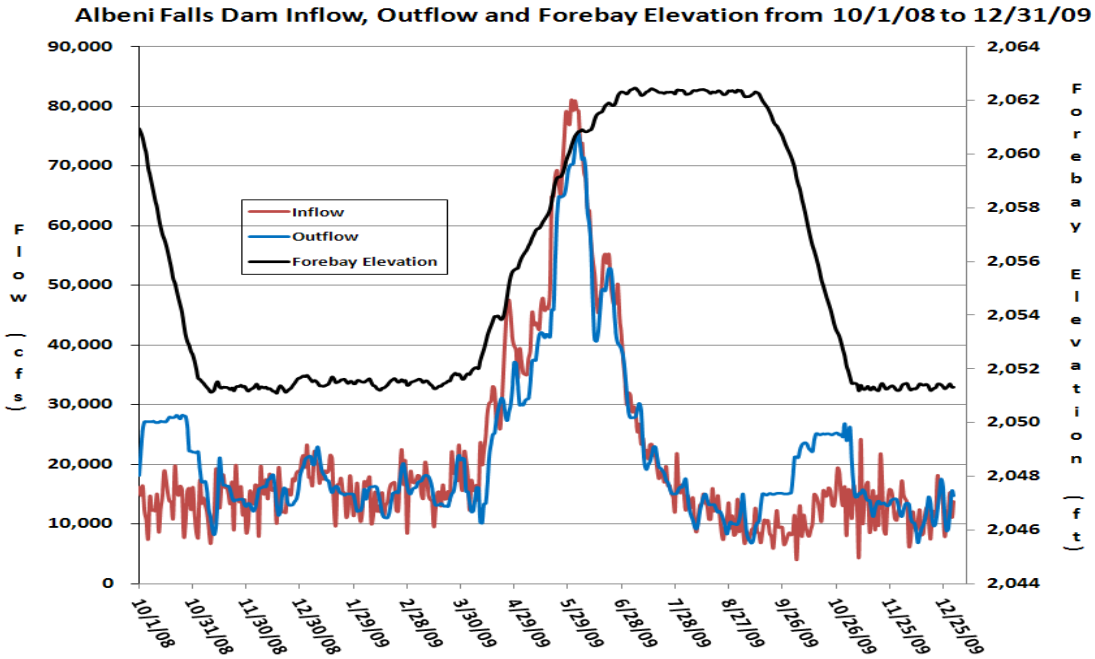

Figure 5. Albeni Falls Dam Inflow, Outflow and Forebay Elevation from October 1, 2008, through December 31, 2009.

The project was operated to standard flood control criteria (Figure 5). Lake Pend Oreille was drawn down to a minimum control elevation (MCE) of 2,051 feet for kokanee spawning in November 2008 after interagency coordination consistent with the USFWS' 2000 FCRPS BiOp (FWS 2000). The lake was operated between elevations 2051 and 2052 feet for kokanee incubation from January through early April in 2009. Refill of Lake Pend Oreille started April 7, and the lake reached its target elevation 2062.25 feet by June 27. For the remainder of the summer and until mid-September, the lake elevation was maintained at between 2,062 and 2,062.5 feet. The lake was drawn down mid-

September through early November to reach an MCE of 2,051 feet, as determined through interagency coordination for kokanee spawning. The lake elevation was then held through December at between 2,051 and 2,051.5 feet until the Idaho Department of Fish and Game (IDFG) declared the end of kokanee spawning at the end of December. After the end of spawning was declared, the lake was managed to between 2,051 and 2,052 feet.

RPA Action 5 – Lower Columbia and Snake River Operations: *The Action Agencies will operate the FCRPS run-of-river mainstem lower Columbia River and Snake River projects (Bonneville, The Dalles, John Day, McNary, Ice Harbor, Lower Monumental, Little Goose and Lower Granite projects) to minimize water travel time through the lower Columbia and Snake rivers to aid in juvenile fish passage. These run-of-river operations will be included in the annual WMP (see RPA Action 6).*

The 2009 WMP included operations for these run-of-river projects. The projects were operated consistent with the WMP and the FOPs to minimize water travel time through the lower Columbia and Snake rivers to aid in juvenile fish passage and water temperature management. River operators do as much as possible to manage flows to help fish while also managing for flood risk and safe navigation. Specific operating rules, including earmarking amounts of water for fish flows, are used at individual reservoirs to provide salmon flows, protect resident fish, control floods, and operate for navigation and other authorized purposes. Further discussions of these operations are included in the minutes of the TMT meeting "Annual Review of Lessons Learned 2009" at *http://www.nwd-wc.usace.army.mil/tmt/agendas/2009/1211min.pdf*

Lower Monumental, Ice Harbor, Little Goose, and Lower Granite projects operated at minimum operating pool (MOP) from April 7 through September 3, in full coordination with regional forums. In a few instances, pool levels went outside of MOP criteria for a short time due to navigation safety issues, primarily for passage of fish barges.

The storage projects in the Columbia and Snake river systems, which are described under RPA action 4 above, have limited ability to shape natural runoff. This limited storage capability can be managed to make modest adjustments in river flows for fish but cannot convert a dry water year into a much better one or save water from a wet year for future dry years. As a result, flow objectives for juvenile fish are goals that cannot be physically achieved under many conditions. The flow objectives were used for pre-season planning and in-season water management to guide decision making. Figures 6, 7, and 8 show the observed outflow at McNary, Lower Granite, and Priest Rapids dams relative to the flow objectives.

In 2009, the Columbia River had a below average water year, with the January through September volume as measured at The Dalles Dam at 84 percent of average. Spring precipitation in the Snake River Basin brought up Snake River flows to 96 percent of average for the same period. On the Columbia River mainstem, during the spring flows preliminarily spiked at The Dalles in mid-April and then dropped again until early May with steadily increasing flows for the rest of May. Flows peaked the second week of June and then steadily receded. John Day Dam was operated at 262.5 to 264 feet from April 10 through September 30, 2009.

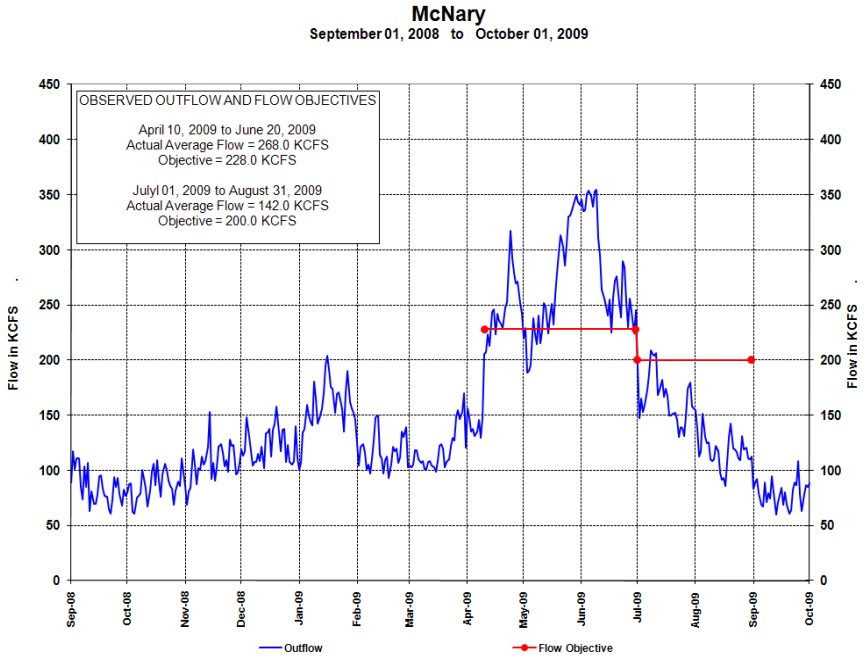

Figure 6. McNary Dam, Observed Outflow and Flow Objectives. The flow objectives are not achievable in all water conditions; rather they are used for pre-season planning and in-season water management to guide decision making.

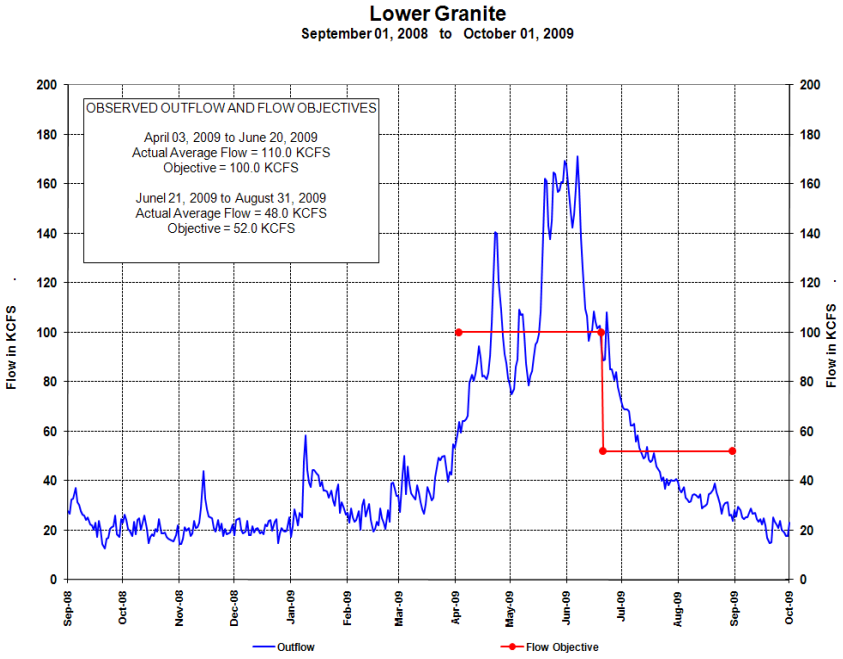

Figure 7. Lower Granite Dam, Observed Outflow and Flow Objectives. The flow objectives are achievable in all water conditions; rather they are used for pre-season planning and in-season water management to guide decision making.

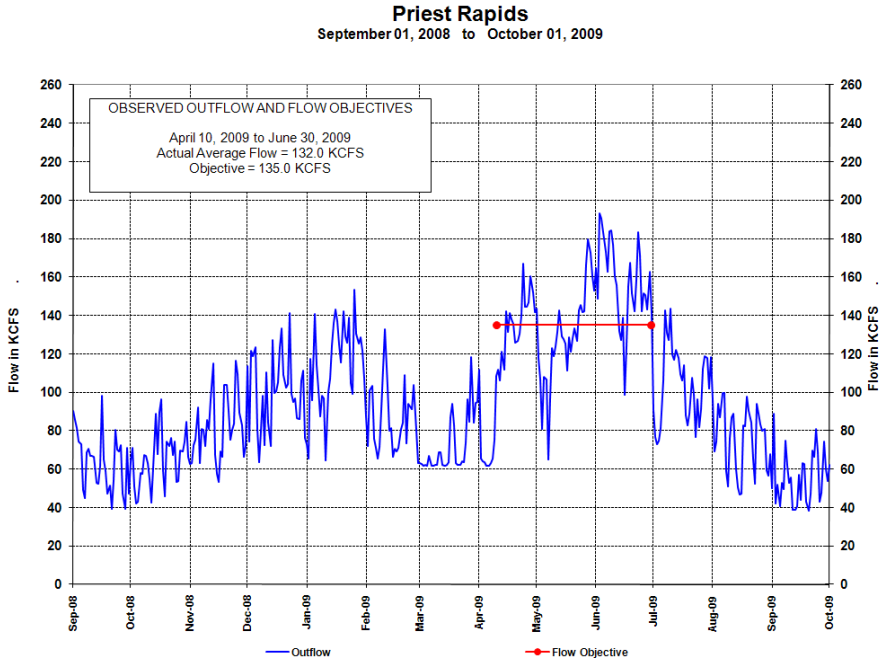

Figure 8. Priest Rapids Dam, Observed Outflow and Flow Objectives. The flow objectives are not achievable in all water conditions; rather they are used for pre-season planning and in-season water management to guide decision making.

RPA Action 6 – In-Season Water Management: *Prioritization of the use of flow augmentation water is done through in-season management by the Regional Forum. Each fall, the Action Agencies will prepare an annual Water Management Plan (WMP) and seasonal updates that describe planned hydrosystem fish operations for the upcoming fall and winter, and for the spring, and summer passage seasons. The annual WMP strives to achieve the best possible mainstem passage conditions, recognizing the priorities established in the FCRPS BA and the need to balance the limited water and storage resources available in the region. Fall/winter and spring/summer updates are prepared as more data is available on the water conditions for that year. A draft update of the WMP will be prepared by October 1 each year, with a final plan completed by January 1. The fall/winter update to the WMP will be drafted by November 1 and finalized by January 1. A draft of the spring/summer update to the WMP will be prepared by March 1 and finalized by May 15.*

The annual WMP for the 2009 operating season (October 1, 2008, through September 30, 2009) and the 2010 operating season (October 1, 2009, through September 30, 2010) were developed collaboratively with the region in accordance with the 2008 BiOp.

In fall 2008, the Action Agencies developed the WMP for the 2009 operating season. A draft of the 2009 spring/summer update to the 2009 WMP was released on March 1, 2009, and the final spring/summer update was released on May 15, 2009.

A draft of the WMP for the 2010 operating season was released on October 1, 2009, and the fall/winter update was released on November 1, 2009. The final WMP was released on December 31, 2009, and the final fall/winter update was released on December 31, 2009.

RPA Action 7 – Forecasting and Climate Change / Variability: *The Action Agencies will hold annual forecast performance reviews looking at in-place tools for seasonal volume forecasts and to report on the effectiveness of experimental or developing/emerging technologies and procedures. As new procedures and techniques become available and are identified to have significant potential to reduce forecast error and improve the reliability of a forecast, the Action Agencies will discuss the implementation possibilities with regional interests. The purpose is to improve upon achieving upper rule curve elevations by reducing forecasts errors and thereby providing for improved spring flows. The Action Agencies will work collaboratively with other agencies and research institutions to investigate the impacts of possible climate change scenarios to the Pacific Northwest and listed salmon and steelhead. Focus areas will cover 1) modeling the hydrology and operations of the Columbia River system using possible future climate change scenarios, 2) investigating possible adaptation strategies for the*

system, 3) monitoring the hydrologic system for trends, cycles, and changes, and 4) staying abreast of research and studies that address climate cycles, trends, and modeling.

Columbia River Forecast Group

The Action Agencies and Fish Accord partners formed the Columbia River Forecast Group (CRFG) to collaboratively implement this RPA action. The CRFG spent most of 2009 developing a charter and organizational structure as well as organizing expectations and a strategy for the group. Under the terms of the charter, the CRFG is also open for participation from any representative of a governmental organization, academic institution, or invited guests of the CRFG who are willing to contribute to the effectiveness and success of the group. Even as the start-up process was proceeding, two workshops were held to review the performance of the previous year's forecasts and to hear speakers on various topics related to water supply forecasting. The first workshop was in March 2009 (to review water year 2008), and a second was held in December 2009 (to review water year 2009).

The March 12, 2009, workshop was attended by numerous agencies including the Natural Resources Conservation Service, NWRFC, U.S. Geological Survey (USGS), Washington Department of Ecology (WDOE), NOAA Fisheries, Columbia River Inter-Tribal Fish Commission (CRITFC), Bonneville Power Administration (BPA), U.S. Army Corps of Engineers (Corps), Bureau of Reclamation (Reclamation), Northwest Power and Conservation Council (NPCC), and BC Hydro and Power Authority. The morning session included brief overviews of the water supply forecast procedures used in 2008 as well as an assessment of the performance of the procedures during the past water year. Also included in the workshop were sessions ranging from new applications developed to utilize Ensemble Streamflow Predictions (ESP) to ongoing work evaluating glacial changes on future water supply. With climate change being part of the group's focus, the workshop included several talks addressing current work on developing climate change streamflow scenarios for the Columbia River Basin and a project to evaluate the impacts of climate change on water supply forecast procedures over time.

The December workshop recapped the 2009 water year forecast performance and included speakers addressing topics such as extended range weather forecasting, use of various teleconnection parameters for use in extended range forecasting, Geographical Information System (GIS) and other modeling tools, and an update regarding the Corps' flood risk management modeling work for the Columbia River Treaty 2014/2024 Review. A portion of the workshop was also set aside for discussion regarding the feasibility of using mid-month updating for water supply forecasting and, therefore, more frequent updates of end-of-month flood control target elevations. This discussion provided information and guidance for the development of test cases for looking at the value of mid-month updates, which was to be incorporated in the group's workplan for 2010.

Toward the end of 2009, the group developed a workplan for 2010 to address specific issues surrounding water supply forecasting and implementation. In general the 2010 workplan includes:

- Working with the Corps on its efforts to improve the water supply forecast equations for Libby Dam through evaluation of various climate indices.
- Working with BPA and the Columbia River Treaty Hydrometeorological Committee to look at the benefits of additional snow pillows in the Columbia Basin in British Columbia.
- Working with the Corps and Reclamation to assess the benefits of mid-month water supply forecast updates. The effort entails looking at two test locations: Hungry Horse and Dworshak dams.
- Develop an Annual Report and report format for the group that includes an appendix that will track water supply forecast performance each year.

Climate Change Study

The Action Agencies have been collaborating on the development of a climate change and hydrology dataset to be used in their longer-term planning models in the Columbia-Snake River Basin and to

adopt a set of methods for incorporating these data into these longer-term planning models. The purpose of adopting such data and methods is to promote consistent incorporation of regional climate projection information in the agencies' planning efforts, and to promote efficient development of these data and methods by pooling agency resources.

The Action Agencies met with outside agencies including National Oceanic and Atmospheric Administration (NOAA) Fisheries, NPCC, and CRITFC to coordinate a work plan ("Climate and Hydrology Dataset for Use in the RMJOC Agencies Longer Term Planning Studies") for the development of these climate change datasets and to filter through existing global circulation models. The group agreed on a subset of scenarios for further work. Runoff scenarios were generated by the University of Washington's Climate Impacts Group (CIG) and reviewed by the Action Agencies. CIG used temperature and precipitation data input from global circulation models with a variety of emissions scenarios to create data sets of unregulated flows at 297 locations in the Columbia River Basin.

The Action Agencies selected a subset of the CIG data resulting in 18 data sets of monthly future regulated flows at all key points in the FCRPS using system reservoir models. The 18 data sets included twelve "hybrid-delta" data sets of future runoff of the Columbia River that reflected 30-year periods centered around 2020 (six scenarios) and 2040 conditions (six additional scenarios). In addition, six "transient" data sets, which are time-evolving temperature and precipitation data sets beginning in 1950 evolving through 2099, were also selected. Future work in 2010 is expected to be the development of 1) additional inflow data by Reclamation for its projects in tributaries to the mainstem Columbia River 2) water supply forecasts reflecting the respective climate change conditions for each scenario for key points across the entire Columbia-Snake River Basin, 3) flood control regulation modeling by the Corps, and 4) reservoir regulation modeling of the FCRPS by BPA to assess the climate change impacts to reservoirs, generation, inflows and major ESA fish flow objectives for the Columbia River Basin. The climate change study officially began in October 2009 and is scheduled for completion in spring 2011.

RPA Action 8 – Operational Emergencies: *The Action Agencies will manage interruptions or adjustments in water management actions, which may occur due to unforeseen power system, flood control, navigation, dam safety, or other emergencies. Such emergency actions will be viewed by the Action Agencies as a last resort and will not be used in place of operations outlined in the annual WMP. Emergency operations will be managed in accordance with TMT Emergency Protocols, the Fish Passage Plan (FPP) and other appropriate Action Agencies emergency procedures. The Action Agencies will take all reasonable steps to limit the duration of any emergency impacting fish.*

No operational emergencies occurred in 2009.

RPA Action 9 – Fish Emergencies: *The Action Agencies will manage operations for fish passage and protection at FCRPS facilities. They may be modified for brief periods of time due to unexpected equipment failures or other conditions. These events can result in short periods when projects are operating outside normal specifications due to unexpected or emergency events. Where there are significant biological effects of more than short duration resulting from emergencies impacting fish, the Action Agencies will develop (in coordination with the in-season management Regional Forum and implement appropriate adaptive management actions to address the situation. The Action Agencies will take all reasonable steps to limit the duration of any fish to limit emergency.*

Two "fish emergency" situations occurred during 2009, one at Lower Granite Dam and one at McNary Dam:

Lower Granite Dam: Fish collection for routine transport at Lower Granite Dam continued until the operation was temporarily stopped on May 22 due to excessive debris entering the collection system and clogging the incline dewatering screen. These conditions caused injury and mortality to fish present in the collection system (screens, raceways, and sampling tanks). NOAA Fisheries and TMT representatives were notified of the change in operations on May 22. Corps personnel calculate that a total of over 500,000 juvenile salmonids passed Lower Granite Dam on May 22, with a total of 721 juvenile fish mortalities associated with the debris conditions. These mortalities included 347 clipped yearling Chinook, 104 unclipped yearling Chinook, 60 clipped subyearling Chinook, 54 unclipped

subyearling Chinook, 37 clipped steelhead, 9 unclipped steelhead, 23 clipped sockeye, 6 unclipped sockeye, and 81 coho. In addition, project personnel noted that an undetermined number of impacted fish exited the bypass system, increasing the overall total number of mortalities. The 721 known mortalities represent approximately 0.14 percent of the total number of juvenile fish estimated to have passed Lower Granite Dam on May 22. Fish collection for transport operations at Lower Granite Dam resumed on May 25 after debris levels subsided, with notification to TMT representatives on May 26.

McNary Dam: Water temperatures at the McNary Juvenile Fish Facility increased rapidly on July 16-18, resulting in temperatures ranging from 64 degrees Fahrenheit in the gatewells to 71 degrees Fahrenheit in the bypass system. It is believed this relatively large temperature change, which continued until July 24, stressed fish passing through the system and contributed to elevated juvenile mortality. The average daily facility mortality rate between July 16 and July 22 was 8.8 percent, peaking at 17.1 percent on July 18 (11,101 fish mortalities occurred, of which an estimated 405 were listed Chinook). The north powerhouse turbine unit operating priority began on July 17 for temperature abatement as described in the Fish Passage Plan (FPP). The Juvenile Fish Facility switched to primary bypass on July 22 until July 23. In addition, on July 21, several regional fish managers submitted a System Operational Request (SOR) to the TMT requesting an increase in spill from 50 percent of project outflow to 24-hour spill to the gas cap to pass as many fish as possible via the spillway. As requested in the SOR and supported by TMT members, the Corps began gas cap spill at McNary Dam at 1300 hours on July 22, 2009. At 1300 hours on July 24, the Corps achieved all the criteria outlined in the SOR and resumed 50 percent spill. Fish transport operations changed from alternate-day departures to daily departures on July 24 and continued through August 16. This reduced fish holding times in the raceways. By July 24, fish mortalities returned to the normally observed low levels as a result of reduced temperature gradients and reduced fish holding times.

In both instances, these actions were coordinated with the region through the TMT process.

RPA Action 10 – Describe actions taken to provide 1 MAF of treaty storage: *BPA and the Corps will pursue negotiations with Canada of annual agreements to provide 1 MAF of storage in Treaty space by April 15 consistent with:*

- *Providing the greatest flexibility possible for releasing water to benefit U.S. fisheries May through July.*
- *Giving preference to meeting April 10 upper rule curve elevation or achieving refill at Grand Coulee Dam over flow augmentation storage in Canada in lower water supply conditions.*
- *Releasing flow augmentation storage to avoid causing damaging flow or excessive TDG in the United States or Canada.*
- *BPA and the Corps will coordinate with Federal agencies, States and Tribes on Treaty operating plans.*

The Columbia River Treaty Operating Committee Agreement on Operation of Treaty Storage for Non-Power Uses for December 15, 2008, through July 31, 2009, (Non-Power Uses Agreement) was executed on December 20, 2008. Under this agreement, 1 maf of flow augmentation water was stored in Mica Reservoir during January 2009. All flow augmentation storage was released by July 31, 2009, under the Non-Power Uses Agreement. Treaty operations were coordinated during fall 2009 stakeholder briefings.

RPA Action 11 – Non-Treaty Storage: *BPA, in concert with BC Hydro, will refill the remaining non-Treaty storage space by June 30, 2011, as required under the 1990 non-Treaty storage agreement. Refill will be accomplished with minimal adverse impact to fisheries operations.*

Some progress was made in return of non-Treaty Storage, with BPA filling to nearly match the BC Hydro storage. At the end of 2009 the BC Hydro account remained at 88.4 percent of full and the U.S. Parties accounts stood at 88.3 percent full. BPA filled 223 ksfd (A “ksfd” is a thousand-second-foot-day, a volume of water sufficient to provide a flow of 1,000 cubic feet per second for a 24-hour period, or approximately 1983 acre-feet) between September 2008 and February 2009, with no activity in the accounts after February for the balance of the year.

RPA Action 12 – Non-Treaty Long-Term Agreement: *BPA will seek to negotiate a new long-term agreement on use of non-Treaty space in Canada so long as such an agreement provides both power and non-power benefits for BC Hydro, BPA, and Canadian and U.S. interests. As part of these negotiations, BPA will seek opportunities to provide benefits to ESA-listed fish, consistent with the Treaty. If a new long-term, non-Treaty agreement is not in place, or does not address flows for fisheries purposes, BPA will approach BC Hydro about possibly negotiating an annual/seasonal agreement to provide U.S. fisheries benefits, consistent with the Treaty.*

Before approaching BC Hydro to negotiate a new long-term, non-treaty storage (NTS) agreement, BPA has committed to the following:

- Substantial refilling of the U.S. NTS account
- The Dry Year Strategy Work Group defining potential use of NTS in dry years
- Coordinating with federal agencies, states, and tribes under the BiOp
- Coordinating with tribes under the Fish Accords
- Establishing the collective U.S. interests in terms of such a new NTS agreement

In addition, BC Hydro has agreed to coordinate with Canadian stakeholders regarding reservoir impacts in Canada. Stakeholder coordination in Canada and the United States began in fall 2009.

An annual NTS agreement was negotiated in 2009 between BPA and BC Hydro. During June 2009 a total of 56 ksfd was stored to reduce inflow to Grand Coulee Dam during the peak of freshet period. This storage was released from late July through early September.

RPA Action 13 – Non-Treaty Coordination with Federal Agencies, States, and Tribes: *Prior to negotiations of new long-term or annual non-Treaty storage agreements, BPA will coordinate with Federal agencies, States, and Tribes to obtain ideas and information on possible points of negotiation, and will report on major developments during negotiations.*

No long-term storage agreement was negotiated in 2009, but coordination continued with federal agencies, states, and tribes to obtain information, ideas, and viewpoints for possible future negotiations.

RPA Action 14 – Dry Water Year Operations: *Flow management during dry years is often critical to maintaining and improving habitat conditions for ESA-listed species. A dry water year is defined as the lowest 20th percentile years based on the Northwest River Forecast Center's (NWRFC) averages for their statistical period of record (currently 1971 to 2000) using the May final water supply forecast for the April to August period as measured at The Dalles. The Action Agencies will complete the following activities to further the continuing efforts to address the dry flow years:*

- *Within the defined "buckets" of available water (reservoir draft limits identified in RPA Action 4), flexibility will be exercised in a dry water year to distribute available water across the expected migration season to optimize biological benefits and anadromous fish survival. The Action Agencies will coordinate use of this flexibility in the Regional Forum TMT.*
- *In dry water years, operating plans developed under the Treaty may result in Treaty reservoirs being operated below their normal refill levels in the late spring and summer, therefore, increasing flows during that period relative to a standard refill operation.*
- *Annual agreements between the U.S. and Canadian entities to provide flow augmentation storage in Canada for U.S. fisheries needs will include provisions that allow flexibility for the release of any stored water to provide U.S. fisheries benefits in dry water years, to the extent possible.*
- *BPA will explore opportunities in future long-term NTS storage agreements to develop mutually beneficial in-season agreements with BC Hydro to shape water releases using NTS space within the year and between years to improve flows in the lowest 20th percentile water years to the benefit of ESA-listed ESUs, considering their status.*
- *Upon issuance of the FCRPS Biological Opinion, the Action Agencies will convene a technical workgroup to scope and initiate investigations of alternative dry water year flow strategies to enhance flows in dry years for the benefit of ESA–listed ESUs.*
- *In very dry years, the Action Agencies will maximize transport for Snake River migrants in early spring, and will continue transport through May 31.*
- *BPA will implement, as appropriate, its Guide to Tools and Principles for a Dry Year Strategy to reduce the effect energy requirements may pose to fish.*

Because the 2009 water year did not meet the definition for a dry year, the dry year strategy was not implemented.

The dry year strategy technical work group held a meeting on November 19, 2009. Participants included Action Agencies, NOAA Fisheries, and representatives from the Colville tribe, CRITFC, and NPCC. Discussion covered a wide range of topics such as what to include in the BaseCase hydro modeling, proposed operating alternatives (what actions to consider), when to initiate dry year operations, and how to perform the biological analysis. This group agreed on the overall study objectives, agreed on the general study steps, and defined the first alternative for modeling.

The biological sub-group and COMPASS modeling group met several times in 2009 and made some progress in the development/expansion of the Comprehensive Fish Passage Model (COMPASS) to include the mid-Columbia and identified numerous challenges for assessing operational effects on fall Chinook or chum.

RPA Action 15 – Water Quality Plan for Total Dissolved Gas and Water Temperature in the Mainstem Columbia and Snake Rivers: *The Action Agencies will continue to update the Water Quality Plan for Total Dissolved Gas and Water Temperature in the Mainstem Columbia and Snake Rivers (WQP) and implement water quality measures to enhance ESA-listed juvenile and adult fish survival and mainstem spawning and rearing habitat.*

The Water Quality Plan for Total Dissolved Gas and Water Temperature in the Mainstem Columbia and Snake Rivers (ACOE 2009) was updated in January 2009. The 2009 plan was coordinated among the Corps and regional federal, state, local, and tribal stakeholders and was tied to other past and current water quality efforts in the region. This document sets forth the Corps' plan concerning water quality in the mainstem Columbia and Snake rivers, including actions called for in the 2008 BiOp that pertain to improving water quality for ESA-listed salmon and steelhead and applicable TMDLs. (Currently there are three TMDLs for TDG in the lower Columbia River, lower Snake River, and middle Columbia River, which are in effect until 2020.)

Real-time monitoring and reporting of TDG and temperatures measured at fixed monitoring sites:

The Dissolved Gas Monitoring Plan of Action was updated for 2009 and is included as Appendix B of the 2009 Annual TDG and Temperature Report. Access to the data is available at *http://www.nwd-wc.usace.army.mil/tmt/wqnew/tdg_and_temp/2009/*.

Continued development of fish passage strategies with less production of TDG:

Four efforts were implemented to further develop fish passage strategies and reduce TDG through structural and operational alternatives in 2009:

- Chief Joseph Dam: A post-construction spill test was conducted in 2009 to evaluate TDG production with the completed flow deflectors. The final report is expected to be released in 2010.
- Little Goose Dam: Installed surface spillway weir in spillbay 1, along with flow deflectors in spillbays 1 and 8, prior to start of juvenile fish migration season.
- John Day Dam: Construction continued on the John Day Spill Bay 21 flow deflector (Construction was completed in first quarter of 2010).
- The Dalles Dam: Construction continued on the spillwall between spillbays 8 and 9 at The Dalles Dam (Construction was completed in March 2010). This project is expected to improve juvenile egress conditions without the need to increase spill, which would increase TDG.

Update the SYSTDG model to reflect modifications to spillways or spill operations:

The System Total Dissolved Gas (SYSTDG) model was used as a real-time decision support tool to manage spill at lower Columbia and Snake river projects. The model was updated to incorporate the spillway flow deflectors at Chief Joseph Dam and spill pattern changes that were implemented in 2009.

Continued development and use of SYSTDG model for estimating TDG production to assist in real-time decision making, including improved wind forecasting capabilities as appropriate:

After completion of the fish migration season, the Corps performed a statistical evaluation of the predictive errors based on observed TDG levels during the 2009 fish passage season to quantify the uncertainty of SYSTDG estimates and improve modeling accuracy and reliability. The results of this analysis are included as Appendix G of the *2009 Dissolved Gas and Water Temperature Monitoring Report* at *http://www.nwd-wc.usace.army.mil/tmt/wqnew/tdg_and_temp/2009/*. Wind forecast improvements were not incorporated into SYSTDG in 2009.

Continued development of the CEQUAL-W2 model for estimating river temperatures from Dworshak Dam on the Clearwater and Upper Snake River near the confluence with the Grand Ronde River (USGS Anatone gauge) through the lower Snake River (all four Corps lower Snake River projects) to assist in real-time decision making for Dworshak Dam operations:

The CE-QUAL-W2 model was used from late June through mid-August 2009 to support decisions regarding operation of Dworshak Dam for flow augmentation and temperature management on the lower Snake River. The results were presented and discussed routinely with TMT members and Action Agencies to develop best management strategies.

The Corps' Walla Walla District made improvements in pre-processing data that resulted in more efficient model execution.

Expand water temperature modeling capabilities to include Columbia River from Grande Coulee to Bonneville dams to better assess the effect of operations or flow depletions on summer temperatures:

In 2009, the Corps submitted funding requests to initiate the effort to expand temperature modeling capabilities to include the middle and lower Columbia River. Initial work efforts are expected to begin in 2010.

Investigate alternatives to reduce total mass loading of TDG at Bonneville Dam while maintaining juvenile survival performance:

The Action Agencies performed base-case and alternative spill model simulations to evaluate alternative summer spill operations at Bonneville Dam. Testing of final alternatives is expected to occur in 2010.

Continued operation of the Lower Snake River projects at MOP:

All lower Snake River projects were operated at MOP for the 2009 fish passage season. This operation is recommended because reducing the cross section of the reservoirs may assist in moderating river temperatures. See additional information under RPA action 5.

RPA Action 16 – Tributary Projects: *The tributary projects that have not yet completed ESA Section 7 consultation are located in the Yakima, Okanogan, and Tualatin river basins. Reclamation will, as appropriate, work with NOAA Fisheries in a timely manner to complete supplemental, project-specific consultations for these tributary projects. These supplemental consultations will address effects on tributary habitat and tributary water quality, as well as direct effects on salmon survival in the tributaries. The supplemental consultations will address effects on mainstem flows only to the extent to which they reveal additional effects on the in-stream flow regime not considered in the FCRPS and Upper Snake River BA/Comprehensive Analysis.*

Reclamation is working on ESA Section 7 consultations for the Yakima, Okanagan, and Tualatin Project operations. Biological Assessments (BA) have been submitted to NOAA Fisheries for all these projects.

Reclamation completed work on a draft supplement to the 2000 BA for the Yakima Project. NOAA Fisheries and USFWS have suggested that Reclamation should consider delaying submission of the supplement until issues associated with the Yakima Basin Work Group/Basin Study are resolved so that potential actions coming from those efforts can be incorporated into the supplement.

NOAA Fisheries requested a time extension to complete work on the Okanogan Project BiOp, which was granted. During this period, Reclamation and NOAA Fisheries have been investigating the potential for refining the proposed action.

Clarifying information has been provided to NOAA Fisheries for use in developing a BiOp for the Tualatin Project, now scheduled for completion in 2012.

RPA Action 17 – Chum Spawning Flows: *Provide adequate conditions for chum spawning in the mainstem Columbia River in the area of the Ives Island complex and/or access to the Hamilton and Hardy Creeks for this spawning population.*

2008-2009 Operation

For chum tailwater readings, the official gauge is 0.9 mile downstream from Bonneville Dam's first powerhouse, 50 feet upstream from Tanner Creek, and at River Mile (RM) 144.5

Chum operations were coordinated regularly through the TMT prior to the initiation of chum spawning and through the end of chum emergence. Chum operations were complicated by forebay constraints in place to facilitate the construction of the spillwall at The Dalles Dam. In response, the Action Agencies drafted a plan for operations during chum spawning season. Some of the conditions addressed in the plan included: 1) use of a new gauge installed near The Dalles' spillbay 23, to help with real-time surface elevation monitoring throughout the season; 2) modification of operating restrictions for spillwall construction to support more flexibility of the chum operations; and 3) specific guidance from the salmon managers on real-time management (timing, patterns) of excess water that might enter the system. Excess water was generally discharged at night, when chum tend not to spawn. In addition, the TMT developed contingency plans for managing chum operations that established a priority for actions to be taken to manage excess water if it could not be managed at night.

Beginning November 7, 2008, Bonneville Dam was operated at a tailwater elevation between 11.3 and 11.7 feet. High inflows at times during November and December necessitated deviations to move excess water at night (from 1500 to 0600 hours). The salmon managers recommended the Action Agencies utilize nighttime hours, expand the operating range, and use late afternoon pulses to move excess water. If those steps were insufficient, the Action Agencies were to target a Bonneville Dam tailwater elevation of 12 feet, with an operating range of 11.5-12.5 feet, if necessary, to manage the excess water.

Chum spawning operations ended on December 31, 2008, and the post-spawning and incubation operation began on January 1, 2009.

On January 1, 2009, when operations shifted from a spawning to an incubation operation, a 24-hour minimum tailwater elevation of 11.5 feet took effect to protect chum redds through incubation and the end of emergence. On April 1, 2009, chum emergence was completed.

2009-2010 Operation

The 2009-2010 chum operation began on November 6, 2009. The Action Agencies issued the following guidance to Bonneville Dam to protect spawning chum: 1) maintain a project tailwater elevation of no lower than 11.3 feet during all hours; 2) maintain an 11.3 to 11.7 foot project tailwater elevation between 0600 and 1700 hours daily, with the target elevation of 11.5 feet; and 3) as conditions allow, maintain an 11.3 to 11.7 foot tailwater elevation between 1700 to 0600 hours, with a target elevation of 11.5 feet. The Corps noted spikes on November 8 and 9 were due to higher flows being passed at night (ideally around midnight), pursuant to the protocols in the current teletype for chum spawning operations. During 2009, the abundance of spawning chum salmon was a bit higher compared to 2008; however abundance was still lower than the 10-year average.

On December 30, the TMT agreed with regional salmon managers that chum spawning operations did not need to continue beyond December 30. Based on this information the Action Agencies ended the chum spawning operation at 1600 hours on December 30, 2009.

RPA Action 18 – Configuration and Operation Plan (COP) for Bonneville Project: *The Corps will consider all relevant biological criteria and prepare, in cooperation with NOAA Fisheries and the co-managing agencies, a Configuration and Operational Plan for the Bonneville Project (2008). As part of the first phase of modifications, the Corps will investigate, and implement the following reasonable and effective measures to reduce passage delay and increase survival of fish passing through the forebay, dam, and tailrace as warranted. Initial modifications will likely include:*

Bonneville Powerhouse I

- *Sluiceway modifications to optimize surface flow outlet to improve fish passage efficiency (FPE) and reduce forebay delay (2009).*
- *Minimum-gap turbine runner installation to improve survival of fish passing through turbines (2009)*

Bonneville Powerhouse II

- *Screened bypass system modification to improve fish guidance efficiency (FGE) and reduce gatewell residence time (2008)*
- *Shallow BGS installation to increase Corner Collector efficiency and reduce forebay delay (prototype 2008)*

Bonneville Dam Spillway

- *Spillway operation or structure (e.g., spillway deflectors) modification to reduce injury and improve survival of spillway passed fish; and to improve conditions for upstream migrants (2013).*

The COP will be updated periodically and modifications may be made as new biological and engineering information is gathered. The COP and modifications will be coordinated through the Regional Forum. Comments developed by NOAA Fisheries on the draft COPs shall be reconciled by the Corps in writing to NOAA Fisheries' satisfaction before release of the final COP. If Phase I actions fail to meet the intended biological targets, the COP will be updated to identify additional Phase II actions for further implementation.

- **Powerhouse I Sluiceway Modifications** – Planned sluiceway modifications, including increasing the width of the collection channel, shaping the sluiceway floor, removing the decommissioned juvenile bypass outfall and other components, and automating the sluiceway gates were completed during the 2009-10 winter work period.
- **Powerhouse I Minimum-Gap Turbine Runner Installation** – Installation of minimum-gap runners continued in 2009 (The final minimum-gap runner was installed in 2010).
- **Powerhouse II Screened Bypass System Modifications to Improve Fish Guidance Efficiency** – Improvements to the juvenile bypass system were completed in 2008. The intended purpose of those modifications was to increase the fish guidance efficiency of the juvenile bypass system. Since completion of those modifications, a fish injury problem has been identified. Research to better understand the nature and source of these injuries was conducted during the 2008 and 2009 juvenile fish passage seasons. An alternatives report to evaluate potential solutions to the gatewell injury problem was initiated in 2009 and will be completed in 2011.
- **Powerhouse II Shallow Behavioral Guidance System (BGS) Installation** – A prototype shallow draft BGS was installed in 2008 and evaluated in 2008 and 2009. During the spring 2008, Unit 11, the turbine at the Corner Collector (south) end of Powerhouse II, was taken offline due to mechanical failure. The unit remained offline through the 2009 for evaluation. Pre- and post-BGS results are presented in the Table 2 below.

Table 2. Percent of yearling Chinook, yearling steelhead, and subyearling Chinook passing from the Bonneville Dam Second Powerhouse forebay into the Corner Collector in 2004 and 2005 without the BGS compared to 2008-09 with the BGS. Results from 2004-05 are based on radio telemetry studies (Reagan et. al 2005; Adams et al. 2006); 2008-09 results are based on acoustic telemetry studies (Faber et al. 2009; Faber et al. 2010).

Age / Species	Percent of Second Powerhouse Salmonids that Passed through the Corner Collector		
	2004-05 (No BGS)	2008 (With BGS)	2009 (With BGS)
Yearling Chinook	40%	49%	40%
Yearling steelhead	70%	75%	59%
Subyearling Chinook	40%	40%	52%

- **Spillway Operation or Structure Modification to Reduce Injury and Improve Survival** – An alternatives report that evaluated the cost, feasibility, and potential biological benefits of structural modification to the spillway was completed in 2009.

  Analysis and reporting of biological results from the 2008 spillway survival study were completed in 2009. No other actions were taken in 2009 pending performance testing. Results from 2008 and 2007 studies indicated that subyearling Chinook spillway survival can be increased substantially by changing summer spill operations from 75 kcfs daytime spill to 85 kcfs daytime spill (see Table 3 below).

Table 3. Subyearling Chinook spillway Survival Rates from radio and acoustic telemetry studies at Bonneville Dam, 2004 – 2008. From Counihan et al. 2005a; Counihan et al. 2005b; Ploskey et al. 2007; Ploskey et al. 2008; Ploskey et al. 2009.

Year	Operation	Subyearling Chinook Spillway Passage Survival Rate
2004	48 Day / TDG Cap Night	88%
2005	75 Day / TDG Cap Night	91%
2006	75 Day / TDG Cap Night	86%
2007	85 Kcfs Daytime Only	93% (daytime survival estimate)
2008	85 Day / TDG Cap Night	97%

RPA Action 19 – Configuration and Operation Plan for The Dalles Project: *The Corps will consider all relevant biological criteria and prepare, in cooperation with NOAA Fisheries and the co-managing agencies, a Configuration and Operational Plan for The Dalles Project (2008). As part of the first phase of modifications, the Corps will investigate, and implement the following reasonable and effective measures to reduce passage delay and increase survival of fish passing through the forebay, dam, and tailrace as warranted. Initial modifications will likely include:*

- *Turbine operation optimization to improve overall dam survival (2011)*
- *Extended tailrace spill wall to increase direct and indirect survival of spillway passed fish (2010)*

The COP will be updated periodically and modifications may be altered as new biological and engineering information is gathered. The COP and modifications will be coordinated through the Regional Forum. Comments developed by NOAA Fisheries on the draft COPs shall be reconciled by the Corps in writing to NOAA Fisheries' satisfaction before release of the final COP. If Phase I actions fail to meet the intended biological targets, Phase II actions, as described in the FCRPS BA – Appendix B.2.1 will be considered for further implementation.

The initial COP had already been completed at the time of the BiOp. The key objective of the COP is achievement and maintenance of hydro performance standards. Significant accomplishments at The Dalles Dam in 2009 included the following:

- **Turbine operation optimization to improve overall dam survival** – Completed purchase of a model turbine runner. This will be used in construction of a physical model so that flow patterns can be observed. That data will be used to develop a best operating point hypothesis. Also see RPAs 27 and 55.6.
- **Extended Tailrace Spill Wall to Increase Direct and Indirect Survival of Spillway Passed Fish** – Construction of an extended length spillwall was completed during the 2009-10 winter work period. The 700-foot long spillwall is expected to increase survival to meet juvenile passage dam survival performance standards. Performance testing was carried out during the March 2010 juvenile fish migration season.
- **COP Update** – An update to the COP was completed in 2009. The current version is available at *http://www.nwp.usace.army.mil/pm/e/reports/afep/config/TDA-COP_December2009.pdf*.

RPA Action 20 – Configuration and Operation Plan for John Day Project: *The Corps will consider all relevant biological criteria and prepare, in cooperation with NOAA Fisheries and the co-managing agencies, a Configuration and Operational Plan for the John Day Project (2008). As part of the first phase of modifications, the Corps will investigate, and implement the following reasonable and effective measures to reduce passage delay and increase survival of fish passing through the forebay, dam, and tailrace as warranted. Initial modifications will likely include:*

- *Full-flow bypass and PIT-tag detection installation to reduce handing stress of bypassed fish (2007)*
- *Turbine operation optimization to improve overall dam survival (2011)*
- *Surface flow outlet(s) construction to increase FPE, reduce forebay delay and improve direct and indirect survival (prototype 2008 with final installation by 2013), and improve tailrace egress conditions.*

The COP will be updated periodically and modifications may be altered as new biological and engineering information is gathered. The COP and modifications will be coordinated through the Regional Forum. Comments developed by NOAA Fisheries on the draft COPs shall be reconciled by the Corps in writing to NOAA Fisheries' satisfaction before release of the final COP. If Phase I actions fail to meet the intended biological targets, Phase II actions, as described in the FCRPS BA – Appendix B.2.1, will be considered for further implementation.

Preparation of the COP addendum was continued in 2009, and is expected to be completed in 2011. Significant accomplishments at John Day Dam in 2009 included the following:

- **Full-flow Bypass and PIT-tag Detection Installation** – This action was completed in 2007.
- **Turbine Operation Optimization to Improve Overall Dam Survival –** Work continued in 2009 to develop a best turbine operating point hypothesis to test in 2011. Lab studies to develop an understanding of the effect of the turbine pressure environment on juvenile Chinook were completed in 2009 and a new study to assess the effects of rapid decompression on tagged versus untagged fish was started. Lab data from rapid decompression studies and computational fluid dynamic model data were synthesized to analyze and estimate pressure-related mortalities for turbine-passed fish. The Turbine Survival Program (TSP) team hypothesized that the best operating point for juvenile fish survival at John Day Dam is approximately half way between peak efficiency and the upper one percent of the peak efficiency range. Coordination with John Day Dam operators and BPA on conducting a best turbine operation field test was initiated in 2009. Coordination will continue in 2010 to determine if a field test is feasible, and to develop a test plan. Also see RPAs 27 and 55.6.

- **Surface Flow Outlet(s) Construction** – Two prototype spillway weirs were tested a second year to determine if surface spill near the powerhouse reduces turbine entrainment. Two spill treatments, 30 percent and 40 percent spill, were tested to help design the final configuration, including tailrace improvements. Compared to previous years, the spillway weirs reduced the proportion of juvenile salmonids that pass through turbines (see Table 4 below). An expanded avian wire array was installed in the tailrace to better protect fish from heavy predation by birds observed in 2008. Due to a design flaw, many of the new wires broke during the juvenile migration season, and bird predation was substantial in the summer. After coordination with resource agencies and tribes, the Corps shut down the spillway weirs in the summer and reverted back to the FPP spill pattern. The 40 percent versus 30 percent spill test continued throughout the summer, but without the spillway weirs.

Table 4. Yearling Chinook, steelhead, and subyearling Chinook percent passage through John Day Dam turbines during pre-Top Spill Weir (TSW) years with 24-hour spill (Baseline) and TSW tests in 2008 and 2009. (Beeman et al. 2006; Beeman et al. 2003; Hansel et al. 2003; Weiland et al. 2010; Weiland et al. 2009).

Species/Age	Percent of Fish Passing Through Turbines		
	Baseline (No TSWs)	2008 (w/TSWs)	2009 (w/TSWs)
Yearling Chinook	10-17%	7%	8%
Yearling steelhead	7-15%	3%	3%
Subyearling Chinook	25-30%	17%	NA

Evaluations of alternatives for tailrace modifications continued in 2009 with a focus on an extended length deflector in spill bay 20. The extended deflector was designed, new spill patterns developed with Top Spill Weirs (TSWs) moved to bays 18 and 19, and a new avian wire array designed for the tailrace. Installation of these features was planned for the 2009-10 winter work period.

RPA Action 21 – Configuration and Operational Plan for the McNary Project: *The Corps will consider all relevant biological criteria and prepare, in cooperation with NOAA Fisheries and the co-managing agencies, a Configuration and Operational Plan for the McNary Project (2009). As part of the first phase of modifications, the Corps will investigate, and implement the following reasonable and effective measures to reduce passage delay and increase survival of fish passing through the forebay, dam, and tailrace as warranted. Initial modifications will likely include:*

- *Turbine operation optimization to improve survival of fish passing through turbines (2013)*
- *Improve debris management to reduce injury of bypass and turbine passed fish (2011)*
- *Relocate juvenile bypass outfall to improve egress, direct, and indirect survival on bypassed fish (2011)*
- *Surface flow outlet installation to increase FPE, reduce forebay delay, and improve direct and indirect survival (temporary structure testing in 2007 and 2008 to develop a permanent system)*

The COP will be updated periodically and modifications may be altered as new biological and engineering information is gathered. The COP and modifications will be coordinated through the Regional Forum. Comments developed by NOAA Fisheries on the draft COPs shall be reconciled by the Corps in writing to NOAA Fisheries' satisfaction before release of the final COP. If Phase I actions fail to meet the intended biological targets, Phase II actions, as described in the FCRPS BA – Appendix B.2.1, will be considered for further implementation.

Progress continued in 2009 on surface passage alternative feasibility studies and biological testing of prototype spillway weirs at McNary Dam. Information and data resulting from these actions were incorporated in the selection of alternatives and their associated biological evaluations for the McNary COP. The McNary COP was initiated in 2009, with alternatives identified, screened, and ranked

through the Regional Forum. Completion of the COP is expected in 2011. Significant accomplishments at McNary Dam in 2009 included the following:

- **Turbine operation optimization to improve survival of turbine passed fish** – A Biological Index Test (BIT) was planned for 2009 to evaluate operating turbines above the upper end of the 1 percent efficiency range at McNary Dam. The evaluation was limited to operations within 1 percent due to concerns of potential gatewell descaling raised in the Studies Review Work Group (SRWG) forum. A gatewell descaling evaluation is being conducted in 2010 at McNary Dam.
- **Debris management** – An evaluation of the existing screen cleaning data and consultation with project staff was conducted to initiate the process for improving debris management at McNary Dam. Preliminary analysis of available screen cleaning data showed little correlation between descaling detected at the McNary Dam fish facility and screen cleaning events. Further data collection and analysis will be conducted in 2010.
- **Juvenile Bypass Outfall Relocation Site Selection** – The McNary Dam outfall relocation project entered the design and site selection phase. Progress in 2009 included modeling visits to the Corps' Engineer Research and Development Center (ERDC), visual tracking data modeling, estimates of potential survival improvements and a literature review of related predator information. Modeling efforts narrowed the potential site locations to a zone well downstream of the existing outfall.
- **Surface Flow Outlet Installation - Prototype Spillway Weir Evaluation** – In 2009, the third year of biological testing was conducted to assess relative juvenile survival, passage efficiencies, and forebay behavior while operating two prototype spillway weirs. In 2007, the weirs were installed in spillbays 20 and 22. During 2008, the weir in spillbay 22 was moved to spillbay 19 to investigate whether this configuration would improve biological performance. In 2009, the weir in spillbay 19 was moved to spillbay 4 for the spring outmigration. Spill operations maintained for this test and biological performance are discussed below.
- Evaluation of Survival and Passage Rates with Respect to Spill Operations – During the spring fish passage season a single treatment test of 40 percent spill was undertaken. After May 20, there was also an involuntary spill that took the overall spill level above 40 percent for 80 percent of the remaining days during the spring spill period. This was not a distinct break in flow volume as in 2008, and the subsequent survival and passage analysis was provided as a single estimate for the entire spring migration period. It was found that a shift occurred in spillway weir passage, for both steelhead and yearling Chinook, when spillway weir 1 was shifted from the south end of the spillway (spillbay 19 in 2007 and spillbay 22 in 2008) to the north in 2009 (spillbay 4). Steelhead passage over the spillway weirs dropped from 67.4 percent in 2007 to 41.6 percent in 2008 and 34.9 percent in 2009. Yearling Chinook passage over spillway weirs was also lower during 2009 than 2007-2008. The total discharge was similar for the three years, but the late season involuntary spill was present during 2008-2009, and surface flow outlets are generally less effective at passing fish at higher flow levels. The relative concrete survival estimates exceeded the performance standard for steelhead (99.2 percent) and yearling Chinook (97.2 percent) during 2009.
- The summer passage season test was a single treatment of 50 percent spill, and subyearling Chinook were tagged for a telemetry evaluation. This was the first year for estimating survival at 50 percent, and average flow was lower than 2006-2008 when we tested the 40 percent vs. 60 percent spill treatments. With 50 percent spill during 2009, subyearling Chinook passage through the spillway weirs was notably higher than had been estimated during 2008. The primary passage difference was in the number passing spillway weir 1. The average summer flow volume was lower in 2009 than in 2008, which appears to make smolts more readily utilize a surface passage route. The relative concrete survival estimate with 50 percent spill for

subyearling Chinook was 89.2 percent, which did not meet the performance standard. This was influenced heavily by mortality attributable to thermal shock which occurred beginning around July 18. It is believed that passing smolts were being rapidly transitioned through water where the temperature differential was roughly 6 degrees Fahrenheit, inducing thermal shock and subsequent mortality. This water temperature issue emerged around July 17, after which time the measured survival for passing subyearlings declined precipitously from earlier estimates. Powerhouse units were being run at a slightly higher level on the north end of the powerhouse, and this is thought to have contributed to the thermal shock thought to have been inducing mortality.

RPA Action 22 – Configuration and Operation Plan for the Ice Harbor Project: *The Corps will consider all relevant biological criteria and prepare, in cooperation with NOAA Fisheries and the co-managing agencies, a Configuration and Operational Plan for the Ice Harbor Project (2008). As part of the first phase of modifications, the Corps will investigate, and implement the following reasonable and effective measures to reduce passage delay and increase survival of fish passing through the forebay, dam, and tailrace as warranted. Initial modifications will likely include:*

- *Guidance screen modification to improve FGE (2010)*
- *Turbine operation optimization to improve survival of turbine passed fish (2011)*
- *Spillway chute and/or deflector modification to reduce injury and improve survival of spillway passed fish through the RSW (2009)*
- *Turbine unit 2 replacement to improve the survival of fish passing through turbines and reduce oil spill potential (2012)*

The COP will be updated periodically and modifications may be altered as new biological and engineering information is gathered. The COP and modifications will be coordinated through the Regional Forum. Comments developed by NOAA Fisheries on the draft COPs shall be reconciled by the Corps in writing to NOAA Fisheries' satisfaction before release of the final COP. If Phase I actions fail to meet the intended biological targets, Phase II actions, as described in the FCRPS BA – Appendix B.2.1, will be considered for further implementation.

The Ice Harbor COP, initiated in 2007, was further developed in 2008 with alternatives refined and screened. A draft was released for regional review in December 2008. Review continued through 2009. Completion of the COP is now scheduled for 2011. Significant accomplishments at Ice Harbor Dam in 2009 included the following:

- **Guidance Screen Modification to improve fish guidance efficiency (FGE)** – Due to a lack of regional support, this action has been deferred indefinitely, and it was not included in the draft COP.
- **Turbine operation optimization to improve survival of turbine passed fish** – See RPA actions 27 and 55.6.
- **Design Documentation Report Phase I Ice Harbor Unit 2 Test Turbine** – The TSP team prepared a plan (FY2008 & FY2009) for the development of a test turbine as a replacement for the failing Ice Harbor Unit 2 runner. BPA and Corps' Walla Walla District have agreed to support the design and installation of a test turbine optimized for to improve survival and reduce juvenile fish passage injury at Ice Harbor Dam. The design of this test turbine was developed using a process recommended by the TSP team and was incorporated into the procurement documents. The contract was advertised in spring 2009 and awarded in 2010.
- **Development of Direct Capture of Turbine-Passed Fish Test Methods** – The preliminary Ice Harbor test turbine design project included the design and implementation of a selected direct capture method for the purpose of sampling run-of-the-river fish for verification of pressure related and other injuries after passing through a turbine unit and potentially as a turbine fish survival and injury evaluation tool (FY2010 activity will be development of a biological study plan and design documents).
- **Evaluation of Survival and Passage Rates with Respect to Spill Operations** – In 2009, passage behavior, passage distribution, and survival were evaluated using radio-telemetry at

Ice Harbor Dam for yearling Chinook, juvenile steelhead, and subyearling Chinook. Two treatments were planned (30 percent spill and 45 kcfs daytime spill/gas cap nighttime spill) and a third (50 percent spill) was evaluated due to involuntary spill during the latter part of the spring study. No reference fish (controls) were released below Ice Harbor Dam for these evaluations, hence all survival estimates are single release. Single release survival estimates ranged between 91-94 percent for yearling Chinook, 90-95 percent for juvenile steelhead, and 89-91 percent for subyearling Chinook salmon. The 30 percent spill operation produced the highest survival estimates for both stocks of Chinook salmon while juvenile steelhead had slightly higher survival during the 50 percent spill operations. The results of these evaluations were not intended to evaluate concrete survival, but they may be used to inform operations in future years.

- **Removable Spillway Weir (RSW) modifications** – Design and hydraulic tests continued in 2009 on potential RSW spillway chute modifications and inclusion of Passive Integrated Transponder (PIT) tag system integration. Implementation of modifications is planned for winter 2011-2012.

RPA Action 23 – Configuration and Operation Plan for the Lower Monumental Project: *The Corps will consider all relevant biological criteria and prepare, in cooperation with NOAA Fisheries and the co-managing agencies, a Configuration and Operational Plan for the Lower Monumental Project (2010). As part of the first phase of modifications, the Corps will investigate, and implement the following reasonable and effective measures to reduce passage delay and increase survival of fish passing through the forebay, dam, and tailrace as warranted. Initial modifications will likely include:*

- *Primary bypass operations with PIT-tag detection installation to reduce handling stress of bypassed fish (2007)*
- *Juvenile bypass system outfall relocation to improve egress, direct and indirect survival on bypassed fish (2011)*
- *Turbine operation optimization to improve the survival of fish passing through turbines (2013)*
- *RSW installation to improve FPE, reduce forebay delay, and improve direct and indirect survival (2008)*

The COP will be updated periodically and modifications may be altered as new biological and engineering information is gathered. The COP and modifications will be coordinated through the Regional Forum. Comments developed by NOAA Fisheries on the draft COPs shall be reconciled by the Corps in writing to NOAA Fisheries' satisfaction before release of the final COP. If Phase I actions fail to meet the intended biological targets, Phase II actions, as described in the FCRPS BA – Appendix B.2.1, will be considered for further implementation.

The COP for Lower Monumental Dam was rescheduled for completion in 2011. A spillway weir was installed in 2008 and a second year of biological performance testing was performed in 2009. Significant accomplishments at Lower Monumental Dam in 2009 included the following:

- **Evaluation of Survival and Passage Rates for Spill Operations** – In 2009, a two treatment spring test was conducted based on bulk spill and uniform spill patterns for yearling Chinook salmon and steelhead from April 28 to May 24, and bulk spill only for sub-yearlings in summer from June 8 to July 3.
- Yearling Chinook salmon relative concrete survival estimate exceeded the BiOp performance standard for both the bulk and uniform spill patterns (97.5 percent and 97.3 percent, respectively) in 2009. Steelhead relative concrete survival estimates exceeded the BiOp performance standard for both the bulk (97.6 percent) and flat (96.7 percent) spill patterns in 2009. The subyearling Chinook relative concrete survival estimate was slightly under the BiOp standard at 92.9 percent during the bulk spill pattern operation.
- **Evaluation of the Approach Depth of Fish Entering the Spillway Weir** – In 2009, a study to determine the approaching depth of fish entering the Lower Monumental Dam spillway weir was conducted. A direct injury study in 2008 indicated there was a higher level of injury among fish released deep (1.5 feet above the ogee; 12.8 percent injury rate) as opposed to fish released shallow (6.5 feet above the ogee; 2.2 percent). During the 2009

vertical distribution study, we determined that only 3 percent of fish were detected moving at depths greater than the deep release pipe. This suggests that only a very small proportion of the run-of-river fish would be expected to be exposed to conditions similar to those experienced by fish released from the deep release pipe during the 2008 direct injury study.

- **Continued progress on the Juvenile Outfall Relocation Project** – During August 2009 both velocity and egress model tests of potential outfall relocation sites were conducted at the US Army ERDC. Site selection and design will continue in 2010.

RPA Action 24 – Configuration and Operation Plan for the Little Goose Project: *The Corps will consider all relevant biological criteria and prepare, in cooperation with NOAA Fisheries and the co-managing agencies, a Configuration and Operational Plan for the Little Goose Project (2009). As part of the first phase of modifications, the Corps will investigate, and implement the following reasonable and effective measures to reduce passage delay and increase survival of fish passing through the forebay, dam, and tailrace as warranted. Initial modifications will likely include:*

- *Turbine operation optimization to improve the survival of fish passing through turbines (2014)*
- *Primary bypass operations with PIT-tag detection installation to reduce handling stress of bypassed fish (2008)*
- *Primary bypass outfall relocation to improve egress, direct and indirect survival on bypassed fish (2009)*
- *Surface spillway weir and deflector installation to improve FPE, reduce forebay delay and improve direct and indirect survival (2009).*

The COP will be updated periodically and modifications may be altered as new biological and engineering information is gathered. The COP and modifications will be coordinated through the Regional Forum. Comments developed by NOAA Fisheries on the draft COPs shall be reconciled by the Corps in writing to NOAA Fisheries' satisfaction before release of the final COP. If Phase I actions fail to meet the intended biological targets, Phase II actions as described in the FCRPS BA – Appendix B.2.1 will be considered for further implementation.

Significant progress to resolve juvenile passage issues has been accomplished at Little Goose Dam. However, adult passage concerns associated with current spill operations have prompted debate over the current configuration. The Little Goose COP was initiated in 2010 and will be completed in 2011. Significant accomplishments at Little Goose Dam in 2009 included the following:

- **Surface spillway weir and deflector installation** – A spillway weir was installed in spillbay 1 and flow deflectors were installed in spillbays 1 and 8, prior to the start of the juvenile fish migration season.
- **Passage and survival evaluation** – The purpose of the 2009 passage and survival study was to document fish passage and survival when the dam was operated with a new spillway weir that was installed in March of 2009. The USGS used radio telemetry to examine behavior, passage, and survival of spring and summer juvenile salmonid migrants passing Little Goose Dam. Tagged fish were released near Central Ferry State Park, 21 km upstream from the dam, and in the tailrace, approximately 0.5 km downstream from the dam. Relative concrete survival estimates were 99.4 percent for yearling Chinook, 99.8 percent for steelhead, and 95.2 percent for sub-yearling Chinook.
- **Direct Injury Evaluation of the Spillway Weir and a Spillbay with a New Spill Deflector** – Post-construction evaluation included estimating the direct injury of salmonids prior to the juvenile outmigration. The study design included estimating the survival (direct effects) and injury of yearling Chinook salmon during passage through a newly installed spillway weir in spillbay 1 with a low and high crest. The investigation also evaluated survival and condition of fish passing over new flow deflectors (30-foot turning radius) installed in both spillbay 1 (spillway weir) and spillbay 8 (unmodified spillway gate). The direct survival/condition of the fish was determined by the HI-Z Turb 'N Tag recapture technique.
- **Juvenile Bypass System Full Flow PIT-Tag Monitoring** – The installation of a juvenile PIT-tag monitoring system in the full-flow section of the primary bypass pipe occurred during

the 2008-2009 winter maintenance period. The system provides PIT-tag detections without subjecting fish to potential stressors in the facility.

- **Juvenile Bypass Outfall Relocation** – Construction was initiated on the relocation of the bypass outfall in late 2008. The relocation was completed during the 2009–2010 juvenile bypass system winter maintenance period. The relocated outfall will release fish in an area with higher river velocities and consistent downstream flow during all operations. This relocation is expected to decrease predation on the bypassed fish.

RPA Action 25 – Configuration and Operation Plan for the Lower Granite Project: *The Corps will consider all relevant biological criteria and prepare, in cooperation with NOAA Fisheries and the co-managing agencies, a Configuration and Operational Plan for Lower Granite Project (2009). As part of the first phase of modifications, the Corps will investigate, and implement the following reasonable and effective measures to reduce passage delay and increase survival of fish passing through the forebay, dam, and tailrace as warranted. Initial modifications will likely include:*

- *New juvenile fish facility including orifice configuration changes, primary dewatering, holding for transport, and primary bypass to improve direct and indirect survival for all collected fish (2012)*
- *Turbine operation optimization to improve survival of turbine passed fish (2014)*

The COP will be updated periodically and modifications may be altered as new biological and engineering information is gathered. The COP and modifications will be coordinated through the Regional Forum. Comments developed by NOAA Fisheries on the draft COPs shall be reconciled by the Corps in writing to NOAA Fisheries' satisfaction before release of the final COP. If Phase I actions fail to meet the intended biological targets, Phase II actions as described in the FCRPS BA – Appendix B.2.1 will be considered for further implementation.

Alternatives and the associated biological evaluations for the Lower Granite COP were completed in 2009. Completion of the COP is expected in 2011. Significant accomplishments at Lower Granite Dam in 2009 included the following:

- **Juvenile Fish Facility (JFF) Upgrade** – Development of the Engineering Design Report on modifications to upgrade the JFF at Lower Granite Dam continued, and the report is expected to be completed in 2010. The facility design will include kelt management facilities, benefits to transported fish, and improvement to collected lamprey.

RPA Action 26 – Chief Joseph Dam Flow Deflectors: *The Corps will complete the flow deflector construction at Chief Joseph Dam by 2009.*

Deflector construction was initiated in 2005 in response to RPA action 136 in the 2000 BiOp and previous discussions on the importance of these deflectors. Chief Joseph Dam does not have spill for fish passage, but water is spilled at this project and Grand Coulee Dam to pass high flows. Investigations by the Corps concluded that installing flow deflectors at Chief Joseph Dam, which is immediately downstream of Grand Coulee Dam, and shifting spill and power generation between the projects is the most cost-effective alternative for gas abatement at these two dams.

Construction of flow deflectors on all 19 spillway bays at Chief Joseph Dam was completed in September 2008. This completed the structural component of the two-part alternative to reduce TDG downstream of Chief Joseph and Grand Coulee dams. A successful spill test was carried out in spring 2009. No further testing is planned.

RPA Action 27 – Turbine Unit Operations: *The Action Agencies will operate turbine units to achieve best fish passage survival (currently within 1 percent of best efficiency at mainstem dams on the Lower Columbia and Lower Snake rivers from April 1–October 31 (hard constraint) and from November 1–March 31 (soft constraint) each year. Continue turbine operations evaluations and apply adaptive management to operate units in their optimum configuration for safe fish passage.*

In 2009, turbine units on mainstem dams on the lower Columbia and lower Snake rivers were operated within 1 percent of best efficiency from April 1-October 31 (hard constraint) and from November 1-March 31 (soft constraint).

Work continued to determine the safest operating point for fish passing through existing FCRPS turbines. Physical model studies and numerical model studies were conducted to further this understanding. The Corps completed a final draft report of rapid decompression effects on tagged and untagged fish, and it initiated a new study to determine whether effects of rapid decompression on tagged fish differ from the effects on untagged fish.

An alternatives study was continued in 2009 to assess the feasibility of directly capturing juvenile fish that have passed through a mainstem dam turbine. This method provides a means of directly assessing turbine mortality, including capturing the effects of rapid decompression.

Hydropower Strategy 2 (RPA Action 28)

RPA Action 28 – Columbia and Snake River Project Adult Passage Improvements: *The Corps will implement the following structural improvements to adult passage at the mainstem Columbia and Snake river projects:*

- *Bonneville Dam*
  - *Improve the Bradford Island ladder system to reduce stress and improve reliability of upstream adult passage (2013).*
- *The Dalles Dam*
  - *East ladder emergency auxiliary water supply system and/or modifications that return adult salmon and steelhead use of the North ladder to pre-spillwall conditions to improve reliability of upstream adult passage (2013).*
- *John Day Dam*
  - *Adult ladder systems modifications to improve upstream adult passage conditions (2011).*
- *Ice Harbor Dam*
  - *Repair or replace north shore fishway auxiliary water supply (AWS) equipment as needed so that any two of the three pumps can meet flow criteria.*
- *Little Goose Dam*
  - *Investigate adult passage and determine whether structural, operational, or tailrace modifications can alleviate adult passage delays or blockages during spill operations for optimum juvenile passage (See RME Action 54).*
- *Lower Granite Dam*
  - *Investigate and if necessary provide additional auxiliary water supply for the new adult trap at lower Granite so that it can operate at full capacity when the forebay is operated at MOP without affecting the fishway AWS (2012).*
  - *Adult fishway modification to improve upstream adult passage conditions impaired by temperature differentials (need will be determined by results of further research) (prototype 2011).*

- **Bonneville Dam** – No action taken in 2009.
- **The Dalles Dam** – The Corps prepared a letter report that gives preliminary design and cost information for a backup water supply alternative. Further efforts on the north ladder were deferred pending spillwall completion and testing. This will allow for evaluation of the effects of the new configuration on adult use of the north ladder.
- **John Day Dam** – Completed plans and specifications for the north ladder exit section and count station improvements. Continued progress on a design document report for ladder entrance and Auxiliary Water System (AWS) improvements in the lower north fish ladder.
- **Ice Harbor Dam North Shore Adult Fish Ladder AWS** – Warranty replacement of two of three gear shafts on the north shore AWS pumps was completed in fall 2008. The third gear shaft was replaced in early 2009. These actions will allow the system to meet the hydraulic criteria outlined in the fish passage plan.

- **Little Goose Dam Adult Passage Delays** – Adult passage was monitored at Little Goose Dam in 2009, but it did not reveal any passage delays.
- **Lower Granite Dam Water supply for adult trap** – The water supply valve for the trap was replaced during the 2009-2010 winter maintenance period. At MOP, all six adult fish holding tanks can now be operated without causing any flow reduction to the AWS.
- **Lower Granite Dam Ladder Temperature Monitoring** – Water temperature monitoring is ongoing in the Lower Granite Ladder, but no adult behavioral studies were conducted in 2009.

Hydropower Strategy 3 (RPA Actions 29–31)

RPA Action 29 – Spill Operations to Improve Juvenile Passage: *The Corps and BPA will provide spill to improve juvenile fish passage while avoiding high TDG supersaturation levels or adult fallback problems. Specific spill levels will be provided for juvenile fish passage at each project, not to exceed established TDG levels (either 110 percent TDG standard, or as modified by State water quality waivers, currently up to 115 percent TDG in the dam forebay and up to 120 percent TDG in the project tailwater, or if spill to these levels would compromise the likelihood of meeting performance standards (see RPA action table, RME Strategy 2). The dates and levels for spill may be modified through the implementation planning process and adaptive management decisions. The initial levels and dates for spill operations are identified in Table 2 of the RPA action table. Future Water Management Plans will contain the annual work plans for these operations and spill programs, and will be coordinated through the TMT. The Corps and BPA will continue to evaluate and optimize spill passage survival to meet both the hydrosystem performance standards and the requirements of the Clean Water Act (CWA).*

Spill Operations

Spill operations for 2009 are reported in the 2009 Dissolved Gas and Water Temperature Monitoring Report (*http://www.nwd-wc.usace.army.mil/tmt/wqnew/tdg_and_temp/2009/*). This report describes the Corps' water quality monitoring program for 2009. The report provides information consistent with the TDG waiver issued by Oregon and the criteria adjustment by Washington. The report also includes the following additional technical information:

- Flow and runoff conditions for the spill season
- Duration and volume of spill for fish passage versus spill for other reasons for each project
- Data from the physical and biological monitoring programs, including incidences of gas bubble trauma (GBT)
- Progress on implementing measures contained in the lower Columbia and lower Snake River total dissolved gas TMDL documents.

The report focuses on the water quality monitoring of TDG and temperature at the 12 Corps dams in the Columbia River Basin.

Spring Spill

During 2009, spring spill at the lower Columbia and Snake River projects were consistent with the 2009 Spring FOP (*http://www.nwd-wc.usace.army.mil/tmt/documents/fpp/2009/final/App_E.pdf*). Spring spill began April 3 and continued through June 20 at the lower Snake River projects. Spring spill began April 10 and continued through June 19 at McNary Dam, through June 30 at John Day and The Dalles dams; and through June 20 at Bonneville Dam.

The 2009 Spring FOP called for the following spill operations during the spring:

- Lower Granite Dam: 20 kcfs, 24 hours per day
- Little Goose Dam: 30 percent of total project outflow, 24 hours per day
- Lower Monumental Dam: to the spill cap, 24 hours per day

- Ice Harbor Dam: spill alternating between 30 percent of total project outflow 24 hours per day, or 45 kcfs during the day and up to the spill cap at night
- McNary Dam: 40 percent of total project outflow
- John Day Dam: 30 percent of total project outflow from April 10 through April 27 and from June 4 through June 30, and alternating between 30 percent and 40 percent of total project outflow from April 27 through June 4
- The Dalles Dam: 40 percent of total project outflow
- Bonneville Dam: 100 kcfs

Total river flows as measured at Bonneville Dam remained elevated on the Columbia River from the third week of May to the second week of June, when the freshet occurred. Total river flows on the Columbia River during this period ranged from a daily average flow of 93 kcfs to 360 kcfs, with an overall daily average flow of 218 kcfs. These flows were lower than in 2008, when the daily average flow was between 276 and 418 kcfs. Flow began to taper off in late June and early July. Total river flows as measured at Ice Harbor Dam remained elevated on the Snake River from May to early June, when the freshet occurred there. Total river flows on the lower Snake River from May to early June ranged from a daily average flow of 137 kcfs to 169 kcfs.

Summer Spill

During 2009, consistent with the Summer FOP, summer spill began June 21 and continued through August 31 at the lower Snake River projects. Summer spill on the lower Columbia River began June 20 at McNary Dam, July 1 at John Day and The Dalles dams, and June 21 at Bonneville Dam. Spill continued through August 31.

The 2009 FOP called for the following spill operations during the summer:

- Lower Granite Dam: 18 kcfs, 24 hours per day
- Little Goose Dam: 30 percent of total project outflow, 24 hours per day
- Lower Monumental Dam: 17 kcfs, 24 hours per day
- Ice Harbor Dam: From June 21 through July 11, spill alternating between 30 percent of the river flow 24 hours per day, or 45 kcfs during the day and up to the spill cap at night. From July 12 through August 31, 45 kcfs during the day and up to the spill cap at night.
- McNary Dam: spill 50 percent of total project outflow
- John Day Dam: spill 30 percent of total project outflow, 24 hours per day
- The Dalles Dam: 40 percent of total project outflow
- Bonneville Dam: spill 85 kcfs during the day and to the spill cap at night from June 21 through July 20. Spill 75 kcfs during the day and to the spill cap at night from July 21 through August 31.

Total river flows continued to recede on the Columbia River during July and tapered off in August. Total river flows on the Columbia River during July were a daily average of 165 kcfs. Total river flows on the Columbia River during August averaged 118 kcfs.

On the Snake River total river flow also began to decrease in July and tapered off in August. On the Snake River the daily average total river flow was 51 kcfs, which is among the highest of the last five years. Daily average total river flows during August was 32 kcfs, which is also among the highest of the last five years.

Total Dissolved Gas Instances

The intent of the spill operations is to help meet juvenile fish survival performance standards identified in the 2008 FCRPS BiOp. These fish passage spills may result in the generation of TDG supersaturation in the Columbia and lower Snake rivers at levels above current state and federal water quality standards. The states of Washington and Oregon have exceptions to these standards as long as the elevated TDG levels provide for improved fish passage through the spillway without causing more harm to fish populations than through other passage routes.

There are instances when TDG levels exceed state standards resulting from either voluntary spill for fish passage or involuntary spill. These instances can result from:

- Flows exceeding powerhouse capacity
- Operation or mechanical failure of non-generating equipment (e.g. spill gates, fixed monitoring stations, communication errors, etc)
- Professional judgment and uncertainty in modeling results

During the 2009 fish passage spill season, there were a total of 308 TDG instances: 116 instances from voluntary spill and 192 instances from involuntary spill. These instances are measured in gauge-days[2] where TDG levels exceed either the Washington or Oregon TDG criteria.

Instances from voluntary spill:

- 1 - related to non-generating equipment (operation or mechanical failure)
- 17 - malfunctioning fixed-monitoring station gauges
- 98 - uncertainties associated with using best professional judgment, SYSTDG model, and forecasts

Instances from involuntary spill:

- 191 - high runoff flows and flood control efforts, BPA load requirements lower than actual powerhouse capacity, and involuntary spill
- 1 - outage of hydro power equipment

During the 2009 migration season, there were 52 instances in which TDG levels were higher than either the Oregon one-hour standard or Washington two-hour standards of 125 percent TDG, all but one due to involuntary spill associated with high runoff. The other instance resulted from special spill operations to pass debris. Debris spill operations can elevate TDG levels for a short period of time (usually from one to four hours) but are necessary to allow for safe access to juvenile fish passage systems.

Examination of data obtained from the Fish Passage Center (under "Smolt Data" at *www.fpc.org*) showed that 11,148 juvenile fish were examined for gas bubble trauma at Corps dams in 2009. Of those, only 25 were found to have moderate symptoms and none had severe symptoms.

RPA Action 30 – Juvenile Fish Transportation in the Columbia and Snake Rivers: *The Corps and BPA will continue the juvenile fish transportation program toward meeting system survival performance metrics of Snake and Columbia River salmon and steelhead with some adaptive management modifications based on results of RME. The Corps and BPA will continue to collect and transport juvenile fish at Lower Granite, Little Goose, Lower Monumental, and McNary dams, although under a modified operation as described in Table 3 and Table 4 of the RPA action table. While the dates mentioned in this section should be considered firm planning dates, if in-season information or results of ongoing RME indicates a need for adaptive management (for example, if modifying these dates are likely to increase in-*

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

river or system survival and would be likely to provide equivalent or increased SARs of the species transported), the Action Agencies will consider revising the dates and operations through the Regional Forum.

The 2009 transportation program was conducted in accordance with NOAA Fisheries ESA Permit Number 1237 and the Juvenile Fish Transportation Program criteria in the Corps' 2009 FPP. The start dates for initiating transport operations were staggered at Snake River operating projects. Collection of juvenile fish for barge transport began May 1 at Lower Granite Dam, May 5 at Little Goose Dam, and May 8 at Lower Monumental Dam. Before transport began, sampling operations took place at the Lower Granite, Little Goose, and Lower Monumental facilities in support of research activities, BPA-sponsored smolt monitoring activities, and assessment of bypass system conditions. Smolt Monitoring Program activities took place daily at Lower Granite Dam throughout the entire season. Transport operations at the Snake River facilities continued through October 1 at Lower Monumental Dam and through October 31 at Little Goose and Lower Granite dams.

Fish at McNary Dam were bypassed from March 31 through July 15 and transported from July 16 to October 1. Before transport began, sampling operations took place on an every-other-day basis beginning April 8 to support research and BPA-sponsored smolt monitoring activities, as well as to assess bypass system conditions.

Juvenile fish barged during 2009 were released at varying locations below Bonneville Dam as required in the permit. The ending date for the barging season in 2009 was August 14 for Snake River facilities and August 15 for McNary Dam. Trucks carried juvenile fish from August 16 through the end of the transport season. Trucked fish were released into the Bonneville Juvenile Monitoring Facility outfall flume. No early season (April) trucking took place in 2009.

Estimates of the number of fish collected, bypassed, and transported as part of the juvenile fish transportation program are based on sampling portions of the fish collected. Sampled numbers were expanded according to the percentage of the time sampled. At Snake River operating projects, the sampled fish were hand-counted and differentiated by species and whether or not adipose fins were clipped. A total of 6,593,661 juvenile fish were collected at Lower Granite Dam, with 2,465,023 of these fish bypassed to the river and 4,119,643 transported. At Little Goose Dam, 5,182,190 juvenile salmon and steelhead were collected in 2009. Of these, 2,228,651 were bypassed back to the river, and 2,944,890 were transported. At Lower Monumental Dam, 1,182,585 juvenile salmon and steelhead were collected in 2009. Of these, 13,891 fish were bypassed, and 1,167,425 were transported. At McNary Dam, 3,784,658 juvenile salmon and steelhead were collected in 2009. Approximately 3,298,319 of the fish collected were bypassed back to the river to meet fishery agency requirements, and 448,833 juvenile fish were transported.

A total of 16,743,094 juvenile salmon and steelhead were collected at all transport program locations in 2009, with 8,680,791 fish transported (52 percent) and 8,005,884 bypassed (48 percent). Of the fish transported, 8,637,279 were transported by barge (99 percent) and 43,512 were trucked (1 percent).

Table 5. Estimated Proportion of Non-Tagged Spring/Summer Chinook and Steelhead Smolts Transported in the Columbia and Snake Rivers in 2009.

Species	Percent Transported in 2009
Snake River Spring Chinook—Wild	40%
Snake River Spring Chinook—Hatchery	38%
Snake River Spring Steelhead—Wild	46%
Snake River Spring Steelhead—Hatchery	43%

RPA Action 31 – Configuration and Operational Plan Transportation Strategy:

The Corps, in coordination with the Regional Forum, will initiate a Configuration Operational Plan in 2009. The plan will be completed in 2010 and will present a strategy for prioritizing and carrying out further transportation actions at each dam. Comments developed by NOAA Fisheries on the draft COPs shall be reconciled by the Corps in writing to NOAA Fisheries' satisfaction before release of the final COP. Construction actions for transportation are primarily in the context of changes to juvenile bypass systems. Changes meant to increase adult salmon returns through the juvenile fish transportation process are being evaluated. Some changes include additional barges, a new juvenile fish facility at Lower Granite Dam and modifications to the juvenile fish facilities at Little Goose, Lower Monumental and McNary dams.

Various studies continued in 2009 to inform the Transportation Strategy COP, slated for completion in 2011. The data will be used to evaluate operational and construction alternatives to improve the transportation program. Significant among these were the following studies:

- **Transportation of Hatchery Spring Chinook of 2002-2004 and Hatchery Steelhead of 2003-2005 from McNary Dam** – The draft report of research for McNary Dam transport was received and reviewed during October 2009. Based on overall study results, Columbia River hatchery Chinook salmon that passed McNary Dam via the spillway/turbine route had higher smolt-to-adult return (SARs) than fish collected and transported (geometric mean of 0.83 with 95 percent CI, 0.72-0.93). However, if a hatchery Chinook was guided into the juvenile collection system, transport provided a benefit over returning the fish to the river via the full-flow bypass pipe (geomean of 1.39 with 95 percent CI, 1.04-2.14).
- In contrast to results for spring Chinook salmon, overall results from studies of Columbia River hatchery steelhead transported from McNary Dam showed that transportation provided a benefit over fish that passed the dam through the spillway/turbine route (geomean of 1.10 with 95 percent CI, 1.02-1.18). Also, if a fish was guided into the juvenile collection system, transport provided a benefit over returning to the river via either the full-flow bypass pipe (geometric mean of 1.20 with 95 percent CI, 1.10-1.31) or the facility bypass pipes (geomean of 1.39 with 95 percent CI, 1.15-1.72).
- **Evaluation of Effects of Extended Transport on Survival of Salmonid Smolts: Impacts of Fish Predation in the Lower Columbia River** – The draft report "Evaluation of Effects of Extended Transport on Survival" was received and reviewed in 2009. In 2006-2007, tagged experimental groups of smolts were released on an outgoing tide, during nighttime hours to determine if survival to adult return for these fish noticeably improved over the standard release site. The result of the analysis of predation effects shows that extended transportation provides a substantial benefit to survival of transported fish through the lower Columbia River. The ratio of extended transport survival over status quo transport was 1.1 to 1.4 depending on the type of smolt (subyearling Chinook were predicted to have the greatest benefit). The effect on in-river migrant smolts originating from upstream of Bonneville Dam or from sources downstream of Bonneville Dam was negligible (survival ratio of 0.98 to 1.00). Because the

results only examined the effects of predation to the point of ocean entry, it is not possible to conclusively state that benefits to survival will carry over to higher adult returns.

- **Transportation of Juvenile Salmonids on the Snake River, 2007: Final Report for the 2003 Fall Chinook Salmon Juvenile Migration** – From 2001 through 2003, hatchery subyearling fall Chinook salmon were PIT-tagged at Lyons Ferry Hatchery and released in the Snake River 81 km above Lower Granite Dam at river kilometer 254. Fall Chinook salmon were also collected, tagged, and transported from Lower Granite Dam during September and October 2003 to develop an index of adult returns from fish transported in the fall.
- The study was designed to compare the SAR of fish transported as juveniles from Lower Granite Dam with that of fish released to migrate inriver and not detected at any collector dam. However, recent data have shown that the method used to estimate numbers of non-detected yearling Chinook migrants cannot produce unbiased estimates of non-detected Snake River fall Chinook salmon. This method assumes equal probabilities of downstream detection among fish from each cohort after release. However, it is now known that a considerable proportion of fall Chinook overwinter within the migration corridor.
- The combined SAR (jacks through age-4 ocean fish) for Lyons Ferry Hatchery study groups was 0.09 percent (95 percent CI, 0.05-0.14 percent) for transported, 0.13 percent (0.02-0.24 percent) for bypassed, and 3.64 percent (0.00-8.68 percent) for holdover groups. The SAR for fall transport index fish was 3.84 percent (3.08-4.60 percent). Transportation appeared to neither greatly harm nor help Snake River fall Chinook salmon. For the 2003 releases overall, the transported group had slightly lower SARs than the bypassed group, but the highest SARs were seen in holdover fish, or those that delayed migration. Fall transport index fish also had relatively high SARs.

Hydropower Strategy 4 (RPA Action 32)

RPA Action 32 – Fish Passage Plan:

The Corps will annually prepare a FPP in coordination with NOAA Fisheries and the Regional Forum through the FPOM. The Corps will operate its projects (including juvenile and adult fish passage facilities) year-round in accordance with the criteria in the FPP. Comments developed by NOAA Fisheries on the draft FPP shall be reconciled by the Corps in writing to NOAA Fisheries' satisfaction before release of the final FPP.

The draft 2009 FPP was released in October 2008. The final *FPP, Corps of Engineers Projects, CENWD-PDW-R* (*http://www.nwd-wc.usace.army.mil/tmt/documents/fpp/2009/*) was released in March 2009. The FPP was completed in full coordination with the region. Corps fish passage facilities were operated in accordance with criteria in the FPP. Any deviations from the FPP were coordinated with the region and were necessary to protect fish or make emergency repairs on vital equipment.

Hydropower Strategy 5 (RPA Action 33)

RPA Action 33 – Snake River Steelhead Kelt Management Plan: *The BPA and Corps will prepare a Snake River Kelt Management Plan in coordination with NOAA Fisheries and the Regional Forum. The BPA and Corps will implement the plan to improve the productivity of interior basin B-run steelhead populations.*

BPA and Corps completed the 2009 Kelt Management Plan and released it for comment in December. The 2009 version of the Kelt Management Plan was a synthesis of previous research on kelt migration studies through the hydrosystem as well as kelt reconditioning efforts. The 2009 Kelt Management Plan also discussed research efforts that would continue in 2010 as well as kelt-specific operations at Bonneville and The Dalles dams. To facilitate increased efforts in the kelt research program, the Corps

initiated construction of kelt holding facilities at Lower Granite Dam. In addition, the Corps worked with BPA, CRITFC, and the University of Idaho to provide space and water for kelt holding tanks associated with reconditioning efforts at the Dworshak Fish Hatchery.

BPA funded CRITFC to prepare a Master Plan for kelt.BPA project number 2007-401-00, which will provide the detail on the reconditioning topic in the broader Kelt Management Plan. The Master Plan will focus on kelt collection and reconditioning at various locations. CRITFC has subcontracted portions of this project to the University of Idaho. Preparing a Kelt Master Plan is one deliverable that CRITFC will provide as part of its contract with BPA. The Kelt Master Plan, which will apply to reconditioning Snake River kelts, is part of a three-step technical review process required by the NPCC for artificial propagation projects, particularly those that affect natural populations and involve construction of capital facilities.

Habitat Implementation Reports, RPAs 34–38

Table 6. Habitat Strategy Reporting, RPA Actions 34–38

RPA Action No.	Action	Annual Progress Report
Habitat Strategy 1		
34	Tributary Habitat Implementation 2007 to 2009 – Progress Toward 2018 Habitat Quality Improvement Targets	• Status of project implementation (including project milestones) through December of previous year for all 2007-2009 actions. • Report physical metrics for implementation achieved (e.g., miles of access, cfs of streamflow acquired, numbers of screens, miles or acres of habitat protected or enhanced, and miles of complexity enhanced) relative to the project objectives.
35	Tributary Habitat Implementation 2010-2018 – Achieving Habitat Quality and Survival Improvement Targets	• Status of project implementation (including project milestones) through December of previous year for all actions identified in implementation plans. • Report physical metrics for implementation achieved (e.g., miles of access, cfs of streamflow acquired, numbers of screens installed, miles of acres of habitat protected or enhanced, and miles of complexity enhanced by benefited population(s)) relative to the total needed to complete the project and achieve the estimated survival benefits, by project.
Habitat Strategy 2		
36	Estuary Habitat Implementation 2007 to 2009	• Status of project implementation (including project milestones) through December of previous year for all 2007-2009 actions. • Report physical metrics for implementation achieved (e.g., number of acres protected/restored/enhanced; riparian miles protected) relative to the total needed to complete project and achieve the estimated survival benefits.

Table 6. Habitat Strategy Reporting, RPA Actions 34–38

RPA Action No.	Action	Annual Progress Report
37	Estuary Habitat Implementation 2010-2018 – Achieving Habitat Quality and Survival Improvement Targets	• Status of project implementation (including project milestones) through December of previous year for all actions identified in implementation plans. • Report physical metrics for implementation achieved (e.g., number of acres protected, restored, enhanced; riparian miles protected) relative to the total needed to complete the project and achieve the estimated survival benefits, by project. • By ESU, report progress toward Evolutionary Significant Unit/Distinct Population Segment (ESU/DPS)-specific survival benefit. • Where ESU/DPS-specific survival benefits are not achieving the progress guidelines above, identify processes or projects in place to ensure achievements by the next comprehensive report.
38	Piling and Piling Dike Removal Program	• Status of project implementation (including project milestones) through December of previous year for all actions identified in implementation plans. • Report physical metrics for implementation achieved (e.g., number of pilings/pile dikes removed, habitat area restored) by project.

Habitat Strategy 1 (RPA Actions 34–35)

RPA Action 34 – Tributary Habitat Implementation 2007 to 2009 - Progress Toward 2018 Habitat Quality Improvement Targets:

The Action Agencies will provide funding and technical assistance necessary to implement the specific projects identified for implementation in 2007 to 2009 as part of a tributary habitat program to achieve the population-specific overall habitat quality improvement identified in Table 5 of the RPA action table.

If projects identified for implementation in 2007-2009 prove infeasible, in whole or in part, the Action Agencies will implement comparable replacement projects in 2010-2013 to maintain estimated habitat quality improvements to achieve equivalent survival commitments at the population level, or alternatively at the major population group (MPG) or ESU level. Habitat and population-specific survival benefits in each implementation plan cycle must also compensate for not meeting estimated benefits in the previous implementation plan cycle. Replacement project selection will follow Action 35 below.

RPA action 34 includes specifications for the three-year cycle from 2007 to 2009. Summary information for water quantity and quality, in-stream habitat complexity, riparian improvement and protection, and access actions completed through 2009 is presented in Section 1 of this report. Detailed information on the 2007 to 2009 progress of individual projects and actions is presented in Section 4, Attachment 3, Tables 1 through 6. The projects and actions listed in Tables 1 through 6 were identified as implementation commitments in the 2007 FCRPS BiOp. NOAA Fisheries used these actions in its jeopardy analysis and to finalize RPA actions 34 and 35 in the BiOp. The tables are organized by Evolutionarily Significant Unit (ESU) and Distinct Population Segment (DPS) and include project descriptions and habitat metrics that were completed from 2007 to 2009. Projects may be reported multiple times if they benefit more than one species or more than one population.

It should be noted that the metrics included in these tables are not yet consistent with the Katz et al. (2006) metrics described in RPA action 73. The actual metrics reported will evolve as the Action Agencies, working with regional forums, develop a comprehensive system to collect, store, and report tributary habitat action implementation information consistent with the guidance provided in Katz et al. (2006). The Action Agencies will eventually track and report habitat metrics appropriate for their respective habitat programs that are consistent with the Katz et al. (2006) metrics.

The Population Summary in Section 4, Attachment 2, summarizes metrics completed in 2009 that are related to the populations listed in the 2008 BiOp RPA 35, Table 5. Attachment 2 is included to provide an overview of implementation progress relative to the population-specific biological needs presented by state and tribal partners.

RPA Action 35 – Tributary Habitat Implementation 2010–2018 - Achieving Habitat Quality and Survival Improvement Targets:

The Action Agencies will identify additional habitat projects for implementation based on the population specific overall habitat quality improvement still remaining in Table 5 of the RPA action table. Projects will identify location, treatment of limiting factor, targeted population or populations, appropriate reporting metrics, and estimated biological benefits based on achieving those metrics. Pertinent new information on climate change and potential effects of that information on limiting factors will be considered.

Annual progress for projects implemented under RPA action 35, which includes specifications for three-year cycles between 2010 and 2018, will be reported in future progress reports.

However, one of the 2008 BiOp's key improvements over previous BiOps is the expanded use of population-specific biological information to target actions in combination with the use of on-the-ground experts to identify and prioritize tributary habitat projects and assess their biological benefits. In 2009, the "expert panel" process was conducted by the Action Agencies to address collaboration with states and tribes as recommended by the Oregon District Court, and it support the process called for in RPA action 35.

Beginning in March 2009, the Action Agencies conducted and facilitated expert panel workshops in LaGrande and Joseph, Oregon, Wenatchee and Pomeroy, Washington, and Lewiston, McCall ,and Salmon, Idaho. The local experts focused on those areas where fish populations have the greatest biological need (as listed in the BiOp RPA table, action 35, Table 5): the Clearwater, lower Snake, Grande Ronde/Imnaha, upper Salmon, and upper Columbia (Wenatchee, Entiat, Methow, and Okanogan) geographic areas. The process was used to inform the 2010–2012 Implementation Plan released in June 2010 and provided input for the Action Agencies to assess habitat quality improvements for salmon and steelhead. Expert panel members reviewed the benefits associated with habitat actions completed between 2007 and 2009, revised those benefits where necessary, identified potential habitat improvement actions for the 2010–2012 implementation cycle, and associated biological benefits with the 2010–2012 actions (2008 FCRPS BiOp, RPA 35; 2007 FCRPS CA, Appendix C, Annex 1). Presentation of this information in upcoming Implementation Plans will illustrate the progress on commitments contained in RPA 35, Table 5 of the 2008 FCRPS BiOp.

Attendees at the workshops included representatives from NOAA Fisheries, tribal and state fish and wildlife agencies, the U.S. Forest Service, USFWS, local watershed groups, conservation districts, and recovery boards. All had extensive knowledge of and experience with local habitat conditions, and many hold undergraduate and advanced degrees in natural resource-related fields.

Additional Reports

Reclamation has produced a number of additional reports that document tributary habitat accomplishments. These reports are listed in Section 4, Attachment 4; the reports can be accessed at *http://www.usbr.gov/pn/programs/fcrps/thp/index.html*.

Habitat Strategy 2 (RPA Actions 36–38)

RPA Action 36 – Estuary Habitat Implementation 2007 to 2009:

The Action Agencies will provide funding to implement specific actions identified for implementation in 2007–2009 as part of a 10-year estuary habitat program to achieve the estimated ESU survival benefits of 9.0 percent and 6.0 percent for ocean type and stream-type ESUs, respectively. Projects in an early state of development such that quantitative physical metrics have not been related to estimated survival benefits will be selected per Action 37. If projects identified for implementation in 2007–2009 prove infeasible, in whole or in part, the Action Agencies will implement comparable replacement projects in 2010–2013 to provide equivalent habitat benefits needed to achieve equivalent survival benefits.

During 2009, the Action Agencies completed seven on-the-ground habitat projects with another nine estuary habitat projects in the planning, development and design phases. An additional action included one land acquisition, Elochoman, for which a feasibility study has been initiated through the Corps' 536 authority. Habitat activities included removing riparian/wetland invasive plant species and planting native species, improving and restoring streams/channels, improving fish passage structures, restoring riparian and wetland areas, and placing large wood material.

2009 accomplishments also included finalizing the Washington Memorandum of Agreement, outlining 21 potential projects and kicking off the initial planning activities of 3 projects. The action agencies developed the framework to implement these MOA projects in future years.

See Section 4, Attachment 5, for further detail on the estuary projects accomplished.

RPA Action 37 – Estuary Habitat Implementation 2010–2018 – Achieving Habitat Quality and Survival Improvement Targets:

The Action Agencies will provide funding to implement additional specific projects as needed to achieve the total estuary survival benefits identified in the FCRPS BA. Projects will identify location, treatment of limiting factor, targeted ESU/DPS or ESUs/DPSs, appropriate reporting metrics, and estimated biological benefits based on the achieving of those metrics. Pertinent new information on climate change and potential effects of that information on limiting factors will be considered.

The Action Agencies continue to utilize the *Columbia River Estuary ESA Recovery Plan Module for Salmon and Steelhead* to guide restoration and protection efforts through a collaborative process. In 2009, the Action Agencies continued development of a strategic approach to identifying restoration and protection projects in the estuary using a new Ecosystem Classification System being developed by the University of Washington and the U.S. Geological Survey. The strategic approach will use guiding principles based on salmonid ecology to identify potential sites with the highest value to salmon and steelhead. This is a collaborative effort between the Action Agencies and other regional interests, including the Lower Columbia River Estuary Partnership (LCREP), the states of Oregon and Washington, the Cowlitz Tribe, and local restoration practitioners, including the Columbia River Estuary Study Taskforce (CREST), the Columbia Land Trust, watershed councils, and conservation districts.

- *Action Agencies will actively engage the LCREP Science workgroup to identify project benefits in coordination with other regional experts, using recovery planning products and the modified LCREP project selection criteria (FCRPS BA Attachment B.2.2-3) to identify projects that will benefit salmon considered in this RPA.*

  In 2009, the Action Agencies continued to utilize LCREP's Science Work Group, using its ecosystem criteria to help select restoration and protection projects in the Lower Columbia River and Estuary.

- *To support project selection the Action Agencies will convene an expert regional technical group. This group will use the habitat metrics to determine the estimated change in survival which would result from full implementation.*

  The Expert Regional Technical Group (ERTG) was convened in 2009 and began evaluating federal projects for their survival benefit potential. The ERTG has five members, representing: the Oregon Department of Fish and Wildlife; the Washington Department of Fish and Wildlife; NOAA Fisheries' Northwest Fisheries Science Center; the Department of Energy's Pacific Northwest National Laboratory, and the Skagit River System Cooperative.

- *Project proposals will clearly describe the completed project in terms of quantitative habitat metrics which can be used to quantitatively evaluate progress and completion of individual projects.*

  In 2009, the ERTG and the Action Agencies began development of a template for the data needed for submission of proposed projects to ERTG. That template requires clearly described habitat metrics for each aspect of the project. This approach is expected to provide project sponsors with clear guidelines regarding the information they need to provide, and reduce the amount of time needed for ERTG to provide habitat benefit estimates.

- *The expert regional technical group will use the approach originally applied in the FCRPS BA (Attachment B.2.2) (Estimated Benefits of Federal Agency Habitat Projects in the Lower Columbia River Estuary) and all subsequent information on the relationship between actions, habitat and salmon productivity models developed through the FCRPS RM&E to estimate the change in overall estuary habitat and resultant change in population survival.*

  In 2009, the ERTG reviewed the habitat benefit estimation approach applied in the FCRPS BA. It then attempted to further systematize the FCRPS BA method, and explored several approaches aimed at increasing the degree of repeatability of estimates. The ERTG is developing its methodology for estimating survival benefits, with the goal of finalizing the method in 2010.

- *If actions from the previous cycle prove infeasible, in whole or in part, the Action Agencies will ensure implementation of comparable replacement estuary projects in the next implementation plan cycle to maintain estimated habitat quality improvements at the ESU/DPS level and achieve equivalent survival benefits. Selection of replacement projects, to ensure comparable survival benefits, will be made based on input from expert panels, regional recovery planning groups, the Northwest Power and Conservation Council, and NOAA Fisheries.*

  Some projects scheduled for completion in 2007-2009 were delayed or proved infeasible. The Action Agencies will construct projects in the 2010-2013 implementation period to replace the survival benefits those projects would have provided. The total amount of survival benefits still needed for the 2007-2009 implementation period is not yet known, since the ERTG is still finalizing its methodology for determining survival benefit estimates, leaving several of the projects completed in 2008 and 2009 still "unscored."

  Replacement project selection will be based on input from expert panels, regional recovery planning groups, the Northwest Power and Conservation Council, and NOAA Fisheries.

- *FCRPS RM&E results will actively inform the relationship between actions, estuary habitat change and salmon productivity and new scientific information will be applied to estimate benefits for future implementation.*

  As information from FCRPS estuary research and restoration project effectiveness monitoring becomes available, it will be applied to the process of estimating benefits for projects implemented between 2010 and 2018.

- *If new scientific or other information (except incomplete implementation of project modification) suggests that habitat quality improvement estimates for projects from the previous cycle were significantly in error, the Action Agencies will examine the information and review the project or projects in question and their estimated benefits. This review will occur as part of the 2009 Annual Report and the Comprehensive RPA Evaluations in 2013 and 2016 and will be performed in conjunction with NOAA Fisheries. In the event such review find that habitat based survival improvement were significantly overstated, the Action Agencies will implement replacement projects (selected as per new projects above) to provide benefits sufficient to achieve the ESU/DPS-specific survival benefit estimated for each affected project.*

  In 2009 the Action Agencies actively engaged consultants, LCREP's Science Workgroup, the ERTG and other sources regarding new scientific information. A summary of recent publications is provided after the discussion of RPA Action 61, below. The Action Agencies have examined that and other information, and are not aware of any information that would indicate habitat quality improvement estimates for projects completed in the 2007-2009 implementation cycle were "significantly overstated". The Action Agencies will continue to coordinate with LCREP's Science Workgroup, and the ERTG regarding new scientific information.

When available, new scientific information resulting from FCRPS research, monitoring, and evaluation (RME) will be applied to estimate benefits for projects implemented between 2010 and 2018.

RPA Action 38 – Piling and Piling Dike Removal Program:

To increase access to productive habitat and to reduce avian predation, the Action Agencies will develop and implement a piling and pile dike removal program.

- *In 2008, the Action Agencies will work with [the]Lower Columbia River Estuary Program develop a plan for strategic removal of structures that have lower value to navigation channel maintenance, present low-risk to adjacent land use, support increased ecosystem function, and are cost-effective.*

  A final draft pile structure program plan was presented to NOAA in November 2008, and was reviewed in early 2009. This plan will be modified as new information becomes available.

- *Beginning in 2008 and 2009, the Action Agencies will begin implementation. Implementation will continue through 2018.*

  In 2009, LCREP implemented a NOAA Fisheries-funded pile removal pilot project at Coal Creek Slough, near Longview. Pre- and post-project monitoring for that effort was provided by the Corps. One outcome of that effort was a report on the feasibility of assessing the effects of pile structure removal projects (Vavrinec et al., 2009) In 2009, the Corps also initiated the contract process for a study to identify which pile dike structures are still needed to meet its navigation requirements. The Corps also determined that, because its pile structures were congressionally authorized, additional process may be required before removal can occur. As a result, emphasis for the early part of the program turned to removal of pile fields, and the Action Agencies, with LCREP and others, worked on planning for pile field removal pilot projects. Three pile fields were identified for possible removal as part of a pilot project.

Hatchery Implementation Reports, RPA Actions 39–42

Table 7. Hatchery Strategy RPA Action Reporting

RPA Action No.	Action	Annual Progress Report
Hatchery Strategy 1		
39	FCRPS Funding of Mitigation Hatcheries – Programmatic	• Status of submittal/approval of Hatchery and Genetic Management Plans (HGMPs), including site-specific application of Best Management Practices.
40	Reform FCRPS Hatchery Operations to Reduce Genetic and Ecological Effects on ESA-Listed Salmon and Steelhead	• Status of implementation through December of the previous year for all reforms identified in the BiOp RPA table, action 40, Table 6. • Status of implementation of future reforms identified by the Action Agencies following the Hatchery Scientific Review Group (HSRG) process.
Hatchery Strategy 2		
41	Implement Safety Net Programs to Preserve Genetic Resources and Reduce Short-term Extinction Risk	• Status of implementation through December of the previous year for all safety net programs identified in the BiOp RPA table, action 41, Table 7.

Table 7. Hatchery Strategy RPA Action Reporting

RPA Action No.	Action	Annual Progress Report
42	Implement Conservation Programs to Build Genetic Resources and Assist in Promoting Recovery	• Status of implementation through December of the previous year for all conservation programs identified in the BiOp RPA table, action 42, Table 8.

Hatchery Strategy 1 (RPA Actions 39–40)

RPA Action 39 – FCRPS Funding of Mitigation Hatcheries – Programmatic:

The FCRPS Action Agencies will continue funding hatcheries in accordance with existing programs, and will adopt programmatic criteria for funding decisions on mitigation programs for the FCRPS that incorporate BMPs. The Hatchery Effects Report, the August 2006 NOAA Fisheries paper to the PWG and the NOAA Fisheries 2007 Guidance Paper should be considered in developing these criteria in addition to the BMPs in the Action Agencies' BA. Site specific application of BMPs will be defined in ESA Section 7, Section 10, or Section 4(d) consultations with NOAA Fisheries to be initiated and conducted by hatchery operators with the Action Agencies as cooperating agencies.

In 2009, the Action Agencies continued to fund mitigation hatcheries in accordance with existing programs and, as appropriate, used the programmatic funding criteria developed in 2008 for funding decisions on mitigation programs for the FCRPS.

To implement RPA action 39, NOAA Fisheries announced initiation of its ESA consultation process in a series of letters to Columbia Basin hatchery operators and other interested parties. The process was initiated in September 2008 for upper Columbia hatchery programs, in March 2009 for programs in the Mid-Columbia Steelhead DPS, and in May 2009 for Snake River Basin programs. Following each NOAA Fisheries announcement, the Action Agency-funded hatchery operators in these regions began updating the Hatchery and Genetic Management Plans (HGMPs) for their respective hatchery programs. Information from the reports of the recently completed USFWS Hatchery Review Team process and the Hatchery Scientific Review Group (HSRG) will guide and inform the development of program-specific HGMPs.

Throughout 2009, hatchery program operators in the Upper Columbia region continued to develop Hatchery and Genetic Management Plans (HGMPs) for Action Agency-funded hatchery programs. Action Agencies reviewed and commented on draft HGMPs during development. As of December 2009, updated HGMPs for all FCRPS hatchery programs in the three regions requiring consultation were either underway or completed and sent to NOAA Fisheries (Tables 8, 9, and 10). In March 2009, the USFWS submitted a letter requesting Section 7 consultation and a consultation-ready HGMP for the spring Chinook program at Leavenworth National Fish Hatchery (NFH) to NOAA Fisheries. HGMPs for Entiat and Winthrop hatcheries were submitted in July 2009. Updated and completed HGMPs will be submitted to NOAA Fisheries in 2010 and 2011 to initiate consultation on other programs.

In March 2009, hatchery program operators in the Mid-Columbia region began developing HGMPs for Action Agency-funded hatchery programs. Action Agencies reviewed and commented on draft HGMPs during development. Updated and complete HGMPs will be submitted to NOAA Fisheries in 2010 and 2011 to initiate consultation.

In May 2009, hatchery program operators in the Snake River Basin began developing HGMPs for Action Agency-funded hatchery programs. Action Agencies reviewed and commented on draft HGMPs during development. Updated and complete HGMPs will be submitted to NOAA Fisheries in 2010 to initiate consultation.

In July 2009, the Action Agencies sent a letter to hatchery program operators that described a process for working collaboratively on development of HGMPs for consultation and transmitted the criteria for funding decisions on ongoing and new hatchery programs in the Columbia Basin.

Table 8. FCRPS-Funded Hatchery Programs in the Upper Columbia Region.

Program	Operator	Lead Action Agency	Basin
Leavenworth National Fish Hatchery (NFH) spring Chinook	USFWS	Reclamation	Wenatchee
Entiat NFH summer Chinook program	USFWS	Reclamation	Entiat
Upper Columbia steelhead kelt reconditioning	Confederated Tribes of the Colville Reservation (CTCR)[1] and Yakima Nation (YN)[2]	BPA	Okanogan, Entiat, Wenatchee
Winthrop NFH Methow Composite spring Chinook	USFWS	Reclamation	Methow
Winthrop NFH steelhead	USFWS	Reclamation	Methow
Methow coho	YN	BPA	Methow
Wenatchee coho	YN	BPA	Wenatchee

1/ Confederated Tribes of the Colville Reservation program is conducted in the Okanogan Subbasin

2/ The Yakama Nation upper Columbia kelt reconditioning program will probably be located in the Wenatchee Subbasin near Dryden, Washington, and not at Entiat NFH as originally proposed. The Yakama Nation will be the operator, with funding from BPA, for this FCRPS BiOp/Columbia Basin Fish Accords project.

Table 9. FCRPS-Funded Hatchery Programs in the Mid-Columbia Region

Program	Operator	Lead Action Agency	Basin
Yakima Spring Chinook	YN	BPA	Yakima
Yakima Summer-Fall Chinook [1]	YN	BPA	Yakima
Yakima Coho	YN	BPA	Yakima
Yakima Steelhead Kelt Reconditioning	YN	BPA	Yakima
Touchet Endemic Steelhead	Washington Department of Fish and Wildlife (WDFW)	BPA (LSRCP)	Walla Walla

Program	Operator	Lead Action Agency	Basin
Umatilla Spring Chinook	Oregon Department of Fish and Wildlife (ODFW) & Confederated Tribes of the Umatilla Indian Reservation (CTUIR)	BPA	Umatilla
Umatilla Fall Chinook [2]	ODFW & CTUIR	BPA and Corps	Umatilla
Umatilla Coho Chinook [3]	ODFW & CTUIR	BPA	Umatilla
Umatilla Summer Steelhead	ODFW & CTUIR	BPA	Umatilla

1/ COE funds release of John Day mitigation fish (fall Chinook salmon) in the Yakima Subbasin.

2/ Sub-yearling program funded by BPA, and Yearling program funded by COE

3/ BPA funds the operation of the CTUIR acclimation releases in the Umatilla Subbasin; and Mitchell Act Funding covers the Bonneville and Cascade Hatcheries operations of the program.

Table 10. FCRPS-Funded Hatchery Programs in the Snake River Region

Program	Operator	Lead Action Agency	Basin
Lyons Ferry Summer Steelhead	WDFW	BPA (LSRCP)	Lower Snake
Snake River Stock Fall Chinook (Lyons Ferry Hatchery) [1]	WDFW	BPA (LSRCP)	Lower Snake
Tucannon Summer Steelhead Endemic	WDFW	BPA (LSRCP)	Tucannon
Tucannon Summer Steelhead (Lyons Ferry)	WDFW	BPA (LSRCP)	Tucannon
NF Clearwater Summer Steelhead (B-Run-Clearwater Hatchery)	IDFG	BPA (LSRCP)	Clearwater
NF Clearwater Summer Steelhead (B-Run-Dworshak NFH)	USFWS	BPA (LSRCP)	Clearwater
Clearwater River Basin Spring Chinook (Clearwater Hatchery)	IDFG	BPA (LSRCP)	Clearwater
S.F. Clearwater B-Run Steelhead (Clearwater Hatchery)	IDFG	BPA (LSRCP)	Clearwater
Clearwater Spring Chinook (NPTH-Hatchery)	Nez Perce Tribe (NPT)	BPA	Clearwater

Program	Operator	Lead Action Agency	Basin
Clearwater Fall Chinook (NPTH-Hatchery)	NPT	BPA	Clearwater
Cottonwood Creek Summer Steelhead (Wallowa Stock)	WDFW	BPA (LSRCP)	Grande Ronde
Grande Ronde Basin Summer Steelhead (Wallowa Hatchery)	ODFW	BPA (LSRCP)	Grande Ronde
Grande Ronde Endemic Spring Chinook Salmon Supplementation (Upper Grande Ronde River Spring/Summer Chinook Salmon Stock)	ODFW & CTUIR	BPA (LSRCP)	Grande Ronde
Grande Ronde Basin Catherine Creek Spring/Summer Chinook	ODFW & CTUIR	BPA (LSRCP)	Grande Ronde
Lostine Spring Chinook	ODFW, NPT & CTUIR	BPA (LSRCP)	Grande Ronde
Lookingglass Creek Spring Chinook	ODFW	BPA (LSRCP)	Grande Ronde
Little Sheep Creek Summer Steelhead	ODFW	BPA (LSRCP)	Imnaha
Imnaha Spring/Summer Chinook	ODFW	BPA (LSRCP)	Imnaha
Upper Salmon River B-Run Steelhead (Sawtooth- Magic Valley)	IDFG	BPA (LSRCP)	Salmon
Upper Salmon Spring Chinook (Sawtooth Hatchery)	IDFG	BPA (LSRCP)	Salmon
South Salmon Summer Chinook (McCall Fish Hatchery)	IDFG	BPA (LSRCP)	Salmon
Johnson Creek Summer Chinook (South Fork Salmon)	IDFG & NPT	BPA (LSRCP)	Salmon
Yankee Fork Summer Steelhead Streamside Incubation Supplementation	IDFG & Shoshone-Bannock Tribes SBT	BPA	Salmon
Yankee Fork Summer Steelhead Supplementation	IDFG & SBT	BPA	Salmon
Yankee Fork Chinook Supplementation	IDFG & SBT	BPA	Salmon
SF Salmon-Dollar Creek Summer Chinook (McCall FH-Eggbox)	IDFG & SBT	BPA	Salmon

Program	Operator	Lead Action Agency	Basin
E. Fork Salmon River Natural integrated Steelhead (Sawtooth)	IDFG	BPA (LSRCP)	Salmon
Little Salmon River A&B Run Steelhead (Niagara/Magic Valley)	IDFG	BPA (LSRCP)	Salmon
Pahsimeroi A-Run Steelhead (Niagara Springs)	IDFG	BPA (LSRCP)	Salmon
Upper Salmon River A-Run Steelhead (Sawtooth/ Magic Valley/Hagerman National)	IDFG	BPA (LSRCP)	Salmon
Rapid River Fish Hatchery Chinook (Rapid River and Little Salmon)	IDFG	BPA (LSRCP)	Salmon
Snake River Sockeye (Eagle Fish Hatchery)	IDFG	BPA (LSRCP)	Salmon

RPA Action 40 – Reform FCRPS Hatchery Operations to Reduce Genetic and Ecological Effects on ESA-listed Salmon and Steelhead:

The Action Agencies will undertake/fund reforms to ensure that hatchery programs funded by the Action Agencies as mitigation for the FCRPS are not impeding recovery. The Action Agencies will work with FCRPS mitigation hatchery operators to cost effectively address needed reforms of current hatchery programs while continuing to meet mitigation responsibilities. Specific reforms to be implemented under this action (following any necessary regulatory approval) are listed in Table 6 of the RPA action table. Other reforms will be identified and implemented following the conclusion of the Columbia River Hatchery Scientific Review Group process.

- *For Lower Columbia Chinook: The COE will review the John Day Hatchery Mitigation Program.*

  The reprogramming of the John Day mitigation program has been the topic of ongoing coordination and negotiation for a number of years. The current effort, initiated in 2006, is to coordinate a regionally acceptable detailed plan to accomplish the construction and operational modifications to the program to address a long-held objective to better provide for an in-place, in-kind mitigation concept.

  In 2009, the Corps continued ongoing negotiations with U.S. v. Oregon parties to resolve key issues necessary to proceed with the evaluations and planning for the specific actions to achieve this objective and address the ESA issues associated with the current and potential future mitigation program. It is anticipated that a way forward will be established in 2010.

- *For Snake River Steelhead: Fund the Tucannon River steelhead supplementation program to transition to local broodstock using BMPs.*

  This action will be funded by BPA and implemented by the Lower Snake River Compensation Plan (LSRCP) program office and the Washington Department of Fish and Wildlife (WDFW), the LSRCP hatchery program operator for the Tucannon River steelhead supplementation program. For Tucannon steelhead, WDFW developed a revised HGMP to transition to local broodstock and submitted a summary of the proposed changes to the U.S. v. Oregon Production Advisory Committee for review. The proposal would increase the current Tucannon River endemic stock summer steelhead smolt production from 50,000 to 75,000 fish annually.

  As the program expands toward a production goal of 150,000 in the future, (following needed facility modifications at the Lyons Ferry and Tucannon fish hatcheries), up to two-thirds of the

annual production would be marked for harvest mitigation as part of the LSRCP mitigation program. The remaining one-third of the program would be used for supplementation in the Tucannon River. Production facilities, brood source, size and life history at release, and time of release would all remain the same as the current program.

- *For Middle Columbia Steelhead: Fund the Touchet River steelhead supplementation program to transition to local broodstock using BMPs.*

  This action will be funded and implemented by the LSRCP program office and WDFW. For Touchet steelhead, WDFW submitted a HGMP to NOAA Fisheries in June 2009 to comply with NOAA Fisheries' request to consult on mid-Columbia stocks. The new HGMP is consistent with the current management plan and the U.S. v. OR agreement. WDFW is in the process of conducting statewide review of steelhead hatchery programs and expects that a review of the Touchet program will be completed by the end of 2010.

- *For Upper Columbia Steelhead: For the Winthrop NFH steelhead program, implement measures to transition to local broodstock and to manage the number of Winthrop NFH-produced steelhead on the spawning grounds. Such broodstock and adult escapement reform measures, including capital construction, would be identified through development of an updated HGMP and ESA consultation. Implementation of reform measures is contingent on a finding, in consultation with NOAA, that the measures are biologically and economically feasible and effective. Implementation of reforms will be prioritized and sequenced.*

  The Winthrop NFH continued the pilot program to evaluate longer-term (two-year) rearing of juvenile steelhead as part of a program to transition to a locally adapted steelhead broodstock in the Methow River. The program will continue for several more years and was expanded from 25,000 juvenile steelhead in 2008 to 40,000 in 2009, while still meeting the goal of releasing 100,000 fish during the transition to locally adapted stock. Discussions about where on the Methow River and how to manage returning adult steelhead on the spawning grounds led to testing the fish ladder at Foghorn Dam as a place to intercept adult steelhead. The fish ladder was tested in 2009 and found not to be a very effective method of capturing returning adults. Most adult steelhead were caught by hook and line, with only two collected from the fish ladder. Since Foghorn Dam is not a complete barrier to fish passage, and it is relatively easy for adult fish to pass, a weir or some other type of structure is being considered as a means to guide upstream migrating fish for collection.

  An additional recommendation was for Winthrop NFH to reduce spring Chinook salmon production, thereby increasing steelhead capability. The hatchery investigated a partnership with the Colville Tribe, which indicated an interest in assuming Chinook salmon production. Sufficient progress was made to anticipate the tribe will be able to handle production of 100,000 spring Chinook salmon in coming years.

  In 2009, with BPA funding, the Hatchery Scientific Review Group (HSRG) completed its comprehensive review and analysis of all Columbia River Basin hatchery programs and its final reports with recommendations for hatchery reform.

Hatchery Strategy 2 (RPA Actions 41–42)

RPA Action 41 – Implement Safety Net Programs to Preserve Genetic Resources and Reduce Short-term Extinction Risk: *The Action Agencies will continue to fund the operation of on-going "safety net" programs that are providing benefits to ESA-listed stocks at high risk of extinction by increasing genetic resources and will identify and plan for additional safety-net programs, as needed.*

1. *For Snake River sockeye: Continue to fund the safety net program to achieve the interim goal of annual releases of 150,000 smolts while also continuing to implement other release strategies in nursery lakes such as fry and parr releases, eyed-egg incubation boxes, and adult releases for volitional spawning (see Action 42 for expansion of the program for building genetic resources and assisting in promoting recovery).*

BPA continued to fund the Snake River Sockeye Salmon Captive Broodstock Program, BPA project number 2007-402-00, to preserve this 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 using multiple release strategies, including smolt, fry, and parr releases; eyed-egg incubation boxes; and adult releases for volitional spawning. The Stanley Basin Technical Oversight Committee continues to provide guidance on the program. Since 1999, 1,838 adults from the program have returned to Redfish Lake. In 2009, 833 adult sockeye salmon returned to the Stanley Basin. This is the largest recorded annual return since 1956.

2. *For Snake River Spring/Summer Chinook: For the Tucannon River spring/summer Chinook safety-net supplementation program fund capital construction, operation and monitoring and evaluation costs to implement a program that builds genetic diversity using local broodstock and a sliding scale for managing the composition of natural spawners comprised of hatchery-origin fish.*

   In 2009, BPA funded the final analysis and reporting tasks of BPA project 2000-019-00, Tucannon River Spring Chinook Captive Brood, as this safety-net program neared completion.

3. *For Snake River Spring/Summer Chinook: For the Upper Grande Ronde and Catherine Creek safety net supplementation programs fund capital construction, operation and monitoring and evaluation costs to implement a program that builds genetic diversity using local broodstock, and a sliding scale for managing the composition of natural spawners comprised of hatchery origin fish.*

   BPA continued to fund this safety-net program through BPA project number 2007-404-00, Spring Chinook Captive Propagation - Oregon.

4. *For Snake River Spring/Summer Chinook: Fund the Johnson Creek / South Fork Salmon River safety net supplementation program, as described in the existing Section 10 permit.*

   BPA continued to fund this safety-net program through BPA project number 1996-043-00, the Johnson Creek Artificial Propagation Enhancement project.

5. *For Snake River Spring/Summer Chinook: Fund the experimental captive rearing program for East Fork and West Fork Yankee Fork Salmon River (until phased out by IDFG).*

   BPA continued to fund this experimental captive rearing program through BPA project number 2007-403-00, Idaho Snake River Spring Chinook Captive Propagation.

6. *For Snake River Steelhead, as a project to benefit primarily B-run steelhead, the Action Agencies will work with NOAA Fisheries to develop a trigger for future artificial propagation safety-net planning or to identify populations for immediate safety-net planning.*

   It is not feasible to implement this action at this time because of a lack of adequate B-run steelhead population viability data. Once sufficient data are available (as determined by NOAA Fisheries) through the enhanced Snake River B-run steelhead population productivity and abundance monitoring called for in RPA action 50.5, we will begin to work with NOAA Fisheries to develop the type of "trigger" described above. We estimate it may be several years before adequate data are available from the enhanced monitoring effort

RPA Action 42 – Implement Conservation Programs to Build Genetic Resources and Assist in Promoting Recovery:

The Action Agencies will implement conservation programs for ESA–listed stocks where the programs assist in recovery.

1. *For Upper Columbia Spring Chinook: Fund reintroduction of spring Chinook salmon into the Okanogan Basin consistent with the Upper Columbia Salmon Recovery Plan including capital construction, operation and monitoring and evaluation costs to implement a transition to local broodstock and a sliding scale for managing the composition of natural spawners composed of hatchery origin fish. Re-introduction will be coordinated with the restoration and improvement of spring Chinook habitat in the Okanogan Basin and will be contingent on the availability of within ESU broodstock from the Methow Basin.*

When constructed and fully operational, BPA-funded Chief Joseph Hatchery is expected to serve as the artificial production facility needed for this reintroduction program. This production will initially be contingent on the availability of within-ESU spring Chinook broodstock from the Methow Basin. Chief Joseph Hatchery was approved by the Northwest Power and Conservation Council (Council) in 2009 to move into Step 3 (final design) of the Council's three-step review process for major artificial production projects. Final approval is expected in 2010, and construction is anticipated to begin in late 2010 or 2011.

2. *For Upper Columbia Steelhead: Fund a program to recondition natural origin kelts for the Entiat, Methow and Okanogan basin, including capital construction, operation and monitoring and evaluation costs.*

   In 2009, BPA began funding the Yakama Tribes to implement an Upper Columbia Kelt Reconditioning project that will develop a site plan and construct a steelhead kelt reconditioning facility.

3. *For Upper Columbia Steelhead: Fund a program that builds genetic diversity using local broodstock and accelerates steelhead recovery in the Okanogan Basin as steelhead habitat is restored and improved, including capital construction, operation, and monitoring and evaluation costs.*

   This action is being implemented by the Confederated Colville Tribes through a Fish and Wildlife Program/Columbia River Fish Accords project: Local Okanogan Steelhead Broodstock.

4. *For Middle Columbia Steelhead: Fund a program to recondition natural origin kelts in the Yakima River basin including capital construction, implementation and monitoring and evaluation costs.*

   BPA continued to fund this action through a BPA project, Kelt Reconditioning/Reproductive Success.

5. *For Snake River Steelhead: For the East Fork Salmon River, fund a small-scale program (no more than 50,000 smolts) including trapping locally returning steelhead in the East Fork Salmon River for broodstock, and follow BMPs for rearing, release, and adult management strategies. Fund capital construction, operation, and monitoring and evaluation costs to implement a program that builds genetic diversity using local broodstock and a sliding scale for managing the composition of natural spawners comprised of hatchery origin fish.*

   BPA continued to fund operation and maintenance for this action through the LSRCP Direct Funding Agreement.

6. *For Snake River Spring/Summer Chinook Salmon: For the Lostine and Imnaha rivers, contingent on a NOAA approved HGMP, fund these hatchery programs including capital construction, operation and monitoring and evaluation costs to implement supplementation programs using local broodstock and following a sliding scale for managing the composition of natural spawners composed of hatchery origin fish.*

   As of December 2009, a proposed action and HGMP had not been completed for this program. Because funding of the action is contingent on a NOAA Fisheries-approved HGMP, BPA did not fund construction of the Northeast Oregon Hatchery Lostine and Imnaha spring/summer Chinook propagation facilities in 2009. It is possible that NOAA Fisheries may approve an HGMP for this program during the RPA action 39 ESA consultation process for the Snake River Basin in 2010.

7. *For Snake River Sockeye: Fund further expansion of the sockeye program to increase total smolt releases to between 500,000 and 1 million fish.*

   On September 2, 2008, BPA signed a Fish Accord with Idaho that will provide funding certainty over a 10-year period. The accord included the commitment to provide funding for a new sockeye salmon fish hatchery (property acquisition and construction). Throughout 2009, BPA worked with IDFG and the state of Idaho to identify and begin the acquisition process for property meeting the criteria for a facility that will allow propagation of up to 1 million sockeye salmon smolts. Funding will be provided through ongoing BPA projects.

8. *For Snake River Sockeye: The Action Agencies will work with appropriate parties to investigate feasibility and potentially develop a plan for ground transport of adult sockeye from LGR Dam to Sawtooth Valley lakes or artificial propagation facilities.*

   In 2009, the Action Agencies, together with state and federal fishery agencies, started development of study plan to investigate the feasibility of transporting adult sockeye. (A pilot project to evaluate feasibility of ground transport was implemented in 2010.)

9. *For Columbia River Chum: Fund a hatchery program to re-introduce chum salmon in Duncan Creek including capital construction, implementation and monitoring and evaluation costs as long as NOAA Fisheries considers it beneficial to recovery and necessary to reduce extinction risk of the target population.*

   BPA continued to fund this action through the BPA project, Reintroduction of Chum Salmon into Duncan Creek.

10. *For Columbia River Chum: Fund assessment of habitat potential, development of reintroduction strategies, and implementation of pilot supplementation projects in selected Lower Columbia River tributaries below Bonneville Dam.*

    In 2009, BPA began funding a new project, Development of an Integrated Strategy for Chum Salmon Restoration in the Tributaries Below Bonneville Dam, to implement this action.

Predation Management Implementation Reports, RPA Action 43–49

Table 11. Predation Management RPA Action Reporting

RPA Action No.	Action	Annual Progress Report
Predation Management Strategy 1		
43	Northern Pikeminnow Management Program (NPMP)	Annual progress reports will describe actions taken, including: - Number of pikeminnow removals - Estimated reduction of juvenile salmon consumed - Average exploitation rate - Results of periodic program evaluations (including updates on age restructuring and compensatory responses)
44	Develop strategies to reduce non-indigenous fish	Beginning in 2010, annual progress reports will describe actions taken as a result of the workshop.
Predation Management Strategy 2		
45	Caspian Tern	Annual progress reports will describe actions taken toward the implementation of the Caspian Tern Management Plan.
46	Double-Crested Cormorant	Annual progress reports will describe actions taken if warranted.
47	Inland Avian Predation	Annual progress reports will describe actions taken if warranted.
48	Other Avian Deterrent Actions	Annual deterrent actions will not be reported.

Predation Management Strategy 3		
49	Marine Mammal Control Measures	Not applicable.

Predation Management Strategy 1 (RPA Actions 43–44)

RPA Action 43 – Northern Pikeminnow Management Program:

Action Agencies will continue to annually implement the base program and continue the general increase in the reward structure in the northern pikeminnow sport-reward fishery consistent with the increase starting in 2004. To better evaluate the effects of the NPMP, BPA will increase the number of tagged fish. The Action Agencies will evaluate the effectiveness of focused removals of pikeminnow at The Dalles and John Day dams and implement as warranted. Additional scoping of other mainstem dams will be based upon evaluations and adaptive management principles with input from NOAA Fisheries, and other regional fisheries managers.

Since 1990, BPA has funded the Northern Pikeminnow Management Program (NPMP) to reduce the numbers of larger pikeminnow and improve survival of juvenile salmon. In 2004, after BPA increased the reward for the catch of this predator, the number of pikeminnow removed increased by 25 percent compared to prior years. The increased reward was made permanent in 2005 to sustain the higher catches. This resulted in the highest harvest rate of pikeminnow observed since the program began. The pikeminnow program has removed more than 3.3 million northern pikeminnow from the Columbia River since 1990. Evaluation indicates that as a result of the program, pikeminnow predation on juvenile salmon has declined 38 percent, saving 3-5 million juvenile salmon annually that would otherwise have been eaten by this predator.

The 2008 BiOp calls for BPA to increase tagging efforts to boost the number of tagged northern pikeminnow to better inform and increase the statistical significance of the biological evaluation of pikeminnow removals. The evaluation component of the NPMP uses tag recoveries in sponsored fisheries to quantitatively measure the benefit of removals within the year and cumulatively. In 2009, researchers were able to build upon the increase in cumulative tagging efforts achieved in 2008, which resulted in increases in year-over-year application of tags by 80 percent. This increase in tagging and resultant improvement in estimation is consistent with the 2008 BiOp and Independent Scientific Advisory Board (ISAB) recommendations (The Northern Pikeminnow Management Program Justification, Performance, and Cost Effectiveness, Hankin, 2000 *http://www.nwcouncil.org/library/2000/2000-16.pdf*).

Also in 2009, the exploitation rate on northern pikeminnow was 12.8 percent, within the program objective based on the hypothesis that a 10 to 20 percent exploitation rate (on northern pikeminnow 9 inches or longer) could achieve up to a 50 percent reduction in predation mortality (Rieman and Beamesderfer 1990). The exploitation rate was based on a numerical catch of 141,645 from a sport reward fishery and dam angling fishery. As part of the ongoing annual evaluation of the NPMP, managers determined that continued implementation of the dam angling program component is warranted based on the 2009 catch of 5,369 from the forebays and tailraces of The Dalles and John Day dams.

RPA Action 44 – Develop strategies to reduce non-indigenous fish: *The Action Agencies will work with NOAA Fisheries, states and tribes to coordinate to review, evaluate, and develop strategies to reduce non-indigenous piscivorous predation. The formation of a workshop will be an initial step in the process.*

In May 2009, BPA reconvened a smaller group of participants from the 2008 Predation Workshop to narrow and prioritize approximately one dozen grouped recommendations stemming from the workshop held in fall 2008. As a result of this half-day collaborative meeting with the regional agencies and tribes, the Action Agencies were able to narrow the research objectives to a few high–priority topic areas and critical uncertainties. Specifically the Action Agency's will address the influence

of juvenile American shad on the health and well being of piscivores and their predation rates on juvenile salmonids, the predatory impact of channel catfish on juvenile salmonids, and the potential efficacy of localized removals of smallmouth bass for predation control. In December 2009, the project sponsors submitted for review of the Independent Scientific Review Panel for the NPCC the proposal titled "*Understanding the influence of predation by introduced fishes on juvenile salmonids in the Columbia River Basin: closing some knowledge gaps."*

Predation Management Strategy 2 (RPA Action 45–48)

RPA Action 45 – Reduce Caspian Terns on East Sand Island in the Columbia River Estuary:
The FCRPS Action Agencies will implement the Caspian Tern Management Plan. East Sand Island tern habitat will be reduced from 6.5 to 1.5 to 2 acres. It is predicted that the target acreage on East Sand Island will be achieved in approximately 2010.

In November 2006, the USFWS and Corps signed separate Records of Decision (RODs) adopting the Caspian Tern Management Plan. NMFS completed the biological opinion for the proposed action on February 16, 2006.

In 2008, the Corps began the implementation of the Caspian Tern Management Plan with the construction of a one-acre island in Fern Ridge Reservoir (Oregon). Also completed that year was a one-acre island at Crump Lake (Oregon), and a one-half acre island at Summer Lake. In February 2009, an additional one-half acre island was completed at Summer Lake. The construction of these new islands allowed the Corps to reduce habitat at East Sand Island to 3.5 acres in March 2009.

Reducing habitat at East Sand Island in 2009 forced Caspian terns to nest at a higher density than previously recorded. In addition, Caspian terns that were not able to nest on the main colony formed a satellite colony near the beach on the eastern edge of East Sand Island. The Caspian tern colony consisted of about 9,854 breeding pairs in 2009, not significantly different from 2008.

Monitoring at Rice Island in May 2009 found Caspian terns attempting to nest on the western portion of Rice Island. The Corps immediately contracted services to place dissuasion materials on these locations, filled in nest scraps, and collected two Caspian tern eggs (under Federal Depredation Permit). The dissuasion was successful at keeping Caspian terns from nesting on Rice Island the remainder of the 2009 nesting season.

Construction of new islands continued during the summer 2009 with the creation of an additional one-half acre island at Summer Lake, as well as three new islands in the Klamath Basin at Tule Lake and Lower Klamath National Wildlife Refuges. A total of 3.8 acres were built in the Klamath Basin which included a two-acre island at Tule Lake sump 1b, a one-acre rock island in the Orems Unit, and a 0.8-acre floating island on Sheepy Lake in the Lower Klamath Refuge. Only the floating island will be available for the 2010 nesting season due to vegetation management of the managed wetlands at the other two locations.

The Corps does not expect to reach the initial implementation goal of 1.5 to 2 acres by the 2011 nesting season due to difficulties with developing the sites identified in the Caspian Tern Management Plan. Efforts are ongoing to develop nesting habitat in San Francisco Bay and in Malheur Wildlife Refuge. The ROD provides for the Corps to continue building islands at a two for one ratio to reduce East Sand Island to one acre. Evaluating the impacts from Caspian terns on the survival of juvenile salmonids will continue yearly to determine if more acres of alternative habitat are needed to further reduce habitat to reach the ultimate goal of 1.0 acres at East Sand Island.

The Corps is coordinating the deviations from the Management Plan with the appropriate agencies. This coordination effort is expected to be complete by the end of 2010.

RPA Action 46 – Double-Crested Cormorants: *The FCRPS Action Agencies will develop a cormorant management plan encompassing additional research, development of a conceptual management plan, and implementation of warranted actions in the estuary.*

In 2009, the Action Agencies continued a study to test the feasibility of potential management techniques for reducing losses of juvenile salmonids due to cormorant predation in the Columbia River Estuary. They continued employment of habitat enhancement (placement of old tires filled with nesting material) and social attraction techniques (decoys and audio playback systems) on a floating platform in Fern Ridge Reservoir, near Eugene, Oregon. The Fern Ridge site was selected because it supported significant numbers of cormorants during the non-breeding season.

Cormorants did not attempt to nest on the floating platform, nor were they ever observed perched on the floating platform during the nesting season in 2008 or 2009. Developing methodologies to enhance the size of existing double-crested cormorant colonies, along with establishing new colonies using habitat enhancement and social attraction techniques, may be necessary to shift cormorants from the colony on East Sand Island to alternative colony sites where ESA-listed salmonids are not as vulnerable to cormorant predation.

In 2009, three techniques were tested to discourage nesting by double-crested cormorants on East Sand Island. The first technique, human disturbance, was used on a discrete portion of the breeding colony area. The second technique, hazing with a green laser, was used on cormorants that were roosting on beaches adjacent to the colony. The third technique was the placement of pond liner on a portion of the known nesting area.

The human disturbance technique was tested as a potential method to discourage double-crested cormorant nesting on East Sand Island. Prior to the initiation of any breeding, a visual barrier (a fence of black plastic fabric, approximately 1.5 meters tall) was erected to isolate a small section of the easternmost end of the double-crested cormorant colony. Disturbances ceased as soon as evidence of egg laying was observed.

A green laser (LEM50 laser torch) was used during early morning and late evening periods to test its efficacy for dispersing targeted double-crested cormorants from roosting on East Sand Island. The laser was used during April before double-crested cormorants had initiated egg laying. Results were marginally successful in flushing response, but the birds quickly became accustomed to the laser, at which point the laser was no longer effective. It was determined that this method does not have validity as a long term management tool.

The pond liner was placed on sand and rip-rap areas and was 100 percent successful and dissuaded cormorants from nesting. This could be a possible long-term method for dissuasion, but it is fairly costly and would require maintenance.

RPA Action 47 – Inland Avian Predation:

The FCRPS Action Agencies will develop an avian management plan (for Double-Crested Cormorants, Caspian Terns, and other avian species as determined by RME) for Corps-owned lands and associated shallow water habitat.

In 2009, the Action Agencies and the USFWS met to begin development of an avian management plan for Corps-owned lands and associated shallow water habitat. Three workshops on potential research and management actions were also held in 2009. Development of the plan continued through regional collaboration, and a programmatic framework for the plan was completed. A full draft for regional review is now planned for completion in Q1 2011.

RPA Action 48 – Other Avian Deterrent Actions: *The Corps will continue to implement and improve avian deterrent programs at all lower Snake and Columbia River dams. This program will be coordinated through the Fish Passage Operations and Maintenance Team and included in the FPP.*

Other avian deterrent actions, such as hazing and wire arrays, were carried out in accordance with the FPP (*http://www.nwd-wc.usace.army.mil/tmt/documents/fpp/2009*) as called for in RPA action 48.

An extensive new array of gull deterrent wires was added to John Day Dam tailrace. Evaluations of the effectiveness of the new wire arrays in conjunction with the ongoing harassment program led to plans for modifications to the array in 2010, with construction finished early 2010.

Predation Management Strategy 3 (RPA Action 49)

RPA Action 49 – Marine Mammal Control Measures: *The Corps will install and improve as needed sea lion excluder gates at all main adult fish ladder entrances at Bonneville Dam annually. In addition, the Corps will continue to support land and water based harassment efforts by NOAA Fisheries, Oregon Department of Wildlife (ODFW), Washington Department of Fish and Wildlife (WDFW), and the Tribes to keep sea lions away from the area immediately downstream of Bonneville Dam.*

In 2009, the Corps implemented and evaluated a variety of sea lion deterrents, from physical barriers to non-lethal harassment (Stansell et al. 2009). Sea lion exclusion devices (SLEDs) were installed at Bonneville Dam's 12 primary fishway entrances to prevent sea lions from entering the fishways. SLEDs were installed on January 15, two weeks early, in response to a sea lion being observed in the Powerhouse 2 fishway entrance. The SLEDs were removed in June 2009. The SLEDs feature 15.38-inch (39.05-centimeter) gaps that are designed to allow fish passage. Floating orifice gates (FOGs) were equipped with SLED-like FOG barriers. Acoustic deterrent devices, which emit a 205-decibel sound in the 15 kHz range, were installed at fishway entrances in January 2009 and removed in May 2009.

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 in March 2009 and was conducted daily through the end of May 2009. 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.

In part supported by BPA, CRITFC conducted boat-based harassment along with Oregon Department of Fish and Wildlife (ODFW) and WDFW from December 2008 through May 2009. Boats operated from the Bonneville Dam tailrace (RM 146) downstream to navigation marker 85 (RM 139). The Corps granted boats access to the 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 second powerhouse (PH2) corner collector and smolt monitoring facility. Boat crews ceased using seal bombs after adult salmon 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.

With funding from BPA, ODFW, and WDFW, four floating sea lion traps were deployed along the Powerhouse II corner collector to capture California sea lions. The sea lions were then weighed, branded, and released or transferred to aquariums. Of the 20 California sea lions trapped in 2009, four were sent to aquariums, 10 were euthanized, five were processed (measured, weighed, marked with a three-digit brand, and given acoustic tags), and released. One was already branded (but given an acoustic tag).

RME Implementation Reports, RPA Actions 50–73

The following section provides information on the RME actions implemented by the Action Agencies in 2009. In many cases, Action Agency projects identify actions that were funded and initiated prior to the completion of the 2008 BiOp, or were initiated as part of a previous BiOp. This section of the report will highlight examples of how projects contracted in 2009 fulfilled the RPAs, while Section 4 provides the full list of projects.

Table 12. RME Strategy Reporting

RPA Action No.	Action	Annual Progress Report
RME Strategy 1		
50	Fish Population Status Monitoring	Status of project implementation (including project milestones) through December of the previous year for all actions identified in Attachment B.2.6-1 or subsequent implementation plans.
51	Collaboration Regarding Fish Population Status Monitoring	Status of project implementation (including project milestones) through December of the previous year for all actions identified in implementation plans.
RME Strategy 2		
52	Monitor and Evaluate Fish Performance within the FCRPS	Status of project implementation (including project milestones) through December of the previous year for all actions identified in implementation plans.
53	Monitor and Evaluate Migration Characteristics and River Condition	Status of project implementation (including project milestones) through December of the previous year for all actions identified in implementation plans.
54	Monitor and Evaluate Effects of Configuration and Operation Actions	Status of project implementation (including project milestones) through December of the previous year for all actions identified in implementation plans.
55	Investigate Hydro Critical Uncertainties and Investigate New Technologies	Status of project implementation (including project milestones) through December of the previous year for all actions identified in implementation plans.
RME Strategy 3		
56	Monitor and Evaluate Tributary Habitat Conditions and Limiting Factors	Status of project implementation (including project milestones) through December of the previous year for all actions identified in implementation plans.
57	Evaluate the Effectiveness of Tributary Habitat Actions	Status of project implementation (including project milestones) through December of the previous year for all actions identified in implementation plans.
RME Strategy 4		
58	Monitor and Evaluate Fish Performance in the Estuary and Plume	Status of project implementation (including project milestones) through December of the previous year for all actions identified in implementation plans.

Table 12. RME Strategy Reporting

RPA Action No.	Action	Annual Progress Report
59	Monitor and Evaluate Migration Characteristics and Estuary/Ocean Conditions	• Status of project implementation (including project milestones) through December of the previous year for all actions identified in implementation plans. • Tabulate the amount of absolute acreage by habitat type that is restored or protected every year. (Initiate in FY 2007-2009 Projects.) • Report annually on indices of productivity for the estuary and ocean (i.e., Pacific Decadal Oscillation, primary productivity indices).
60	Monitor and Evaluate Habitat Actions in the Estuary	Status of project implementation (including project milestones) through December of the previous year for all actions identified in implementation plans.
61	Investigate Estuary/Ocean Critical Uncertainties	Status of project implementation (including project milestones) through December of the previous year for all actions identified in implementation plans.
RME Strategy 5		
62	Fund Selected Harvest Investigations	Status of project implementation (including project milestones) through December of the previous year for all actions identified in implementation plans.
RME Strategy 6		
63	Monitor Hatchery Effectiveness	Status of project implementation (including project milestones) through December of the previous year for all actions identified in implementation plans.
64	Investigate Hatchery Critical Uncertainties	Status of project implementation (including project milestones) through December of previous year for all actions identified in implementation plans.
65	Investigate Hatchery Critical Uncertainties	Status of project implementation (including project milestones) and analysis of new information through December of the previous year.
RME Strategy 7		
66	Monitor and Evaluate the Caspian Tern Population in the Columbia River Estuary	Status of project implementation (including project milestones) through December of the previous year for all actions (habitat actions are population response) identified in implementation plans.
67	Monitor and Evaluate the Double-Crested Cormorant Population in the Columbia River Estuary	Status of project implementation (including project milestones) through December of the previous year for all actions (habitat actions are population response) identified in implementation plans.
68	Monitor and Evaluate Inland Avian Predators	Status of project implementation (including project milestones) through December of the previous year for all actions (habitat actions are population response) identified in implementation plans.

Table 12. RME Strategy Reporting

RPA Action No.	Action	Annual Progress Report
69	Monitoring Related to Marine Mammal Predation	Status of project implementation (including project milestones) through December of the previous year for all actions (habitat actions are population response) identified in implementation plans.
70	Monitoring Related to Piscivorous (Fish) Predation	Status of project implementation (including project milestones) through December of the previous year for all actions identified in implementation plans.
RME Strategy 8		
71	Coordination	Status of coordination of RME projects through December of the previous year will be provided.
72	Data Management	Status of data management projects through December of the previous year will be provided.
RME Strategy 9		
73	Implementation and Compliance Monitoring	The Action Agencies will use the project-level detail contained in the Action Agencies' BA databases to track results and assess our progress in meeting programmatic-level performance targets. This performance tracking will be reported through annual progress reports and the 2013 and 2016 comprehensive reports.

RME Strategy 1 (RPA Actions 50–51)

A comprehensive list of all actions implemented by the Action Agencies for RPAs 50 and 51 is included in Section 4.

RPA Action 50 – Fish Population Status Monitoring: *The Action Agencies will enhance existing fish population status monitoring performed by fish management agencies through the specific actions listed below. In addition, ancillary population status and trend information is being obtained through several ongoing habitat and hatchery improvement projects.*

1. *Implement and maintain the Columbia River Basin passive integrated transponder (PIT)-Tag Information System. (Annually)*

   BPA continued implementation of six projects in 2009 in support of the Columbia Basin PIT-Tag Information System (PTAGIS). The primary support for this project comes from BPA project number 1990-080-00, which was continued in 2009. The project supported research that calls for the selection or diversion of specific PIT-tagged fish at any of the mainstem juvenile or adult fish facilities. PTAGIS provides coordination, set-up, operations, and maintenance for approximately one dozen NPCC Fish and Wildlife Program (FWP) or Anadromous Fish Evaluation Program (AFEP) projects throughout the fish migration season. The existing database will be revised to include information from interrogation systems that are being installed in tributaries to measure population-scale abundance and survival.

2. *Monitor adult returns at mainstem hydroelectric dams using both visual counts and the PIT-tag detection system (see Hydrosystem section). (Annually)*

In 2009, the Corps again implemented its adult fish count program as laid out in the FPP. Results are available in the *2009 Annual Fish Passage Report: Columbia and Snake Rivers*, available at *http://www.nwp.usace.army.mil/environment/FishData/docs/2009afpr.pdf*.

BPA continued implementation of three projects in 2009 for additional support of this RPA subaction. For example, the Lower Granite Dam Adult Trap Operations, BPA project number 2001-003-00, continued in 2009 for daily operation of the Lower Granite Dam adult trap to sample steelhead, spring/summer Chinook, and PIT-tagged fall Chinook (scales and length measurement) for run-reconstruction and transportation and life history studies. Fish with coded-wire-tags or PIT tags (if targeted) were diverted into the adult trap holding area for collection of timed samples (a percentage of all passing adults) for run reconstructions. Operation information was included in the adult trap annual report provided to BPA. This RPA is well covered through the Corps' adult fish count program and the BPA projects. Additional work is being implemented in 2010 for upper Columbia spring Chinook and steelhead.

3. *Monitor juvenile fish migrations at mainstem hydroelectric dams using smolt monitoring and the PIT-tag detection system (see Hydrosystem section). (Annually)*

BPA continued implementation of seven smolt monitoring projects in 2009 to address the needs of this RPA subaction. For example, the Smolt Monitoring by Non-Federal Entities project, BPA project number 1994-033-00, collected species, condition, and external mark detail from all sampled fish; condition and length data from a subsample of the smolts; and all incidental species caught in the samples. This RPA will be expanded and fully addressed in 2010 with additional PIT tagging of juvenile fish guided by a tagging plan.

4. *Fund status and trend monitoring as a component of the pilot studies in the Wenatchee, Methow, and Entiat river basins in the Upper Columbia River, the Lemhi and South Fork Salmon river basins, and the John Day River Basin to further advance the methods and information needed for assessing the status of fish populations. (Initiate in FY 2007-2009 Project Funding, review and modify annually to ensure that these projects continue to provide a means of evaluating the effectiveness of tributary mitigation actions).*

In 2009, nine BPA projects continued to be implemented, and one BPA project was initiated to support ongoing pilot studies. For example, the Integrated Status and Effectiveness Program projects, BPA project numbers 2003-010-00 and 2003-017-00, conducted monitoring to evaluate food web and life history responses to habitat change. The projects also conducted juvenile snorkel surveys in winter (30) and summer (42), sampling sites to evaluate population dynamics at restoration sites compared to unrestored sites. These 10 BPA monitoring projects are meeting population status monitoring needs in the John Day, Lemhi, and South Fork Salmon rivers. Additional monitoring is being developed within the Wenatchee, Entiat, and Methow to fully meet the requirements of this RPA subaction.

5. *Provide additional status monitoring to ensure a majority of Snake River B-Run steelhead populations are being monitored for population productivity and abundance. (Initiate by FY 2009, then annually)*

Ten projects were continued to assess B-run steelhead abundance and productivity. For example, the Idaho Monitoring and Evaluation Studies Project, BPA project number 1990-055-00, PIT-tagged juveniles in streams of the Middle Fork Salmon, South Fork Salmon, and Little Salmon rivers to estimate juvenile steelhead production and timing. The project also snorkeled streams to estimate juvenile densities in the Clearwater River and tributaries, and it collected DNA tissue samples in the Salmon River and Clearwater River tributaries to genotype and analyze genetic tissues. The Action Agencies are implementing additional BiOp monitoring projects in 2010 and 2011 identified in a regional collaboration effort with state and tribal entities that support this RPA.

6. *Review and modify existing Action Agencies' fish population status monitoring projects to improve their compliance with regional standards and protocols, and ensure they are prioritized and effectively focused on critical performance measures and populations. (Initiate in FY 2008, develop proposed modification in FY 2009, and implement modifications in FY 2010)*

   Forty-four BPA projects were continued that supported fish population status monitoring based on strategies developed through the Anadromous Salmonid Monitoring Strategy (ASMS) in 2009. Regional fish population status monitoring standards and protocol documentation tools were advanced through Pacific Northwest Aquatic Monitoring Partnership (PNAMP) in 2008 under project 2004-002-00 through management of the Protocol Library tool. The Action Agencies/NOAA Fisheries RME work groups recommendation report was reviewed as part of the ASMS and modified to support a regional strategy to meet the needs of the BiOp and ESA recovery.

7. *Fund marking of hatchery releases from Action Agencies funded facilities to enable monitoring of hatchery-origin fish in natural spawning areas and the assessment of status of wild populations. (Annually)*

   Twenty-four BPA projects were continued in 2009 that supported hatchery marking monitoring and research. For example, the Okanogan Basin Monitoring and Evaluation Program (OBMEP) project, BPA project number 2003-022-00, collected data on the abundance of out-migrating juvenile summer steelhead and summer/fall Chinook smolts and installed and tested the operation of a smolt trap in one location on the Okanogan River. The Grande Ronde Supplementation Operations and Maintenance (O&M) and Monitoring and Evaluation (M&E) on Lostine River project, BPA project number 1998-007-02, provided summary data in an annual report on the number of conventional and captive rearing program fish tagged; the average length (mm), weight (g), and condition factors (Fultons), with standard errors; and minimum and maximum values observed for each attribute. BPA project number 2008-740-00 was initiated to support additional marking under BPA-funded hatchery programs. Additional work is expected to occur in the future under this RPA as recommended in the Action Agencies/NOAA Fisheries RM&E Recommendations Report.

8. *Report available information on population viability metrics in annual and comprehensive evaluation reports. (Initiate in FY 2008)*

   All Action Agency population viability information was gathered and stored for future viability assessments. BPA identified placeholder project funds to support the synthesis of fish population data for annual and comprehensive reports, and the Action Agencies and NOAA Fisheries agreed to support a process where NOAA Fisheries would provide population viability information for future reports. Also, the RME Work Group recommended finalizing the NOAA Fisheries viable salmonid population (VSP) data dictionary in coordination with PNAMP and integrating those results into Action Agency project requirements. Current information on population abundance is provided in earlier sections of this report.

RPA Action 51 – Collaboration Regarding Fish Population Status Monitoring:

The Action Agencies will enhance existing fish populations status monitoring performed by fish management agencies through the following collaboration commitments:

1. *Support the coordination, data management, and annual synthesis of fish population metrics through Regional Data Repositories and reports (Annually)*

   Ten projects were continued to fully support annual synthesis of fish population data for reports. For example, the StreamNet Library Project, BPA project number 2008-505-00, supported participation in planning, development, and/or coordination meetings with regional projects and programs under the NPCC's FWP to help develop a regional data management framework, to establish data type and data service priorities, and to provide advice in the area of data management, as requested.

2. *Facilitate and participate in an ongoing collaboration process to develop a regional strategy for status and trend monitoring for key ESA fish populations (Initiate in FY 2008)*

   Two BPA projects were continued to support ongoing collaboration to develop regional strategies. In collaboration with NOAA Fisheries, the Action Agencies, and the NPCC, the NPCC FCRPS BiOp RME work groups completed a draft recommendation report. As part of the regional review and collaboration on this report, the Regional Strategy-Status/Trend project, BPA project number 2008-733-00, was funded to support a process to engage state and tribal fish managers through regional workshops to review existing status and trend monitoring and gaps in monitoring programs. This led to the development of the ASMS strategy in Skamania, Washington. The Action Agencies also supported the ongoing PNAMP coordination process through funding of BPA project number 2004-002-00 and contracted staff support in the PNAMP steering committee and fish population work group.

3. *Provide cost-shared funding support and staff participation in regional coordination forums such as the Pacific Northwest Aquatic Monitoring Partnership (PNAMP) fish population monitoring workgroup and the Northwest Environmental Data Network to advance regional standards and coordination for more efficient and robust monitoring and information management. (Annually)*

   Five BPA projects were continued in 2009 to fully provide cost sharing for staff support in regional monitoring and evaluation coordination. For example, the PNAMP Support Project, BPA project number 2004-002-00, facilitated coordination work at the program, subbasin, and regional level by providing personnel to serve as the lead staff, liaison, and point of contact for the PNAMP. This project supports coordination of PNAMP efforts to integrate resource monitoring programs of state, federal, tribal, local, and private organizations in the Pacific Northwest. This project also facilitates the transfer of information within PNAMP and across relevant organizations to establish and maintain strong relationships between science and management, and to promote and facilitate communication among organizations and disciplines. In 2009, BPA also provided contract support for facilitation of the Northwest Environmental Data (NED) Network forum to advance coordinated data management strategies. In addition to internal Action Agency staff support, technical experts were funded for participation in the PNAMP work group products. Action Agency staff also were active in the formation of the Northwest Information Sharing Executive Forum, which involved executives from multiple entities across the Pacific Northwest to advance the common goal of more efficient and robust monitoring and information sharing.

RME Strategy 2 – Hydrosystem RME (RPA Actions 52–55)

A comprehensive list of all actions implemented by the Action Agencies for RPAs 52 through 55 is included in Section 4. All but two RPA subactions are met by projects that either currently or soon will be in place. RPA subactions 52.6 and 55.3 are expected to involve additional action.

RPA Action 52 – Monitor and Evaluate Fish Performance within the FCRPS:

The Action Agencies will monitor the following biological responses and/or environmental attributes involved in passage through the hydrosystem, and report these estimates on an annual basis:

1. *Monitor and evaluate salmonid dam survival rates for a subset of FCRPS projects.*

   The effects of configuration and operation changes were evaluated at John Day Dam in 2009. Route-specific and dam survival were estimated at the dam for 30 percent and 40 percent spill operations and surface weir configuration.

   The Action Agencies addressed this RPA's subaction through implementation of three BPA projects that have successfully demonstrated that acquiring survival estimates is feasible using strategically located releases of smolts tagged with active tags (Juvenile Salmonid Acoustic Tags (JSATs) in these applications). However, the preferred experimental design has not yet been

selected. Two options are being considered, a single-dam format and a multi-dam format. The region is in the process of determining which experimental design is most appropriate. In 2009, under the AFEP program, a new multi-dam experimental design was developed (AFEP project SPE-06-2) that could substantially reduce costs and provide statistically sound dam survival estimates. In the Snake River, the single-dam method is moving forward under projects SPE-W-08 and SPE-W-05 and may soon be applied in dam survival standard tests.

2. *Monitor and evaluate juvenile salmonid in-river and system survival through the FCRPS, including estimates of differential post-Bonneville survival of transported fish relative to in-river fish (D-value) as needed.*

   Eight projects were continued that addressed this RPA's subaction. Tagged smolts entering and migrating through the FCRPS (Lower Granite through Bonneville dams) were used in 2009 to estimate survival and have been produced annually since 1994. NOAA Fisheries conducts the analysis under BPA project 1993-029-00 using fish PIT-tagged fish under the Smolt Monitoring Program, BPA project number 1987-127-00, and Comparative Survival Study (CSS), BPA project number 1996-020-00.

3. *Monitor and evaluate adult salmonid system survival upstream through the FCRPS.*

   Three projects were continued to fulfill this subaction. For example, the PTAGIS system, BPA project 1990-080-00, provides data on returning adults of known origin. In addition, NOAA Fisheries biologists conducted analyses and reported upstream passage survival for 2009.

4. *Provide additional PIT-tag marking of Upper Columbia River populations to provide ESU specific estimates of juvenile and adult survival through the Federal mainstem dams.*

   Two projects were continued to fully address this effort in 2009: BPA projects 2008-724-00 and 1987-127-00. Planning is ongoing for the extent of tagging and stock coverage required and will be specified in the tagging plan being developed under RPA action 52.6. The extent of tagging and stock coverage has not yet been specified. These populations would be incorporated into the annual system smolt and adult survival monitoring. Efforts being undertaken by public utility districts may supplement the federal effort.

5. *Assess the feasibility of PIT-tag marking of juvenile Snake River Sockeye Salmon for specific survival tracking of this ESU from the Stanley Basin to Lower Granite Dam and through the mainstem FCRPS projects.*

   Two projects, BPA project number 2008-724-00 and 1987-12-700, were continued to address this subaction. This work was initiated as a pilot study in 2009 to assess long-term needs with respect to precision levels and sample sizes for future work.

6. *Develop an action plan for conducting hydrosystem status monitoring (analytical approaches, tagging needs, methods, and protocols) in ongoing collaboration with the State and Federal fishery agencies and Tribes. This will be done in coordination with status monitoring needs and strategies being developed for estuary/ocean, habitat, hatcheries, and harvest. (Initiate in FY2009)*

   One BPA project was continued to support the baseline monitoring needs of this RPA. This RPA action will be addressed in FY2009 and FY2010 through development of a regional PIT-tagging plan, including input from the Action Agencies, NOAA Fisheries, other federal agencies, state, and tribal agencies.

7. *Cooperate with NOAA Fisheries, US v Oregon parties, Confederated Tribes of the Colville Reservation, and other co-managers to 1) review relevant information and identify factors (migration timing, spatial distribution, etc.) that might explain the differential conversion rates (BON to MCN) observed for UCR steelhead and spring Chinook salmon compared to SR steelhead and spring/summer Chinook salmon (see RPA Table 7 and **SCA - Adult Survival Estimates Appendix); 2) develop a monitoring plan to determine the most likely cause of these differential losses (considering the potential use of flat plate PIT-tag detectors in tributaries or fishery areas, additional adult detectors at The Dalles and John Day fishways, etc. to provide improved estimates of harvest or stray rates for improved conversion rate estimates in the future); and 3) implement the monitoring plan.*

   Three BPA projects were continued to support this RPA. The feasibility of using a tributary PIT antenna to detect adult salmon in the John Day River (see RPA action 52) was evaluated. The PIT

antenna withstood spring freshet flows and has been detecting PIT-tagged adult fish. Effectiveness monitoring was initiated in 2009 to determine the detection efficiency of the system.

Monitoring adult passage counts is a cornerstone monitoring activity that must be performed on an annual basis. Adult fish counting is typically performed 16 hours per day, during daylight hours, by either video or visual counting methods, at all of the Corps projects that pass fish. Adult fish counting will continue at a minimum on the schedule presented in Table 8.

Adult fish counts were conducted as called for in Table 8 of the RPA with the following exceptions: At The Dalles, John Day, McNary and Ice Harbor dams, adult fish were counted from April 1 through October 31, rather than the dates shown in Table 8. At Lower Granite, 24-hour counts were conducted from June 15 through September 30, rather than through August 31. All changes were fully coordinated during development of the Fish Passage Plan and through the FPOM work group process.

RPA Action 53 – Monitor and Evaluate Migration Characteristics and River Condition

1. *Monitor and estimate the abundance of smolts passing index dams.*

   Three BPA projects were continued in 2009 to address this subaction. For example, the Fish Passage Center project, BPA project number 1994-030-00, calculated passage indices at all collector dams, as well population estimates at Lower Granite Dam. NOAA Fisheries seeks improved smolt abundance estimates and expanded coverage at more dam monitoring sites.

2. *Monitor and describe the migration timing of smolts at index dams, identify potential problems, and evaluate implemented solutions.*

   Eleven BPA projects were continued in 2009 to fully address this subaction. For example, this was addressed by BPA's Smolt Monitoring Program (BPA project 1987-127-00). Data provided by this program were analyzed by the FPC, BPA project number 1994-030-00, and NOAA Fisheries, as well as a host of other regional fish management agencies. Additional evaluation of the Smolt Monitoring Program data is expected to determine the extent to which population-specific (PIT-tagged) data are needed to describe timing.

3. *Monitor and document the condition (e.g., descaling and injury) of smolts at all dams with juvenile bypass system (JBS) systems, identify potential problems, and evaluate implemented solutions.*

   Eight projects were continued to fully address this subaction. As in RPA action 53.2, the Smolt Monitoring Program monitored and documented fish condition in 2009. The FPC and other agencies provided analysis and implementation recommendations. The reduction in handling was the only potential problem identified that may be addressed in future operations.

4. *Monitor and enumerate adult salmonids passing through fishways in the FCRPS, identify potential problems, and evaluate implemented solutions.*

   In 2009, the Corps again implemented its adult fish count program as detailed in the FPP. Results are available in the *2009 Annual Fish Passage Report: Columbia and Snake Rivers*, available at *http://www.nwp.usace.army.mil/environment/FishData/docs/2009afpr.pdf.*

   Fishways were monitored on a regular basis, as per FPP specifications. Results are discussed in an annual Fishway Inspection Report prepared for each project. Fishways were also inspected by representatives from NOAA Fisheries and other agencies. Results of those inspections are available at http://www.fpc.org/documents/Fishway_Inspection_Reports.html.

   See also the discussion of adult passage improvements under RPA 28 above.

5. *In addition to current operations (generally April 10 – August 31), evaluate operation of the Bonneville (second powerhouse) PH2 corner collector from March 1 through start of spill as a potential means to provide a safer downstream passage route for steelhead kelts, and implement if warranted.*

An assessment of the March–April operation of the corner collector was completed in 2008. No further action was taken in 2009.

The Bonneville Corner Collector was operated beginning on April 3, 2009. This was seven days earlier than the start of operations as described in the 2008 BiOp. The April 3 start date was coordinated with the region through the TMT and FPOM processes. Discussions on future operation and evaluations are ongoing and will be addressed in the Kelt Management Plan (RPA 33).

RPA Action 54 – Monitor and Evaluate Effects of Configuration and Operation Actions

1. *Monitor and evaluate the effects of existing spillways, modifications, and operations on smolt survival.*

   An assessment of 30 percent vs. 40 percent spill and surface passage weirs was conducted at John Day Dam. The summer test of fall Chinook passage and survival was cut short due to breakage of avian array wires, allowing high levels of predation.

   The effects of configuration and operation changes on juvenile fish passage were evaluated at Little Goose, Lower Monumental, Ice Harbor, and McNary dams. Studies of direct injury were conducted at the Little Goose spillway weir and spillway.

   See the entries for RPA actions 18 through 25 for specific studies and results.

2. *Monitor and evaluate the effectiveness of traditional juvenile bypass systems and modifications to such, on smolt survival and condition.*

   An assessment of the Bonneville Second Powerhouse bypass system was conducted (see RPA action 18 above) and two projects were continued to monitor the long-term effectiveness of bypass systems. The AFEP regularly evaluates bypass performance as new systems are built or existing systems are upgraded. The passage and survival studies above also estimated the proportions collected by the bypass system and the resulting survival rates.

   See the entries for RPA actions 18 through 24 for specific studies and results.

3. *Monitor and evaluate the effectiveness of surface bypass structures and modifications on smolt survival and condition.*

   Surface passage weirs at John Day Dam and a BGS for the Corner Collector at Bonneville Second Powerhouse were evaluated.

   Route-specific passage and survival rates were estimated at Little Goose, Lower Monumental, Ice Harbor, and McNary dams to fully satisfy this subaction. (Copies of draft reports are under review and are available from the Corps.)

   See the entries for RPA actions 18 through 24 for specific studies and results.

4. *Monitor and evaluate the effectiveness of turbine operations and modifications on smolt survival and condition.*

   The Corps estimated route-specific passage and survival rates at Little Goose, Lower Monumental, Ice Harbor, McNary and John Day dams.

   At Bonneville Second Powerhouse, an assessment of turbine operations on fish injury and survival in the Juvenile Bypass System gatewells was conducted.

   A Biological Index Test was planned to evaluate operating turbines at the higher end of the 1 percent band at McNary Dam. The evaluation was canceled due to concerns of potential gatewell descaling raised in the SRWG forum. As a result of fish health concerns a gatewell descaling evaluation will be conducted in 2010 at McNary Dam.

5. *Monitor and evaluate overall dam passage with respect to modifications at projects (including forebay delay and survival).*

   Five Corps AFEP projects (at Little Goose, Lower Monumental, Ice Harbor, McNary and John Day dams), and two BPA projects, were continued to fully address this subaction through passage and survival studies, which estimate forebay and tailrace passage times and survival rates in the forebay.

6. *Monitor and evaluate the effectiveness of the juvenile fish transportation program and modifications to operations.*

In 2009, the Action Agencies continued to make progress on monitoring and evaluating the effectiveness of the juvenile fish transportation program; this included six BPA projects. Information resulting from 2009 RME will enable further progress in identifying the benefits of transportation and supporting adaptive management actions. Significant 2009 RME is as follows:

- **Spring Migrants:** The Action Agencies continued research to determine the potential of transportation to increase adult returns of anadromous salmon. A PIT-tag study to evaluate weekly SARs for natural spring Chinook and steelhead transported from Lower Granite Dam continued in 2009. More precise transportation data in the April time frame should help clarify effects of transportation on early migrating fish. More precise data in the May time frame should allow for correlation of physical and environmental factors to guide Action Agencies on appropriate triggers of how to operate transportation on an annual basis to maximize adult returns.

- **Summer Migrants:** In 2009, the Action Agencies continued implementing the 2007 fall Chinook salmon consensus proposal and long-term framework developed collaboratively with regional fish management agencies and tribes. This intensive research, monitoring, and evaluation effort for subyearling fall Chinook salmon will help determine the appropriate management strategy to optimize adult returns.

  In 2009, intensive RME efforts were conducted on Snake River fall Chinook salmon. These efforts are expected to provide information to evaluate early life history and migration behavior, the performance of hatchery fish as surrogates for wild fish, and the benefits of late season transportation, as well as to compare production fish groups' performance to wild and surrogate fish.

- **Sockeye transport:** In an effort to better estimate in-river survivals and SARs, a pilot study was initiated in 2009 to examine the relative survival of sockeye subject to transport, bypass, and spill. For this study, sockeye salmon smolts were PIT-tagged at Sawtooth hatchery in Idaho (n=52,833) and Oxbow Hatchery in Oregon (n=10,957). A total of 10,937 PIT-tagged sockeye salmon were released into Redfish Lake Creek, and 52,551 PIT-tagged sockeye salmon were released into the upper Salmon River. Approximately 70 percent of the PIT-tag codes were assigned to be diverted for transportation via barges, and 30 percent returned to the river; with the goal of achieving a 1:1 ratio of transported to in-river migration.

7. *Monitor and evaluate the effects of environmental conditions affecting juvenile fish survival.*

Seven projects were continued to fully address this subaction. Total dissolved gas, temperature, turbidity, and flow are considered key factors, and they are regularly monitored throughout the FCRPS. Many PIT-tagged fish migrating through the system from assorted projects provide response units for analyzing effects on smolt survival or migration characteristics. The FPC, NOAA Fisheries, and the CSS have conducted these types of probative analyses. The Corps funds the collection and recording of temperature and TDG data and index flow at dams. Data Access Real Time (DART) compiles and displays these and other environmental and fish data, as does the FPC.

8. *Monitor and evaluate the effectiveness of reducing predation toward improving juvenile fish survival.*

In 2009, ongoing research under CRFM and BPA FWP funding continued monitoring of avian predators and their colonies (O&M), dam angling, and estimates of annual exploitation of pikeminnow (modeling), in conjunction with juvenile dam survival studies.

9. *Investigate, evaluate and deploy alternative technologies and methodologies for fish passage and the RME Action.*

New passage technologies have been and will continue to be prototyped, tested, and ultimately deployed as part of the AFEP and CRFM. In 2009, a new spillway weir was installed and tested at

Little Goose Dam. Also in 2009, a second year of testing was conducted on two prototype spillway weirs at John Day Dam (see RPA 20 for details), and on the spillway weir that was installed at Lower Monumental Dam (see RPA 23 for details).

10. *Determine if actions directed at benefiting juveniles have an unintended effect on migrating adults (e.g., certain spill operations).*

    This issue is addressed at each project as need arises. The AFEP forum addresses this matter. No adult behavior studies were conducted in the Walla Walla district during 2009.

11. *Install and maintain adult PIT-tag detectors in fish ladders at key dams in the FCRPS and evaluate adult survival (conversion rates).*

    BPA continued the Adult Pit Detector Installation project in 2009. PIT-tag detectors are now installed in all key FCRPS ladders. However, currently there are no detectors at The Dalles and John Day dams. Tributary turn-off and straying between Bonneville and McNary dams is of concern when calculating conversion rates or upstream passage survival. If stream-based PIT detectors successfully function in the major tributaries in this reach, the need for additional ladder coverage could be circumvented. (Those systems were tested again in 2009).

12. *Monitor and evaluate the effects of fish ladder operations and configurations on adult passage rates.*

    Five projects were continued to fully address this subaction. This issue is addressed at each project as needed through the AFEP process.

13. *In addition to the current sluiceway operation (generally April 1–November 30), evaluate operation of The Dalles Dam sluiceway from March 1–March 31 and from December–December 15 as a potential means to provide a safer fallback passage route for overwintering steelhead and kelts, implement if warranted.*

    A second year of evaluation was initiated in December 2009 (and continued in March 2010). Results will be used to develop a long-term operation plan.

14. *Investigate surface-flow outlets during wintertime to provide safer fallback opportunity for over wintering steelhead (need will be determined by results of further research).*

    See RPA action 54.13 above. Also see entry for B2 corner collector.

RPA Action 55 – Investigate Hydro Critical Uncertainties and Investigate New Technologies: *The Action Agencies will fund selected research directed at resolving critical uncertainties that are pivotal in lifecycle model analyses.*

1. *Investigate and quantify delayed differential effects (D-value) associated with the transportation of smolts in the FCRPS as needed. (Initiate in FY 2007–2009 Projects)*

    Multiple projects (including nine BPA projects) were continued to fully address this subaction. Species coverage was expanded in 2009 to include sockeye. Other species will continue at some level, but the frequency of and sample size for acquiring estimates needs clarification for future years. This complements RPA 52.2, which calls for D-estimates to be incorporated into system survival evaluations. See discussion of RPA action 31 for further details.

2. *Investigate the post-Bonneville mortality effect of changes in fish arrival timing and transportation to below Bonneville. (Initiate in FY 2007–2009)*

    Multiple projects (including 10 BPA projects) were continued to fully address this subaction through review in the AFEP, with focus on Bonneville-Bonneville SARs (i.e. from Bonneville to the ocean and back to Bonneville). Recent NOAA Fisheries transport studies treat this issue with the expectation that the regional PIT Tagging Plan will fully address the details of this RPA. See discussion of RPA action 31 for further details.

3. *Conduct a workshop every other year with members of the Independent Scientific Advisory Board (ISAB) to review current research and monitoring approaches on post Bonneville mortality for transported and non-transported fish. (Initiate in FY 2009).*

   BPA and the Corps initiated a research project in 2008 and continued in 2009 to fully support this subaction. The workshop is in the early planning stages and will be held in the fall of 2010. The workshop will synthesize research results and analyses, identify further needs, and plan the direction of future research. In 2009, ISAB began review of the proposed 2010 studies for lower river survival and the estuary program.

4. *Investigate, describe and quantify key characteristics of the early life history of Snake River Fall Chinook Salmon in the mainstem Snake, Columbia, and Clearwater rivers. (Initiate in FY 2007-2009 Project).*

   Four BPA projects were continued to fully address this subaction. Studies have been funded by BPA for more than a decade, and complementary projects (such as radio tag investigations in Snake reservoirs) have been funded by the Corps under the AFEP. Additionally, ongoing transport studies have important life history implications. This has been a complex, multi-faceted set of investigations that have taken place over a number of years.

5. *Complete analysis and reporting of a multi-year (2000-2007) investigation on the effects of adult passage experience in the FCRPS on pre-spawning mortality (2008). Following reporting, SRWG will review the results and provide a recommendation on the need and nature of future research. Future research will be coordinated through the Regional Forum.*

   This action was completed in 2008. The final report is posted at *http://www.nwp.usace.army.mil/pm/e/reports/afep/system/SFS_Tech_Report_2009-4_Final.pdf*

6. *Continue development of state-of-the-art turbine units to obtain improved fish passage survival through turbines with the goal of using these new units in all future turbine rehabilitation or replacement programs.*

   In 2009, the Corps submitted a draft final report of the effects of rapid decompression, one of the major injury mechanisms to juvenile fish passing through turbine units, on tagged and untagged fish. Due to the possibility of biased results in that study, the Corps initiated a new study to determine whether effects of rapid decompression on tagged fish differ in type or degree from those on untagged fish.

   The Corps conducted physical studies at the Engineering Research and Development Center observational turbine model to determine alternatives for runner, stay vane, wicket gate and draft tube designs for a new turbine runner at Ice Harbor Dam. The Corps advertised a contract for design, manufacture and delivery of a fixed blade runner for Unit 2, with an option for manufacture and delivery of an adjustable blade runner for Unit 3.

   The Corps also completed a study of alternative methods of capturing fish that have passed through turbines, with study results recommending a direct capture device. Plans and specifications for that direct capture device were then developed. That device is now expected to be deployed at Ice Harbor Dam as part of the effectiveness testing of the new runner design.

7. *Investigate feasibility of developing PIT-tag detectors for spillways and turbines.*

   Two projects continued to fully address this subaction. BPA project number 1983-319-00 continued to address new detectors for spillways and turbines. Work in 2009 involved determining the feasibility of installing a PIT detector in the spillway at Bonneville and Ice Harbor dams, as well as the feasibility of installing detectors in the various surface spill weirs that are currently installed throughout the system.

8. *Evaluate new tagging technologies for use in improving the accuracy and assessing delayed or indirect hydro effects on juvenile or adult fish.*

   Through the Corps' Survival Methodologies Program, research was conducted on the effects of tagging juvenile Chinook salmon in an effort to improve surgical implantation techniques used for implanting acoustic transmitters. Utilizing this research as well as input from regional experts,

substantial progress was made on the standardization of surgical tagging protocols. A final protocol document is pending finalization in 2010. In addition to tagging protocols, standardization of methods for estimating dam passage survival was completed in 2009. This effort included extensive review by the region and the Independent Scientific Review Panel.

BPA funded three projects, including the Pacific Ocean Survival Tracking Project (POST), BPA project number 2003-114-00. This project continued the development of tags and methods in 2009 to determine delayed or indirect effects of hydro passage by looking in the estuary below Bonneville Dam and the ocean environment off the Pacific coast. Data from these efforts are presented in a variety of government reports and peer-reviewed journal articles.

9. *Assess the feasibility of developing PIT-tag detectors for use in natal streams and tributaries, or other locations, as appropriate to support more comprehensive and integrated All-H monitoring designs and assessments of stray rates.*

The feasibility of using a tributary PIT antenna to detect adult salmon in the John Day River was evaluated (see also RPA action 52.7). The PIT antenna withstood spring freshet flows and has been detecting PIT-tagged adult fish. (Effectiveness monitoring in New Marking Monitoring Techniques by BPA was initiated in 2009 and will be continued in 2010 to determine the detection efficiency of the system.)

The Corps supported efforts by NOAA Fisheries to develop a spillway PIT antenna design for Bonneville Dam. Dry tests were run on an existing spillway gate housed in the spillway repair pit. Work in 2009 will include assessing vibration and electro-magnetic fields on an operating gate.

RME Strategy 3 (RPA Actions 56–57)

A comprehensive list of all actions implemented by the Action Agencies for RPAs 56 and 57 is included in Section 4. For RPA 56 and 57, the RME Work Group identified additional monitoring to supplement this ongoing monitoring.

RPA Action 56 – Monitor and Evaluate Tributary Habitat Conditions and Limiting Factors:

The Action Agencies will:

1. *Implement research in select areas of the pilot study basins (Wenatchee, Methow and Entiat river basins in the Upper Columbia River, the Lemhi and South Fork Salmon river basins, and the John Day River Basin) to quantify the relationships between habitat conditions and fish productivity (limiting factors) to improve the development and parameterization of models used in the planning and implementation of habitat projects. These studies will be coordinated with the influence of hatchery programs in these habitat areas.*

Thirty BPA projects were continued and one was initiated by BPA; three projects by Reclamation were continued that have elements that support research in select areas of the pilot study basins (Wenatchee, Methow, and Entiat River basins in the upper Columbia River, the Lemhi and South Fork Salmon River basins, and the John Day River Basin) to quantify the relationships between habitat conditions and fish productivity (limiting factors) and improve the development and parameterization of models used in the planning and implementation of habitat projects. These studies provide a means of evaluating the effectiveness of tributary mitigation actions. The Integrated Status and Trend Monitoring Program (ISEMP) continued to implement action effectiveness studies as part of their research program for the pilot subbasins.

In the Methow River Basin, Reclamation has planned an intensive effectiveness monitoring program that will address the effects of actions intended to address the primary limiting factors there (lack of riparian/off-channel habitat and obstructions). This program began in 2009. Reclamation also conducted a series of meetings in 2007–2008 to finalize the Methow Study Plan. The study plan includes research on habitat limiting factors to fish production, and a Before, After, Control, Impact (BACI)-design study of a large channel rehabilitation project. An extensive PIT-tag array system was constructed on all major tributaries and the main river of the Methow Basin.

Reclamation also completed field work through a sub-contract with Idaho State University to assess fish food webs in the middle Methow River. Finally, Reclamation will provide PIT tags to the USFWS at the Winthrop NFH to tag and release large groups of hatchery fish, both to understand the potential effects of hatchery juveniles on stream-reared juvenile fish production and to use the releases to help estimate trap and detection efficiencies.

In addition, monitoring needed to infer relationships based on correlation among limiting factors, habitat actions, and productivity in support of RPA 3 (comprehensive evaluations) will also be addressed under RPAs 50.6 and 56.3.

2. *Implement habitat status and trend monitoring as a component of the pilot studies in the Wenatchee, Methow and Entiat river basins in the Upper Columbia River, the Lemhi and South Fork Salmon river basins, and the John Day River Basin. (Initiate in FY 2007-2009 Projects, annually review and modify annually to ensure that these project continue to provide a means of evaluating the effectiveness of tributary mitigation actions.)*

   Seven projects were continued that have elements that supported the implementation of habitat status and trend monitoring as a component of the pilot basin studies. For example, BPA project number 2003-017-00 evaluated multiple methodologies to assess salmonid habitat condition and implemented these standards in the in the Wenatchee, Methow and Entiat river basins in the upper Columbia River, the Lemhi and South Fork Salmon river basins, and the John Day River Basin. To further support this RPA, the ASMS strategy identified opportunities to expand habitat status and trend monitoring for one population per major population group.

3. *Facilitate and participate in an ongoing collaboration process to develop a regional strategy for limited habitat status and trend monitoring for key ESA fish populations. This monitoring strategy will be coordinated with the status monitoring needs and strategies being developed for hydropower, habitat, hatchery, harvest, and estuary/ocean.*

   Seven projects continued to be implemented in 2009 to support this RPA. Collaboration work groups for fish population and tributary habitat monitoring were formed in late 2008 and continued to make progress in 2009 on the ASMS that includes fish population and habitat monitoring for at least one population per major population group. Additional projects are being implemented in 2010 and 2011 to support this strategy and help meet this RPA.

RPA Action 57 – Evaluate the Effectiveness of Tributary Habitat Actions

The Action Agencies will evaluate the effectiveness of habitat actions through RME projects that support the testing and further development of relationships and models used for estimating habitat benefits. These evaluations will be coordinated with hatchery effectiveness studies.

1. *Action effectiveness pilot studies in the Entiat River Basin to study treatments to improve channel complexity and fish productivity.*

   BPA project numbers 2002-059-00 and 2003-017-00 were continued to support action effectiveness pilot studies in the Entiat River Basin to study treatments to improve channel complexity and fish productivity. Results of this project were shared in development of the ASMS strategy and upper Columbia River recovery strategy to support further implementation of habitat treatment actions.

2. *Pilot study in the Lemhi River Basin to study treatments to reduce entrainment and provide better fish passage flow conditions.*

   Two BPA projects were continued to fully address the pilot study in the Lemhi River Basin to study treatments to reduce entrainment and provide better fish passage flow conditions. The ISEMP project, BPA project number 200301700, successfully installed large Biomark PIT-tag arrays in the Lemhi and collected PIT-tag information for 2009. The project also continued to conduct habitat and fish population density monitoring to support the evaluation of treatments to reduce entrainment and provide better fish passage flow conditions.

3. *Action effectiveness pilot studies in Bridge Creek of the John Day River Basin to study treatments of channel incision and its effects on passage, channel complexity, and consequentially fish productivity.*

Two BPA projects were continued to fully support action effectiveness pilot studies in Bridge Creek of the John Day River Basin to study treatments of channel incision and its effects on passage, channel complexity, and, consequentially, fish productivity. The ISEMP project, BPA project number 2003-017-00, continued to evaluate changes in fish density relative to action implementation. Findings supported effectiveness of reintroduction of beavers on improving fish habitat condition as a treatment to channel incision.

4. *Project and watershed level assessments of habitat, habitat restoration and fish productivity in the Wenatchee, Methow and John Day basins.*

Seven BPA projects were continued and one was initiated to support project- and watershed-level assessments of habitat, habitat restoration, and fish productivity in the Wenatchee, Methow, and John Day river basins. For example, BPA project number 2003-017-00 completed assessment to develop common protocols for monitoring salmonid habitat conditions and fish juvenile density to support watershed assessments of habitat condition.

Reclamation continued its work through an interagency agreement with USGS to evaluate listed steelhead population changes in response to barrier removals in Beaver, Libby, and Gold creeks, which are tributaries in the Lower Methow River.

Reclamation's 2008 BiOp habitat program provided technical assistance to a suite of partners to help implement habitat improvement projects as defined by RPA Actions 34 and 35. Reclamation's Methow RME Study Plan under an interagency agreement with USGS (see RPA 56 above) evaluated the effectiveness of the M2 Reach habitat improvement actions in the mainstem Methow River.

In 2009, Reclamation and USGS continued the pretreatment monitoring phase of the project; this is designed to address specific questions about the response of target fish species (Chinook salmon, steelhead, and bull trout) to the restoration actions. Reclamation also led coordinated monitoring planning in the Methow Basin, including the development of a water quality monitoring program and an inventory of basinwide passage projects that will lead to an assessment in 2010. Meanwhile, Reclamation and USGS worked on models to predict the response to treatments.

5. *Action Agencies will convene a regional technical group to develop an initial set of relationships in FY 2008, and then annually convene the group to expand and refine models relating habitat actions to ecosystem function and salmon survival by incorporating research and monitoring results and other relevant information.*

The Tributary Habitat and Fish Population Work Group continued to meet in 2009 to evaluate survival models. However, the technical group did not include other technical staff from the co-managers (federal and state agencies and the tribes).

RME Strategy 4 (RPA Actions 58–61)

A comprehensive list is included in Section 4 for all actions implemented by the Action Agencies during 2009 for RPAs 58 through 61. Most of the RPA specifications either were fully covered by ongoing projects or would be fully covered with some additional work elements. Included after the RPA 61 description, below, is a synopsis of 2009 estuary and ocean RME results.

RPA Action 58 – Monitor and Evaluate Fish Performance in the Estuary and Plume

The Action Agencies will monitor biological responses and/or environmental attributes, and report in the following areas:

1. *Monitor and evaluate smolt survival and/or fitness in select reaches from Bonneville Dam through the estuary.*

Two Corps AFEP projects were continued to support this subaction. AFEP Project EST-02-01, A Study of Salmonid Survival and Behavior through the Columbia River Estuary Using Acoustic Tags,

directly addressed this RPA. During 2009, more than 15,000 juvenile salmon were tagged with miniaturized acoustic transmitters, released at several sites upstream of Bonneville Dam, and detected at seven acoustic telemetry arrays deployed across the lower Columbia River and estuary at locations ranging from the Bonneville Dam tailrace to the jetties at the mouth of the Columbia River. Data from the study were used to estimate survival rates of yearling and subyearling Chinook salmon and steelhead in various reaches of the lower river and estuary.

The BPA POST project also supported this RPA during 2009 by estimating survival rates in the lower river and estuary in conjunction with research on survival rates in the eastern Pacific Ocean.

To fully address this subaction, the Estuary/Ocean RME Subgroup recommended assessing the applicability and the feasibility of measuring the fitness of juvenile salmon at select locations in the lower Columbia River and estuary under AFEP project EST-09-P-0, or a new project.

2. *Develop an index and monitor and evaluate life history diversity of salmonid populations at representative locations in the estuary.*

During 2009, this subaction was addressed directly by AFEP project EST-09-P-01, Evaluation of Life History Diversity, Habitat Connectivity, and Survival Benefits Associated with Habitat Restoration Actions in the Lower Columbia River and Estuary. This project was initiated in part to address RPA action 58.2. Other projects collect juvenile salmon density data that are relevant to this subaction: BPA 2005-001-00 and BPA 2003-010-00.

3. *Monitor and evaluate juvenile salmonid growth rates and prey resources at representative locations in the estuary and plume.*

Four BPA projects were continued to fully address the RPA subaction. For example, in BPA projects 1998-014-00, Ocean Survival of Salmonids, and 2003-010-00, Historic Habitat Opportunities and Food-Web Linkages, data were collected on juvenile salmon growth and prey resources during cruises along transects in the nearshore ocean and plume, and research was conducted in estuarine wetlands. Data from these studies and others were used to assess how environmental effects in the estuary and ocean affect juvenile salmon survival and adult return rates.

4. *Monitor and evaluate temporal and spatial species composition, abundance, and foraging rates of juvenile salmonid predators at representative locations in the estuary and plume.*

Two BPA projects were continued to fully support this subaction. BPA project 1998-014-00, Ocean Survival of Salmonids, addressed the plume component of this RPA subaction. The estuary component was addressed through several projects that focused on avian and piscivorous predators. Additional relevant information is presented below as part of the predation RPAs 68-70. Annual surveys of predation on juvenile salmon are conducted, revealing the most common predators and, in some cases, lead to estimates of predation rates.

RPA Action 59 – Monitor and Evaluate Migration Characteristics and Estuary/Ocean Conditions

The Action Agencies will monitor and evaluate selected ecological attributes of the estuary, which include the following or equivalent:

1. *Map bathymetry and topography of the estuary as needed for RME.*

Three BPA projects were continued to fully address this subaction for mapping the channel; however, a gap exists until the bathymetry and topographic mapping are completed for the floodplain. For example, BPA project number 2003-007-00, Lower Columbia River/Estuary Ecosystem Monitoring, was pivotal to work throughout the estuary during 2009 to address this RPA subaction. Hydrographic surveys were conducted during 2008 and 2009 for BPA project number 2003-007-00, based on bathymetric data gaps identified and prioritized at a workshop in October 2007. Numerous other projects collected site-scale elevation data using realtime kinematic GPS. In addition, Light Detection and Ranging (LIDAR) data for topography were

processed for selected sites under AFEP Project EST-02-P-04, Cumulative Effects of Habitat Restoration.

2. *Establish a hierarchical habitat classification system based on hydrogeomorphology, ground-truth it with vegetation cover monitoring data, and map existing habitats.*

   One BPA project was continued to address this RPA subaction, which was a primary objective of BPA project number 2003-007-00, Lower Columbia River/Estuary Ecosystem Monitoring. Development of the classification system continued during 2009.

3. *Develop an index of habitat connectivity and apply it to each of the eight reaches of the study area.*

   During 2009, this subaction was addressed directly by AFEP project EST-09-P-01, Evaluation of Life History Diversity, Habitat Connectivity, and Survival Benefits Associated with Habitat Restoration Actions in the Lower Columbia River and Estuary. This project was initiated in part to address RPA action 59.3. Other projects collect habitat data that are relevant to this subaction include BPA project number 2003-007-00 and AFEP EST-02-P-04.

4. *Evaluate migration through and use of a subset of various shallow-water habitats from Bonneville Dam to the mouth toward understanding specific habitat use and relative importance to juvenile salmonids.*

   One Corps and three BPA projects were continued and another one was initiated to fully address this RPA subaction. For example, BPA project number 2005-001-00, Tidal Freshwater Monitoring, sampled juvenile salmon and associated fish communities in shallow (< 5m) habitats from Longview to Washougal, Washington. As determined from beach seines and trap nets, juvenile salmon can be found year-round in the shallow waters of the lower river and estuary. The data increased understanding of specific habitat use and the relative importance of these habitats to juvenile salmon.

5. *Monitor habitat conditions periodically, including water surface elevation, vegetation cover, plan community structure, primary and secondary productivity, substrate characteristics, dissolved oxygen, temperature, and conductivity, at representative locations in the estuary as established through RME.*

   Nine AFEP and BPA projects were continued that address this RPA subaction. For example, BPA project number 2003-007-00, Lower Columbia River/Estuary Ecosystem Monitoring, monitored habitat conditions at four sites in the reach between Bonneville Dam and Woodland, Washington. Monitored indicators included vegetation composition, percent cover, elevation, substrate, channel cross-sections, and water quality. The data characterized relationships among plant communities, elevation, and hydrology that help in understanding the ecological importance of lower river and estuary habitats.

RPA Action 60 – Monitor and Evaluate Habitat Actions in the Estuary

The Action Agencies will monitor and evaluate the effects of a representative set of habitat projects in the estuary, as follows:

1. *Develop a limited number of reference sites for typical habitats (e.g., tidal swamp, marsh, island, and tributary delta to use in action effectiveness evaluations).*

   Four BPA projects were continued to fully address this RPA subaction. In particular, BPA project number 2003-011-00, Lower Columbia River/Estuary Habitat Restoration, included a component to develop a suite of reference sites as part of action effectiveness monitoring in the lower Columbia River and estuary. Data were collected from four sites during 2009 to assess the structure, function, and condition of a suite of tidal freshwater wetland habitats. Combined with data from previous years, there are over 40 sites in the reference database. Reference site data will be compared with restoration site data to determine the effectiveness of habitat restoration (see RPAs 60.2 and 60.3).

2. *Evaluate the effects of selected individual habitat restoration actions at project sites relative to reference sites and evaluate post-restoration trajectories based on project-specific goals and objectives.*

   Ten projects, where site-scale restoration effectiveness monitoring took place, were continued to fully address this RPA subactions. For example, under BPA project number 2003-011-00, Lower Columbia River/Estuary Habitat Restoration, researchers intensively monitored water surface elevation, bathymetry and topography, substrate, vegetation composition and percent cover, and juvenile salmon density at three sites where tidal reconnections were restored: Mirror Lake, Scappoose Bottomlands, and Fort Clatsop. This and other projects showed that juvenile salmon typically access the newly restored areas once the opportunity is provided. Site-scale action effectiveness was also conducted under AFEP EST-02-P-04.

3. *Develop and implement a methodology to estimate the cumulative effects of habitat conservation and restoration projects in terms of cause-and-effect relationships between ecosystem and controlling factors, structures, and processes affecting salmon habitats and performance.*

   Six projects were continued to fully address this RPA subaction. This subaction was the primary focus of AFEP Project EST-02-P-04, Evaluating Cumulative Ecosystem Response to Habitat Restoration Projects in the Lower Columbia River and Estuary. This multi-year project (2004-2011) has developed and is applying a methodology to evaluate the cumulative effects of multiple habitat restoration projects intended to benefit ecosystems that support juvenile salmon in the lower Columbia River and estuary. During 2009, the levels-of-evidence approach and ecological theory underpinning the analysis, synthesis, and evaluation of cumulative effects were finalized, and a preliminary analysis of restoration cumulative effects was initiated.

RPA Action 61 – Investigate Estuary/Ocean Critical Uncertainties

The Action Agencies will fund selected research direct at resolving critical uncertainties that are pivotal in understanding estuary and ocean effects.

1. *Continue work to define the ecological importance of the tidal freshwater, estuary, plume, and nearshore ocean environments to the viability and recovery of listed salmonid populations in the Columbia River Basin.*

   Seven BPA projects were continued to address this RPA subaction. Implementation of this RPA subaction was organized by water body: tidal freshwater (BPA project number 2005-001-00, Estuary RME Tidal Freshwater); estuary (BPA project number 2003-010-00, Historic Habitat Opportunities and Food-Web Linkages); plume (BPA project number 1998-014-00, Ocean Survival of Salmonids); and nearshore ocean (BPA project number 2003-009-00, Canada-US Shelf Salmon Survival Study). Collectively, these multi-year projects and others investigated the relationships among juvenile salmon condition, growth, and survival indicators. Data showed the importance of understanding factors affecting salmon populations over the entire salmon life cycle.

2. *Continue work to define the causal mechanisms and migration/behavior characteristics affecting survival of juvenile salmon during their first weeks in the ocean.*

   Two BPA projects were continued to fully address this RPA subaction: BPA project number 1998-014-00, Ocean Survival of Salmonids, and BPA project number 2003-114-00, POST. As part of the research, juvenile salmon were sampled with trawls as the fish moved between riverine and marine waters; data on species, age class, abundance, stock origin, size, diet, etc. were collected to determine how juvenile salmon change as they move between environments.

3. *Investigate the importance of early life history of salmon populations in tidal fresh water of the lower Columbia River.*

   Four BPA projects were continued to fully address this RPA subaction. For example, BPA project numbers 2003-010-00, Historic Habitat Opportunities and Food-Web Linkages, and 2005-001-00, Estuary RME Tidal Freshwater, were particularly relevant to this RPA subaction. Monthly beach seine sampling showed that juvenile coho and Chinook salmon were present in shallow, tidal freshwater habitats in the lower Columbia River in the vicinity of the Sandy River Delta during all

seasons, including winter. Based on genetic analysis of stock of origin, possible source populations for these fish ranged from areas in the lower Columbia River to areas in the middle Columbia River and Snake River.

4. *Continue development of a hydrodynamic numerical model for the estuary and plume to support critical uncertainties investigations.*

Two BPA projects were continued to address this RPA subaction. For example, hydrodynamic modeling was conducted under BPA project numbers 1998-014-00, Ocean Survival of Salmonids, and 2003-010-00, Historic Habitat Opportunities and Food-Web Linkages. Modelers worked to develop an advanced observatory for the Pacific Northwest coastal margin, including the Columbia River estuary and plume. CORIE, a collaborative pilot environmental observation and forecasting system, served as the heart of the observatory with its modeling system, observation network, and cyber-infrastructure. Modeling was used to evaluate contemporary and future habitat changes caused by climatic and anthropogenic effects and to describe the temporal and spatial features of the Columbia River estuary and plume that are important for salmon in relation to ocean conditions.

Synopsis of 2009 Estuary and Ocean RME

Status and Trends Monitoring

NMFS (2010a) reported that "During the second half of 2009, the trend of cold ocean conditions that began in 2007 and continued through 2008, changed noticeably. After June, the ocean began to warm significantly, leading to detrimental changes in the pelagic food web and likely high mortality of juvenile salmonids." NMFS's ocean ecosystem indicators (*http://www.nwfsc.noaa.gov/research/divisions/fed/oeip/a-ecinhome.cfmh*) provide context critical to management decision-making in the Columbia River Basin.

Magie et al. (2010), operating a specially modified trawl with a "matrix" antenna designed to increase the detection rate of PIT-tagged fish in the Lower Columbia River Estuary (LCRE) at river kilometer 61-83, found mean survival rates from Lower Granite reservoir to Bonneville Dam during 2009 for yearling Chinook salmon and steelhead were 56 percent (SE = 2.8 percent) and 69 percent (SE = 6.2 percent), respectively. This sampling effort is significant because, since 1998, it has allowed survival estimation between John Day and Bonneville dams using PIT-tag detection data.

McMichael et al. (2010) reported that the preliminary 2009 survival estimate for yearling Chinook salmon from Bonneville Dam tailrace to the mouth of the Columbia River, pooled over all releases, was 0.78 (range = 0.74 to 0.85; SE 0.01). For steelhead, pooled survival was 0.53 (range = 0.47 to 0.60; SE 0.01). For subyearling Chinook salmon, pooled survival was 0.64 (range = 0.36 to 0.78; SE 0.01). The largest losses appeared to occur in the lower 50 km of the river for yearling Chinook salmon and the lower 86 km for steelhead. Mortality of subyearling Chinook salmon was fairly evenly distributed from Bonneville to the mouth. These data will support strategic management actions to reduce mortality rates for juvenile salmonids in the LCRE.

Jones et al. (2010) examined vegetation and elevation data collected at relatively undisturbed, emergent wetland sites throughout the LCRE. This monitoring provided important information on the condition of habitats supporting juvenile salmonids in the LCRE. As stated in the report, this research "…further developed the Columbia River Estuary Ecosystem Classification…collected bathymetry data, filling 12,600 acres of 14,235 acres identified as high and medium priority data gaps and needed for completing the Classification…convened a landcover workshop to discuss collection strategies for landcover data acquisition…collected datasets (such as vegetation, habitat, prey, and salmonids)…to characterize habitat, fish, and prey at all sites and assess year-to-year trends at previously sampled sites…characterized habitat and biological communities at 3 forested tidal freshwater wetlands…"

Action Effectiveness Research.

Johnson and Diefenderfer (eds) (2010) produced the sixth annual report of an eight-year project (2004 through 2011) to evaluate the cumulative effects of habitat restoration actions in the lower Columbia River and estuary. Selected key findings include: a) channel density is probably not a good indicator of habitat development where preexisting channels are present (e.g., Kandoll Farm), but it may be a useful for constructed wetland (e.g., the Crims Island restoration; b) during an intensive material-exchange study at Kandoll Farm during April 2009, inorganic suspended sediments were the predominant component of total suspended sediments during both spring- and neap-tides series; c) habitat opportunity for juvenile salmon can be evaluated by quantifying wetted area, frequency, and duration of inundation using a GIS-based time-area inundation index; and d) juvenile Chinook salmon were found at all historical breaches and created sites and, overall, were second in abundance to stickleback at these sites. These data will be among those used in a comprehensive evaluation of multiple restorations projects, estuary-wide in 2011.

Roegner et al. (2010) found that breaching caused an immediate return of full semi-diurnal tidal fluctuations to diked pastureland and, most importantly, juvenile salmonids quickly expanded into this newly available habitat and utilized prey items presumably produced within marshes at the restored site. Based on size and the timing of hatchery releases, they concluded most Chinook, chum, and coho salmon sampled in restored and reference sites were progeny from wild spawners. In addition, genetic data suggested Chinook salmon originating outside the study area had migrated from the mainstem into shallow tidal freshwater habitats and were utilizing restored wetland habitat. Increasing opportunity for juvenile rearing appears to benefit both wild populations and, for Chinook salmon at least, individuals from other watersheds.

During 2009, the Estuary Partnership and restoration partners continued: a) implementation of action effectiveness research at four project sites and b) development of a suite of reference sites in tidal marshes, swamps, and other estuary habitats having relatively undisturbed ecosystem structure and processes (LCREP 2010). This research will allow managers to assess action effectiveness both at the site- and landscape-scales as part of an adaptively managed habitat restoration program.

Johnson et al. (2010) performed a preliminary meta-analysis of action effectiveness data from seven sites in the LCRE. The seven restoration actions studied are generally producing favorable results in terms of vegetation changes, water temperature, sediment accretion, and juvenile salmon presence. Meta-analysis of Site Evaluation Cards (SECs), which are succinct summaries of project actions and monitoring results, revealed that preparing the SECs requires time, knowledgeable staff, and should be started early in the restoration planning process and updated as new information becomes available.

Critical Uncertainties Research.

Casillas (2009) and Sather (2009) presented data on the ecology of juvenile salmonids in estuarine and tidal freshwater areas, respectively, of the LCRE. In both estuarine and tidal freshwater areas, juvenile salmonids were present at all types of habitats sampled during all months of the year. Abundances peaked in spring. Genetic analysis revealed that many ESUs use LCRE habitats. Regardless of sampling month or site of capture, the diets of juvenile Chinook salmon were generally dominated by aquatic insects.

Casillas (2010) reported on the multi-disciplinary study of juvenile salmon ecology in the Columbia River Estuary and plume. The annual report for 2009 contains pertinent data from research on juvenile salmon catches in trawl surveys: field sampling in 2009; characterizing juvenile salmon in the Columbia River Estuary; biochemical measures of salmon growth; pathogens of juvenile salmon; juvenile salmon prey field sampling; modeling and analysis of plume circulation; and other topics.

From sampling juvenile salmon and zooplankton off the outer coast of Vancouver Island during 2008, Trudel et al. (2010) reported that "…our research shows that different populations of Columbia River

salmon move to different locations along the coastal zone where they establish their ocean feeding grounds and overwinter. We further show that ocean conditions experienced by juvenile Columbia River salmon vary among regions of the coast, with higher plankton productivity and temperatures off the west coast of Vancouver Island than in Southeast Alaska. Hence, different stocks of juvenile salmon originating from the Columbia River and Snake River are exposed to different ocean conditions and may respond differently to climate changes…Our analyses also demonstrate that the marine survival and production of Columbia River Chinook, coho, and sockeye salmon are strongly influenced by the growth conditions and food web quality off the west coast of Vancouver Island."

Morace et al. (2009) presented data on the effects of toxic contaminants on resident and salmonid fishes in the LCRE. They found, "Toxic contaminants are present in the Columbia River Basin; resident and anadromous fish utilizing these ecosystems are exposed to toxic contaminants, and their health is being compromised; urban and industrialized areas in the lower Columbia River are source areas for toxic contaminants for multiple fish stocks; and, a better understanding of the effects and associated sources and pathways of exposure to toxic contaminants is needed to develop reduction efforts and restore fish and ecosystem health."

Systema (2009) presented information on invasive species in the LCRE, including the invasion process, vectors, impacts, threats to the Pacific Northwest, and management actions. He recommended enhanced early detection and rapid response capabilities, vulnerability assessments at federal hydro and fish passage facilities, research on invasive species management, and resolution of permit issues.

RME Strategy 5 (RPA Action 62)

A comprehensive list of all actions implemented by the Action Agencies for RPA action 62 is included in Section *4. For RPA 62, the RME Work Group concluded that many subaction specifications were fully addressed; however, some additional monitoring was recommended to supplement ongoing monitoring.*

RPA Action 62 – Fund Selected Harvest Investigations

The Action Agencies will fund selected harvest investigations linked to FCRPS interests:

1. *Evaluate the feasibility of obtaining PIT-tag recoveries between Bonneville and McNary dams to determine whether recoveries can help refine estimates of in-river harvest rates and stray rates used to assess adult survival rates.*

   Nine BPA projects were continued and two were initiated to fully address this RPA subaction. For example, BPA project number 2008-508-00 evaluated run timing and upstream migration mortality of adult Chinook and sockeye salmon and steelhead through PIT-tagging at Bonneville Dam. A companion project, BPA project number 2008-502-00, Increase Zone 6 Tribal Fishery Monitoring, improved the monitoring and catch sampling of the Zone 6 tribal fisheries by increasing the sample rates and employing additional data collection methods, including PIT-tag technology.

2. *Evaluate methods to develop or expand use of selective fishing methods and gear.*

   Four projects were continued to fully address this RPA subaction. The Action Agencies support investigations of alternative gear and modifications to existing gear strategies for fisheries in the Columbia River Basin. They support development of selective gear methods to reduce hatchery surpluses consistent with HSRG recommendations. BPA project number 2007-249-00, Evaluate Live-Capture Fishing Gear for Salmon, focuses on evaluating the feasibility and efficacy of various live-capture selective fishing gears to harvest hatchery-origin Chinook while protecting natural-origin Chinook. In 2009, this project continued to test and evaluate impacts to existing gear and tested a modified pontoon fishwheel in the mainstem Columbia.

In addition to gear testing, selective fishing can involve modifications to time and area management. BPA project number 1993-060-00, Select Area Fisheries Enhancement, has investigated the use of off-channel terminal fishing locations in concert with hatchery rearing and acclimation protocols to offer commercial and sport fishers harvest opportunities even when conventional mainstem fisheries are severely constrained or eliminated because of ESA limitations.

3. *Evaluate post-release mortality rates for selected fisheries.*

Three BPA projects were continued to support this RPA. BPA project number 2007-249-00, Evaluate Live-Capture Fishing Gear for Salmon project, incorporated monitoring protocols to assess fish condition after capture, holding, and release. Results of these evaluations are presented in the project's 2008 annual report. This is identified as a high-priority area by the RME Work Group.

4. *Support coded-wire tagging and coded-wire tag recovery operations that inform survival, straying, and harvest rates of hatchery fish by stock, rearing facility, release treatment, and location.*

Fourteen BPA projects were continued to address this RPA subaction. BPA has funded the recovery and stock identification of coded-wire tags since the early 1980s. In 2008, four BPA-funded projects implemented recovery efforts in ocean and in-river fisheries as well as some limited spawning ground surveys. In addition, many hatchery O&M projects the Action Agencies fund contain resources directed toward the recovery and stock identification of coded wire tags. The RME Work Group encouraged additional sampling effort on the spawning grounds. This may require shifting some effort from the ocean fisheries to in-river monitoring. The RME Work Group also recommends that contracts include language to improve quality assurance/quality control (QA/QC), analysis, and data management.

5. *Investigate the feasibility of genetic stock identification monitoring techniques.*

Twenty five projects were continued and two were initiated to fully address this RPA subaction. For example, for BPA project number 2008-907-00, the Genetic Assessment of Columbia River Stocks, work began in 2008 to address single nucleotide polymorphism (SNP) discovery, genetic baseline expansion, genetic stock identification (GSI) to evaluate catch, and genetic stock identification of salmon and steelhead passing Bonneville Dam. These four projects are highly related because SNP markers are needed to complete species specific baselines, and these baselines are required to complete GSI for the ESA population diversity requirements to support viability risk assessments and the evaluation of the effects of actions on various populations.

RME Strategy 6 (RPA Actions 63–65)

A comprehensive list of all actions implemented by the Action Agencies for RPA actions 63 through 65 is included in Section 4. For RPAs 63 through 65, the RME Work Group concluded that some subactions were fully addressed; however, additional monitoring was recommended to supplement ongoing monitoring.

RPA Action 63 – Monitor Hatchery Effectiveness

The Action Agencies will continue to fund selected monitoring and evaluation of the effectiveness of Hatchery Actions. The evaluation of hatchery projects will be coordinated with the Tributary Habitat monitoring and evaluation program.

1. *Determine the effect that safety-net and conservation hatchery programs have on the viability and recovery of the targeted populations of salmon and steelhead. (Initiate in FY 2007–2009 Projects)*

Sixteen BPA projects were continued to address this RPA subaction. All ongoing BPA-funded safety-net and conservation program projects to implement RPAs 41 and 42 have monitoring and evaluation elements to evaluate effectiveness. In some cases, there is a separate project to monitor effects on the viability and recovery of targeted populations. For example, BPA project

number 1990-005-00 was implemented to monitor and assesses straying of adult summer steelhead and Chinook salmon returns from the Umatilla subbasin hatchery program. In cooperation with the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), life history characteristics of hatchery-reared summer steelhead will be monitored, assessed, and compared to life history characteristics of naturally reared summer steelhead.

2. *Determine the effect that implemented hatchery reform actions have on the recovery of targeted salmon and steelhead populations.*

Two BPA Projects were continued to address this RPA subaction. In 2009, there were no projects that addressed this RPA for the Tucannon, Touchet, and Winthrop NFH steelhead programs. However, the USFWS is currently evaluating a means of implementing the reform recommendations at Winthrop NFH, WDFW will develop proposals in 2010 for evaluating implementation of the reform actions for the Tucannon and Touchet steelhead programs, with RME funding to be provided through the LSRCP. BPA project number 1989-098-00, Salmon Studies Idaho Rivers Project, was implemented to complete data analysis of brood year 2007 juvenile production by estimating the outmigration of naturally produced Chinook salmon collected in 2008 and 2009. The interim production comparison was completed, with products incorporated into annual progress reports.

RPA Action 64 – Investigate Hatchery Critical Uncertainties

1. *Continue to estimate the relative reproductive success of hatchery-origin salmon and steelhead compared to reproductive success of their natural-origin counterparts for ESA-listed spring/summer Chinook population in the Upper Grande Ronde, Lostine River, and Catherine Creek; listed spring Chinook in the Wenatchee River; and listed steelhead in the Hood River. Continue to fund the ongoing RRS feasibility study for Snake River fall Chinook to completion in 2009.*

Fourteen BPA projects were continued to support this RPA subaction. In 2009, BPA continued to fund relative reproductive success (RRS) studies for listed spring/summer Chinook salmon in the upper Grande Ronde River, Lostine River, and Catherine Creek; for listed spring Chinook in the Wenatchee River; for listed steelhead in the Hood River; and for listed fall Chinook in the Snake River. For example, BPA project number 1988-053-04 funded the installation of five downstream migrant screw traps in the Hood River subbasin, and a mark and recapture program was implemented at the traps. The mark and recapture program is used to estimate numbers of pre-smolt and smolt steelhead and Chinook salmon moving past pre-defined locations in the subbasin. The program recorded numbers of non-supplemented species of anadromous and resident salmon caught at five downstream migrant screw traps located in this subbasin.

The numbers are used to monitor the relative abundance of each species in the trap catch. BPA project number 1989-096-00 was implemented to collect tissues for genetic analysis. Data collection includes microsatellite genotyping, DNA sequencing, and other methods of examining and characterizing genetic variation within and among groups of salmon and steelhead. Data analyses included descriptive population genetic characterization for Tier 2 sites (gene-frequency monitoring), levels of variability, relative relationships among hatchery and wild populations, and changes in those parameters over time. Experimental design at other sites involves parentage analysis to document differences in reproductive success among hatchery fish, wild fish, and the progeny of captive parents.

2. *Determine if properly designed intervention programs using artificial production make a net positive contribution to recovery of listed populations.*

Thirty-nine projects were continued and one was initiated to fully address this RPA subaction. BPA project number 2003-060-00 conducted comparative genetic data analyses between and among all project samples by brood year. Temporal genetic variability within Snake River populations will be evaluated. Wild-origin adults from spawning grounds and other previous samples were sorted into single brood year samples based on scale ages and compared to same brood year wild juvenile samples and other brood year-specific project samples. The relative reproductive success

of Snake River hatchery and wild fall Chinook was evaluated against the proportions of hatchery and wild fall Chinook estimated to be on upper Snake River spawning grounds. The estimates for origins and relative abundance of potential natural spawners were made from data collected annually at the Lower Granite Dam adult trap. Reclamation provided PIT-tags to USFWS to aid in the assessment of a steelhead rearing strategy at Winthrop NFH. Reclamation also supported sampling at Rock Island for a separate study that will provide data for the Winthrop evaluation.

3. *In collaboration with the other entities responsible for steelhead mitigation in the Methow River, BPA will fund a new RRS study for ESA-listed steelhead in the Methow River. BPA will also fund a new RRS study for listed fall Chinook in the Snake River. NOAA Fisheries will provide technical assistance to the Action Agencies in development of conceptual study designs suitable for use by the Action Agencies in obtaining a contractor to implement the new studies.*

Three BPA projects were continued to fully support Subaction 3 of RPA 64. For example, BPA project number 1989-098-00, Salmon Studies in Idaho Rivers Project, estimated overall survival to Lower Granite Dam using the Survival Using Proportional Hazards (SURPH) model by life stage for juvenile Chinook salmon from Idaho Supplementation Studies (ISS) treatment and control streams based on PIT-tag detections at Lower Granite, Little Goose, and Lower Monumental dams on the Snake River and McNary Dam on the Columbia River. A video-type weir was installed and operated in Lake Creek. Net daily and maximum movements were analyzed to determine adult numbers. BPA project number 2007-403-00, Idaho Spring Chinook Captive Propagation Project, conducted research and collected data to evaluate behavioral characteristics of captively reared Chinook salmon and monitor anadromous Chinook salmon returns and redd development on the East Fork Salmon River and West Fork Yankee Fork. Genetic samples of juvenile Chinook salmon were collected to evaluate the spawning success of captively reared adults. Weirs were maintained to monitor anadromous Chinook migration in the East Fork of the Salmon River and to monitor spawning behavior of captively reared adults released to the study area in the East Fork of the Snake River.

Subsequent to RME workshops held in November 2009, WDFW developed a BiOp "fast track" proposal for an RRS study for ESA-listed steelhead in the Methow River. The proposal was submitted to the ISRP for scientific review, with implementation anticipated in 2010.

NOAA Fisheries is expected to proved technical assistance to BPA in 2010 during development of targeted solicitations for the new RRS studies for listed Snake River fall Chinook salmon.

RPA Action 65 – Investigate Hatchery Critical Uncertainties

The Action Agencies will fund research directed at resolving critical uncertainties:

1. *In the mainstem Snake River above the Lower Granite Dam, estimate the effectiveness/fitness in nature of hatchery-origin fall Chinook salmon from federally funded Snake River hatchery programs relative to natural origin Snake River fall Chinook.*

Five BPA projects were continued to support this RPA subaction. For example, BPA project number 1998-010-03 funded PIT-tagging of hatchery spring Chinook salmon (brood year 2008) produced by the Lostine River Conventional Program to estimate the survival and arrival timing of the conventional stock of Lostine River hatchery Chinook salmon for migration year 2010. The project also documented the distribution of fall Chinook salmon redds in the 100-mile reach of the Snake River, between Asotin, Washington, and Hells Canyon Dam. Redd surveys were conducted from a helicopter at weekly intervals, between mid-October and mid-December. Also during this time period, submersible cameras were used to locate redds in waters too deep to be effectively searched from the air. BPA project number 1998-010-04, Snake River Fall Chinook Spawning project, organized and implemented expanded spring Chinook redd counts and assessments in the Grande Ronde subbasin (Lostine, Catherine Creek, and upper Grande Ronde) and analyzed length and weight data for each Fall Chinook Acclimation Program (FCAP) release group. The Hatchery/Harvest RME Work Group identified this as a high-priority area to address in the future. The BPA plans to issue a targeted solicitation in 2010 for a new study to compare reproductive

success/fitness of hatchery origin Snake River fall Chinook to reproductive success/fitness of natural-origin fall Chinook.

2. *Estimate fall Chinook hatchery program effects on the productivity of the fall Chinook salmon ESU.*

   One BPA project was continued and one was initiated to address this RPA subaction. In addition, BPA projects associated with Subaction 1 of RPA 65 were implemented to support Subaction 2 by evaluating fall Chinook salmon productivity. The Hatchery/Harvest RME Work Group recommended additional research on Snake River fall Chinook RRS and effects of hatchery programs on productivity of the ESU, and BPA plans to issue a targeted solicitation for the studies in 2010.

3. *NOAA Fisheries will provide technical assistance to the Action Agencies in development of conceptual study designs suitable for use by the Action Agencies in obtaining a contractor to implement new studies.*

   NOAA Fisheries is expected to provide technical assistance to BPA in 2010 to support development of targeted solicitations for the new Snake River fall Chinook RRS study and any additional study or studies needed to estimate the effects of the fall Chinook hatchery programs on productivity of the ESU.

RME Strategy 7 (RPA Actions 66–70)

A comprehensive list of all actions implemented by the Action Agencies for RPA actions 66 through 69 is included in Section 4. For these RPAs, the RME Work Group concluded that most subactions were fully addressed; however, additional monitoring was recommended to supplement ongoing monitoring.

RPA Action 66 – Monitor and Evaluate the Caspian Tern Population in the Columbia River Estuary

The Action Agencies will monitor the tern population in the estuary and its impacts on outmigrating juvenile salmonids, as well as the effectiveness of the Caspian tern management plan.

One BPA project was continued to fully address this RPA subaction. BPA project number 1997-024-00, Avian Predation on Juvenile Salmonids project, provided for the monitoring of the Caspian tern colony on East Sand Island. Colony size, reproduction rates, diet composition, and predation rates were monitored to determine the effect of the colony on juvenile salmon. Results are further reported at *http://www.birdresearchnw.org*. The Action Agencies also funded Caspian tern monitoring at the alternate habitat sites identified in the Caspian Tern Management Plan.

East Sand Island

In 2009, the Action Agencies continued to monitor the Caspian tern colony located on East Sand Island in the Columbia River Estuary to evaluate their impacts on outmigrating juvenile salmonids. As in previous years, monitoring efforts focused on colony size, reproduction rates, diet composition, and salmonid predation rates. In addition, colony monitoring was done on newly created islands in central and southeastern Oregon.

In 2009, approximately 9,854 pairs of Caspian terns nested on East Sand Island, a slight decrease from the 2008 colony size. Marine forage fish (anchovies, etc.) continued to comprise the majority of the diet for the East Sand Island terns. However, the terns consumed approximately 6.4 million smolts (95 percent c.i. = 5.6 – 7.2 million) in 2009, which is a slight decrease over 2008 consumption, when terns nesting on East Sand Island consumed approximately 6.7 million juvenile salmonids.

Of the approximately 2.5 million PIT-tagged fish that were released into the Columbia River Basin in 2009, 1.5 percent (n = 38,336) were recovered on the East Sand Island tern colony. Of the 38,336 tags recovered, 58.6 percent were from steelhead, 37.9 percent were from Chinook salmon (including sub-yearlings and yearlings), 3.0 percent were from coho salmon, 0.4 percent were from sockeye salmon, and 0.1 percent were from sea-run cutthroat trout. Based on predation rates of PIT-tagged smolts, steelhead were the most susceptible salmonid species to East Sand Island tern predation in

2009, with predation rates in excess of 10 percent for many groups of tagged steelhead. Predation rates on wild populations of steelhead (in-river migrants originating up-river of Bonneville Dam) in 2009 (ca. 11.6 percent) were slightly higher than those observed in 2008 (ca. 9.7 percent; Collis et al. 2009) but similar to the four-year average of 11.3 percent (Collis et al. 2005, 2006, 2007, 2008, 2009).

Effectiveness Monitoring

Social attraction, tern decoys, and tern colony sounds were used in the spring 2009 to attract terns to all new islands, except Crump Lake. The social attraction was successful at attracting Caspian terns to the Fern Ridge Island but predation by bald eagles, peregrine falcons, and great horned owls, prevented terns from nesting on the constructed island in 2008 and 2009.

Crump Lake Island showed great success in 2008 (428 pairs of terns the first year available), and even better success in 2009. More than 700 pairs of terns utilized the new island as well as several thousand ring-bill and California gulls. Diet composition was greater than 80 percent tui chub, 19 percent introduced warm water fish, and only one sucker of unknown species was seen brought on colony. Monitoring by Oregon State University crew at Goose Lake (nearly 35 miles west of Crump Lake) verified that Caspian terns nesting at Crump Lake Island were foraging at least part time at Goose Lake. Eighteen terns that had been banded in the Columbia River Estuary were re-sighted on Crump Lake Island. Band re-sightings were also observed from the Mid Columbia colonies, Nevada, and San Francisco Bay.

At Summer Lake Wildlife Area, Caspian terns nested on both newly created islands. A total of 21 pairs utilized the new islands at Summer Lake with a 100 percent nest success, which has never previously reported for any Caspian tern colony. Diet composition at Summer Lake was very similar to Crump Lake Island birds with tui chub making up greater than 80 percent of the diet. Band re-sightings from East Sand Island were also found on both new islands (n=5) at Summer Lake.

RPA Action 67 – Monitor and Evaluate the Double-Crested Cormorant Population in the Columbia River Estuary

The Action Agencies will monitor the cormorant population in the estuary and its impacts on outmigrating juvenile salmonids and develop and implement a management plan to decrease predation rates, if warranted.

One BPA project was continued to fully address this RPA subaction. BPA project number 1997-024-00, Avian Predation on Juvenile Salmonids project, provided for the monitoring of the double-crested cormorant colony on East Sand Island. Colony size, reproduction rates, diet composition, and predation rates are monitored in order to determine the effect of the colony on juvenile salmon. Results are discussed below and further reported at *http://www.birdresearchnw.org*.

The Action Agencies also are funding assessments of the population status of Pacific Coast double-crested cormorants, the availability of suitable alternative nesting habitat outside the Columbia River Basin, and potential management approaches to decrease cormorant depredation of juvenile salmon in the Columbia River Basin should management of cormorants be determined to be warranted.

In 2009, the Action Agencies continued to monitor and conduct research on double-crested cormorants on East Sand Island in the Columbia River Estuary and to evaluate their impacts on out-migrating juvenile salmonids. As in previous years, monitoring efforts focused on colony size, reproduction rates, diet composition, and predation rates. In 2008 and 2009 addition, 39 radio transmitters were placed on cormorants and followed throughout the years. Results from this effort are still pending, but many of the radio-marked birds moved north to Puget Sound after breeding and some moved up river into the Portland area.

The double-crested cormorant colony on East Sand Island consisted of about 12,087 breeding pairs in 2009, a 10 percent increase in colony size compared to the previous year. Since monitoring began in 1997, the cormorant colony has increased by about 120 percent. Nesting success in 2009 (2.80

fledglings per breeding pair, a significant increase from 2008's 2.26 fledglings per breeding pair), was the highest productivity ever recorded at East Sand Island. As in previous years, salmonids comprise a small portion (9.2 percent) of the cormorant diet in 2009, while marine forage fish (i.e., northern anchovy) and estuarine resident fish (i.e., sculpin, flounder, minnows) comprise over 40 percent of the diet.

In 2009, cormorants nesting on East Sand Island consumed an estimated 11.1 million juvenile salmonids (95 percent c.i. = 7.7 – 14.5 million), compared to an estimated 6.4 million juvenile salmonids (95 percent c.i. = 5.6 – 7.2 million) consumed by terns nesting on East Sand Island.

An analysis of salmonid PIT tags detected at the double-crested cormorant colony on East Sand Island indicated that all species of anadromous salmonids (i.e., Chinook salmon, coho salmon, sockeye salmon, steelhead, and even sea-run cutthroat trout) from all run-types (fall, winter, summer, and spring), and from all tagged ESUs were susceptible to cormorant predation in 2009. The numbers of PIT tags from the various salmonid species and run-types that were recovered on the cormorant colony were roughly proportional to the relative availability of PIT-tagged salmonids released in the basin, suggesting that cormorant predation on salmonid smolts in the estuary was less selective than tern predation. Predation rates in excess of 10 percent and 30 percent, however, were observed for some groups of hatchery fall Chinook and hatchery coho salmon released downstream of Bonneville Dam. A comparison of per capita consumption rates of PIT-tagged fish between terns and cormorants nesting on East Sand Island suggests similar levels of take per nesting adult per colony, with an estimate of 1.5 and 1.8 PIT-tagged fish consumed per nesting tern and cormorant, respectively.

RPA Action 68 – Monitor and Evaluate Inland Avian Predators

The Action Agencies will monitor avian predator populations in the Mid-Columbia River and evaluate their impacts on outmigrating juvenile salmonids and develop and implement a management plan to decrease predations rates, if warranted.

One BPA project was continued to fully address this RPA subaction. BPA project number 1997-024-00, Avian Predation on Juvenile Salmonids, provided aerial surveys to identify any significant avian colonies located in the mid-Columbia River. This includes colonies like the Caspian tern colony on Crescent Island and the double-crested cormorant colony on Foundation Island, which are monitored to determine their effects on juvenile salmon. Reclamation funded a portion of this research to evaluate avian predation on Goose Island in Potholes Reservoir. The funding included sampling and tagging fish at Rock Island Dam. Inland avian monitoring was conducted at primary nesting sites and for overwintering double-crested cormorants throughout 2009. Colony size, reproduction rates, diet composition, and predation rates were monitored to determine the annual trend effect of the colonies on juvenile salmonids.

Caspian terns and double-crested cormorants are responsible for most losses of salmonid smolts to avian predators along the mid-Columbia River, specifically Caspian terns nesting on Crescent Island and double-crested cormorants nesting on Foundation Island, both in McNary Pool. The Caspian tern colony at Crescent Island consisted of 349 breeding pairs in 2009, the smallest the colony has been since monitoring commenced in 1997. Salmonid smolts represented 64 percent of the prey items for terns nesting on Crescent Island in 2009, similar to diet composition during 2000-2008. Based on bioenergetics calculations, consumption of juvenile salmonids by Crescent Island terns was about 360,000 smolts in 2009.

The largest Caspian tern colony on the Columbia Plateau in 2009 was on Goose Island in Potholes Reservoir, where about 486 pairs nested. Data on diet composition of terns nesting at the Potholes colony were limited to smolt PIT tags recovered on the colony after the nesting season. Recovered PIT tags indicated that the numbers of juvenile salmonids from the Columbia River consumed by terns nesting at this off-river colony were surprisingly high, particularly for steelhead from the endangered upper Columbia ESU. PIT tag recoveries on the Potholes tern colony indicated that over 15.5 percent

of upper Columbia steelhead passing Rock Island Dam in 2009 were consumed by Caspian terns nesting at this colony.

The only active double-crested cormorant colony on the mid-Columbia River during 2009 was on Foundation Island in McNary Pool, which consisted of about 310 nesting pairs. The largest cormorant colony on the Columbia Plateau, however, consisted of about 810 pairs that nested in trees at the north end of Potholes Reservoir. Both colonies have declined somewhat over the last four years, indicating that, in the short term, the cormorant breeding population in the region is not increasing. Based on limited diet data for cormorants nesting on Foundation Island, the proportion of salmonids in the diet was similar to 2007 and 2008. Smolt PIT tag recoveries on the Foundation Island cormorant colony were also similar in 2007, 2008, and 2009. The magnitude of smolt PIT tag recoveries at the Foundation Island colony suggests that the impact of cormorants nesting at this colony on survival of juvenile salmonids is comparable to that of Caspian terns nesting at the Crescent Island colony.

Stomach contents of 35 double-crested cormorants collected along the lower Snake River during the winter of 2009-10 indicated that salmonids comprised about 12.4 percent of the diet; most salmonids found in cormorant stomachs were from the ESA-listed run of Snake River fall Chinook. Surveys during winter 2009-10 indicated that less than 250 cormorants over-wintered along the lower Snake River; on average, only 20 percent were observed at one of the four lower Snake River dams. The highest concentrations of cormorants over-wintering along the lower Snake River during 2009-10 were observed between Ice Harbor Dam and the confluence with the Columbia River.

California and ring-billed gulls have nested in large numbers on islands on or near the mid-Columbia River, but these gulls have generally consumed few fish and even fewer juvenile salmonids. However, recent increases in numbers of smolt PIT tags recovered at the gull colony on Miller Rocks in The Dalles Pool, where about 4,600 pairs of gulls now nest, have raised concerns about the impact of gull predation on survival of salmonid smolts. In 2009, nearly 5,500 smolt PIT tags were deposited on the Miller Rocks colony by nesting gulls, compared to 4,211 tags in 2008. The increase in consumption of PIT-tagged smolts by Miller Rocks gulls likely reflects both an increase in size of the gull colony (numerical response) as well as an increase in foraging intensity at nearby John Day Dam and The Dalles Dam (functional response). The magnitude of predation on salmonid smolts by Miller Rocks gulls appears to be unique among gull colonies along the mid-Columbia River.

RPA Action 69 – Monitoring Related to Marine Mammal Predation

As part of RPA 69, the Corps continued to monitor sea lion predation at Bonneville Dam in 2009. For a more comprehensive summary of 2009 monitoring efforts, refer to the field report by Stansell et al. (2009).

1. *Estimate overall sea lion abundance immediately below Bonneville Dam. (Initiate in FY 2007-2009 Projects)*

   Two projects were continued to fully address this RPA subaction. From January 1 to May 31, 2009, the Corps continued to visually monitor the abundance of California sea lions below Bonneville Dam (Figure 9). In addition, a BPA-funded CRITFC project, BPA project number 2008-004-00, estimated general sea lion abundance while conducting in-river hazing on sea lions.

2. *Monitor the spatial and temporal distribution of sea lion predation attempts and estimate predation rates. (Initiate in FY 2007-2009 Projects)*

   Two projects were continued to fully address this RPA subaction. In 2009, the Corps continued land-based visual observations to monitor the expanded adult salmon catch estimate for the Bonneville Dam tailrace observation area. The Corps also monitored the date and location of individual sea lion predation attempts. The BPA-funded CRITFC project observed the total number of sea lion predation attempts and recorded their location and time.

   The expanded adult salmon catch estimate for the Bonneville Dam tailrace observation area was 2.4 percent (n=4,489) of the adult salmon run at Bonneville Dam from January 1 through May 31,

2009. The adjusted estimated catch was 2.7 percent of the run (n=4,960). California sea lions were the primary salmon predator, accounting for 90 percent (n=2,680) of the 2,980 observed catches. This percentage was lower than seen in previous years, as observed salmon catch by Steller sea lions increased from 0.3 percent (n=12) in 2007 to 10 percent (n=300) of total take in 2009 (see Table 13).

Chinook salmon were the most commonly identified prey species, making up about 89 percent (n=2,652) of observed adult salmon catch in 2009. The expanded Chinook catch estimate for the Bonneville Dam tailrace observation area was 1.7 percent (n=3,997) of the Chinook run through June 15, 2009. Note that this time period differs from the passage season used for total salmon estimates. This period includes the Columbia River spring Chinook passage season at Bonneville Dam, which extends beyond the period during which sea lions are present. Steelhead comprise approximately 11 percent (n=328) of observed adult salmon catch during the same period. Steelhead, which are present in the Bonneville Dam tailrace throughout the winter and spring, made up the majority of salmon catches until the spring Chinook salmon run began. Of the total pinniped catch for 2009, California sea lions took 90.2 percent of the Chinook and 87.8 percent of the steelhead (see Table 14).

Physical barriers, including SLEDs and FOG barriers, apparently prevented sea lions from entering the fishways, but acoustic deterrents installed near fishway entrances continued to have no visible effect on sea lions. During daylight hours, dam-based USDA Wildlife Services agents contracted by the Corps, and boat-based crews from ODFW, WDFW, and CRITFC used non-lethal pyrotechnics and rubber bullets to harass sea lions in the dam tailrace. Harassment appeared to temporarily alter the behavior of some sea lions but did not reverse the upward trend in predation estimates.

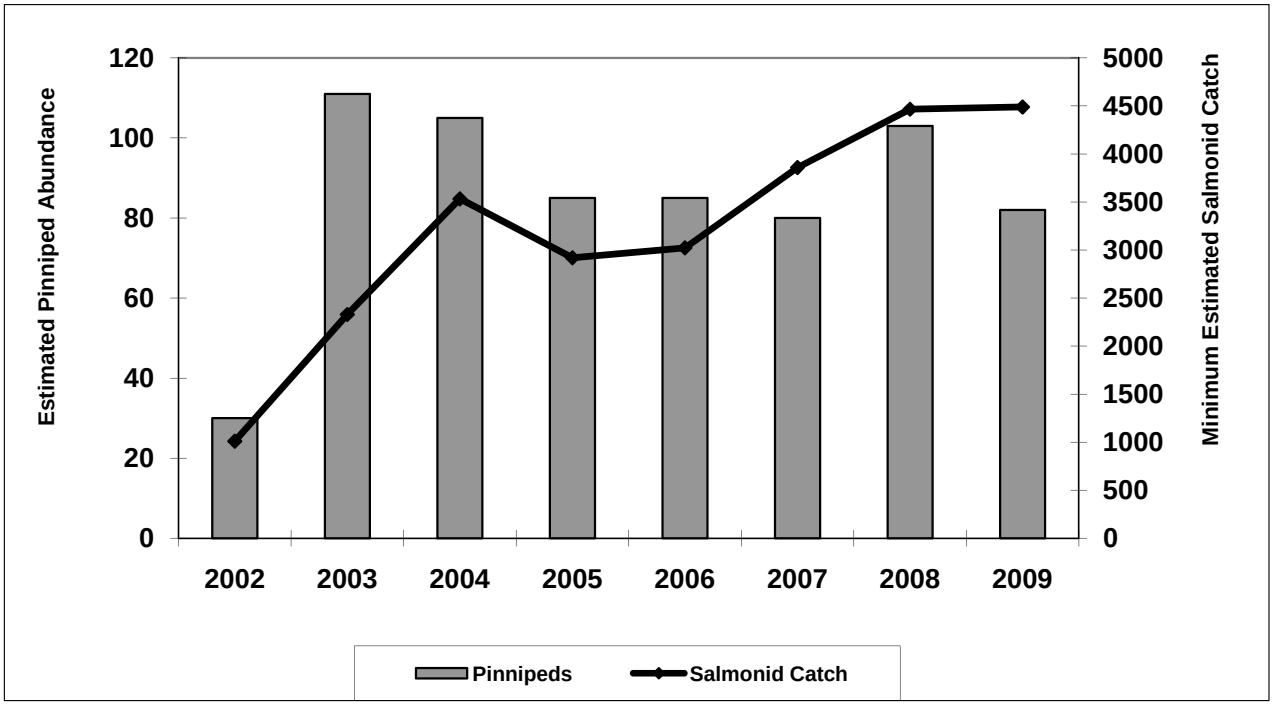

Figure 9. Estimated Minimum Number of Adult Salmonids Consumed by Pinnipeds and Estimated Total Number of Pinnipeds Observed at Bonneville Dam, January 1–May 31, from 2002 to 2009. *Note: In 2005, regular observations did not start until March 18. Pinnipeds observed included California sea lions, Steller sea lions, and harbor seals.*

Table 13. Bonneville Dam Salmonid Passage Catch Summary (2002–2009).

Year	Bonneville Dam Salmonid Passage (Jan. 1–May 31)	Observed Salmonid Catch		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%

Note: Total salmonid passage counts include all adult salmonids that passed Bonneville Dam January 1–May 31. "Expanded" estimates correct for the fact that observers are not present at all locations at all times. "Adjusted" estimates further correct to account for catch events where the prey species could not be identified.

Table 14. California Sea Lion 2009 Catch Estimates: Chinook vs. Steelhead.

	Percent of Total Pinniped Catch Taken by California Sea Lions	Expanded Catch Estimate (California sea lions)
Chinook	90.2%	3,591
Steelhead	87.8%	424

With funding from BPA, ODFW and WDFW used four floating sea lion traps deployed along the PH2 corner collector to capture California sea lions. The sea lions were then weighed, branded, and released, or transferred to aquariums. Of the 20 California sea lions trapped in 2009, four were sent to aquariums, 14 were euthanized, five were processed (measured, weighed, marked with a three-digit brand, and given acoustic tags) and released, one was already branded (but given an acoustic tag). In addition, one California sea lion on the list for removal was trapped in Astoria in August 2009 and euthanized.

3. *Monitor the effectiveness of deterrent actions (e.g., exclusion gates, acoustics, harassment and other measures) and their timing of application on spring runs of anadromous fish passing Bonneville Dam. (Initiate in FY 2007-2009 Projects)*

The effectiveness of deterrent actions and the timing of application on spring runs was determined in 2009 through BPA- and Corps-funded efforts. Physical barriers were effective at preventing sea lions from entering the fishways, but acoustic deterrents installed near fishway entrances had no visible effect. Harassment with non-lethal pyrotechnics and rubber bullets appeared to temporarily alter the behavior of some sea lions, but did not reverse the upward trend in predation estimates.

RPA Action 70 – Monitoring Related to Piscivorous (Fish) Predation

A comprehensive list of all actions implemented by the Action Agencies for RPA action 70 is included in Section 4. For RPA 70, the RME Work Group concluded that the subactions were fully addressed.

1. *Continue to update and estimate the cumulative benefits of sustained removals of northern pikeminnow since 1990.*

   One BPA project was continued to fully address this RPA subaction. The NPMP, BPA project number 1990-07-700, contains an extensive biological evaluation component implemented primarily by ODFW. This program component annually collects and validates biological field data and updates the benefit model with the latest year's data. The 2009 estimated reduction in potential predation was 38 percent, based on the 2009 exploitation rate of 12.8 percent for pikeminnow 250 millimeters in fork length or larger and the cumulative effect of previous years removals.

2. *Continue to evaluate if inter and intra compensation is occurring.*

   One BPA project was continued to fully address this RPA subaction. The evaluation of the NPMP annually assesses whether compensation is occurring as a result of cumulative removals to date. The program evaluation showed no indication of compensation by smallmouth bass, walleye, or channel catfish.

3. *Evaluate the benefit of additional removals and resultant increase in exploitation rate's affect on reduction in predator mortality since the 2004 program incentive increase.*

   One BPA project was continued to fully address this RPA subaction. Exploitation rates since the implementation of the monetary incentive increase in 2004 have significantly exceeded the average exploitation rate of the previous 14 years. System-wide exploitation in 2009 of northern pikeminnow was 12.8 percent based on a numerical catch of 141,645 from a sport reward and dam angling fishery. A significant increase and resultant benefit have been observed since the monetary incentive program was increased in 2004. Some of this may be a result of additional tagging research and the validation of annual tag loss estimates.

4. *Develop a study plan to review, evaluate, and develop strategies to reduce non-indigenous piscivorous predation.*

   In December, 2009 the project sponsors submitted for review of the Independent Scientific Review Panel for the Northwest Power and Conservation Council the proposal titled "*Understanding the influence of predation by introduced fishes on juvenile salmonids in the Columbia River Basin: closing some knowledge gaps.*" Implementation of research activities can occur once this review is completed.

RME Strategy 8 (RPA Actions 71–72)

RPA Action 71 – Coordination

The Action Agencies will coordinate RME activities with other Federal, State and Tribal agencies on an ongoing annual basis.

1. *Organizing and supporting the Corps AFEP.*

   The Corps of Engineers has, since 1952, sponsored biological studies in an integrated, applied research program. These monitoring, research, and evaluation studies are managed under the AFEP.

   In 2009, the Corps again implemented the AFEP program. As usual, one of the major activities was the selection and development of experimental design and methodology of research projects to be carried out in 2010. This process was extensively coordinated with other federal agencies, states, and tribal interests through their involvement in the SRWG, which met several times

through the year. In December 2009, a three-day annual review, open to all interested parties, was held to present the results of AFEP research carried out during the year.

The AFEP program also includes the Fish Facility Design Review Work Group (FFDRWG) and the Fish Passage Operations and Maintenance (FPOM) work group. The FFDRWG provides ongoing review of fish facility design activities. The FPOM work group provides ongoing review of operational activities related to fish passage. All federal, state, and tribal fishery agencies are invited to participate in FFDRWG and FPOM meetings, both of which generally occur monthly.

Further information on the AFEP program, and on the research carried out in 2009 and planned for 20010, is available at *http://www.nww.usace.army.mil/planning/ep/fishres/afep-default.htm* and *http://www.nwp.usace.army.mil/pm/e/afep_docs.asp*

2. *Supporting and participating in the Council's Columbia River Basin Fish and Wildlife Program project planning and review efforts.*

BPA continued to work with Northwest Power and Conservation Council (Council) staff in coordinating its FWP's project planning and review efforts. In 2009, BPA and the Council initiated the process to conduct the RME and Artificial Production Categorical Review to support a comprehensive evaluation of the FWP's research and monitoring projects.

3. *Supporting the standardization and coordination of tagging and monitoring efforts through participation and leadership in regional coordination forums such as PNAMP.*

Four BPA projects and one Reclamation project were continued to fully support this subaction. For example, BPA project numbers 1994-033-00, 1996-020-00, 1996-043-00, and 2004-002-00 200721600, were continued to support RPA action 71.3. The PNAMP funding, BPA project number 2004-002-00 and 2007-216-00, supported this RPA action by coordinating and completing the PNAMP Tagging and Telemetry Monitoring project to evaluate tagging and telemetry work and make recommendations on field protocols and methods for fish tagging and telemetry field data collection techniques. The FPC, BPA project number 1994-033-00, continued to support the evaluation and synthesis of fish passage of tagged fish through the hydropower system.

Reclamation directly participated in PNAMP by providing full-time equivalents (FTE) for the PNAMP steering committee, and by continuing to provide funding for its two coordinators and database expert. Reclamation provided technical expertise for two major PNAMP tasks issued by the Northwest Environmental Information Sharing (NWEIS) executive forum, including development of a white paper on high-level indicators and planning for a region-wide data dictionary.

4. *Working with regional monitoring agencies to develop, cooperatively fund, and implement standard metrics, business practices, and information collection and reporting tools needed to cooperatively track and report on the status of regional fish improvement and fish monitoring projects.*

Ten BPA projects were continued and two were initiated to address this subaction. For example, in 2009, BPA project number 2004-002-00 initiated the PNAMP Integrated Status and Trend Monitoring demonstration project to support management of a regional master sample based on a Generated Random Tessellated Sample (GRTS) design to support efficient and statistically based monitoring designs for fish and habitat programs across the Northwest. PNAMP also supported further development of the Protocol Library tool and Monitoring Glossary that were incorporated into BPA and Council RME Categorical Review proposal tools to support standardization of indicators and metrics, as well as the respective data analysis and data collection methods. In addition, the PNAMP project also endorsed best business practices for documenting metadata for field data collection.

5. *Coordinating the further development and implementation of Hydrosystem, Tributary Habitat, Estuary/Ocean, Harvest, Hatchery, and Predation RME through leadership and participation in ongoing collaboration and review processes and workgroups.*

Four BPA projects were continued to fully support this RPA subaction. The ISEMP project, BPA project number 200301700, continued facilitation and coordination of the RME Tributary Habitat RME workgroup and provided staff time, developed monitoring inventories for the RME gap

assessment, and completed the RPA workgroup draft RPA Recommendation Report. This also coordinated the tributary RME work with the developing data management effort for the basin-wide RME through the Aquatic Resource Schema, and the Status Trend and Effectiveness Monitoring (STEM) Databank.

6. *Coordinating implementation with other appropriate regional collaboration processes. This includes coordination related to statutory provisions for the Federal government (BPA/Council), voluntary coordination among Federal agencies (Federal Caucus), and coordination with regional processes for Federal/non-Federal engagement (Technical Management Team (TMT), System Configuration Team (SCT), PNAMP, Northwest Environmental Data- Network (NED), and others.*

   Two BPA projects were continued and two were initiated to fully support this subaction. For example, BPA project numbers 2004-002-00 and 2008-733-00 were implemented to support regional collaboration processes. BPA funded the Columbia Basin Fish and Wildlife Authority (CBFWA) to support the regional workshops to support development of the Columbia Basin ASMS through collaboration of state, tribal, and federal entities. The workshops supported evaluation of the RME workgroup RME RPA Gap Assessment and Recommendation Report and helped fill gaps in tributary and VSP monitoring. The PNAMP Funding project, BPA project number 2004-002-00, provided funds for full-time staff support at PNAMP to facilitate and organize regional collaboration efforts on monitoring techniques and data management. This project supported the initiation of the ASMS data management strategy to be completed in 2010.

RPA Action 72 – Data Management

The Action Agencies will ensure that the information obtained under the auspices of the FCRPS RME Program is archived in appropriate data management systems.

1. *Continue to work with regional Federal, State and Tribal agencies to establish a coordinated and standardized information system network to support the RME program and related performance assessments. The coordination of this development will occur primarily through leadership, participation, and joint funding support in regional coordination forums such as the NED workgroup, and PNAMP and the ongoing RME pilot studies in the Wenatchee River, John Day River, Upper Salmon River, and Columbia River Estuary. (Initiate in FY 2007- 2009 Projects)*

   One Reclamation and eight BPA projects were continued to fully support this subaction. For example, BPA project number 2008-727-00 was implemented to support development of a coordinated and standardized information management network through use of a PNAMP data steward to help coordinate data management efforts in the region. This included the support for coordination of the Integrated Status and Trends Monitoring (ISTM) and Protocol Library tools and metadata standards white paper.

   Reclamation supported ongoing regional RME coordination through the PNAMP (see http://*www.pnamp.org* for information on PNAMP's 2009 accomplishments), completion of a major database to catalog monitoring protocols (Protocol Library), and the transfer of that technology to a NOAA Fisheries contractor to integrate protocols into a region-wide data dictionary that is being coordinated through PNAMP.

2. *Contribute funding for data system components that support the information management needs of individual Hydrosystem, Tributary Habitat, Estuary/Ocean, Harvest, Hatchery, and Predation RME. (Initiate in FY 2007-2009 Projects)*

   Three BPA projects were continued to address this subaction. The DART, BPA project number 1996-019-00, managed a second-tier database and Internet service. DART provides direct and timely public access to integrated Columbia River Basin environmental, operational, fishery, riverine, ocean, and climactic data resources for sound management of the Columbia River Basin resources and hydrosystem by federal, state, public, and private entities. This project also provides web support to PNAMP. Also, BPA project 2008-727-00 was supported by use of a PNAMP data steward to help coordinate data management efforts in the region. Additional recommendations for data stewards and technical support were identified by the RME Work Group.

3. *Participate in Northwest regional coordination and collaboration efforts such as the current PNAMP and NED efforts to develop and implement a regional management strategy for water, fish and habitat data. (Initiate in FY 2007-2009 Projects).*

   Five BPA projects were continued and three were initiated to fully support this subaction. For example, BPA project numbers 1988-108-04, 2004-002-00, and 1996-017-00 were implemented to support participation in coordination efforts to implement a regional data management strategy. The PNAMP funding for BPA project number 2004-002-00 supported staff for coordination or work sessions and regional collaboration discussion by the PNAMP Data Management Work Group to continue implementation of NED recommendations.

RME Strategy 9 (RPA Action 73)

RPA Action 73 – Implementation and Compliance Monitoring

The Action Agencies will use the project-level detail contained in the Action Agencies' Biological Opinion databases to track results and assess our progress in meeting programmatic level performance targets. This performance tracking will be reported through annual progress reports and the comprehensive reports scheduled for 2013 and 2016.

1. *Annually monitor the successful implementation of projects through standard procedures and requirements of contract oversight and management, and review of project deliverables and final reports.*

   The Action Agencies successfully implemented programs following government contracting requirements with quarterly and/or annual project implementation reporting. BPA continued to implement the Pisces program to track project implementation to support accordance and evaluations of project effectiveness.

2. *Maintain project and action level details for planning and reporting purposes. This approach will provide the most up-to-date information about the status of actions and projects being implemented.*

   BPA updated the Pisces program to track project implementation for all projects and started development of the BPA Dashboard and Taurus program to track action implementation for the FCRPS RPAs. Reclamation continued to assess and plan for the inclusion of its implementation data into a coordinated Action Agency database.

3. *Maintain a comprehensive habitat project tracking system where relevant project information is contained in an accessible comprehensive data system. The data system will contain project level information that is needed for both implementation and effectiveness monitoring. The system will include the set of minimum metrics and metadata for RME data design listed in Data Management Needs for Regional Project Tracking to Support Implementation and Effectiveness Monitoring (Katz et al. 2006). (Initiate in FY 2008)*

   In addition to implementing the Pisces program on all BPA-funded projects, BPA implemented nine projects that tracked and compiled standardized environmental resource project tracking data that could support effectiveness monitoring evaluation efforts. In 2009, the incorporation of Katz et al. (2006) metrics was initiated for Pisces but was delayed to ensure consistency with other NOAA Fisheries regional database tracking systems, which were in the process of validating Katz et al. (2006) metrics in the Pacific Coastal Salmon Recovery Fund (PCSRF) program. For BPA, the Katz et al. (2006) metrics will be reported for fiscal year 2010, with the exception of those metrics that NOAA Fisheries is in the process of updating. Additional work to further align tracking systems will continue in 2010.

   The Action Agencies have recorded project implementation and associated metric information for tributary habitat actions since implementation of tributary habitat actions became part of the FCRPS BiOp RPA in 2000. Examples of these data are presented in Section 4. These data currently are stored in the Pisces database for actions for which BPA provides funding and in a separate database for actions for which Reclamation provides technical assistance. Because these databases were developed in the early 2000s, they currently include only a subset of the metrics contained in Katz et al. (2006); however, most of these projects have already been integrated into

the NOAA Fisheries Pacific Northwest Salmon Habitat Restoration Project Tracking (PNSHP) database that is based on Katz et al. (2006) Further regional coordination by the Action Agencies on habitat implementation metrics is being pursued through PNAMP work groups.

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Acronyms, Abbreviations, and Glossary

The "Action Agencies" refers to Bonneville Power Administration, the U.S. Army Corps of Engineers, and the U.S. Bureau of Reclamation.

AFEP	Anadromous Fish Evaluation Program
ASMS	Anadromous Salmonid Monitoring Strategy
AWS	auxiliary water system
BA	Biological Assessment
BACI	Before, After, Control, Impact
BGS	behavioral guidance screen
BiOp	Biological Opinion
BIT	Biological Index Test
BPA	Bonneville Power Administration
BRZ	Boat Restricted Zone
CBFWA	Columbia Basin Fish and Wildlife Authority
cfs	cubic feet per second
CIG	Climate Impacts Group, University of Washington; is developing climate change streamflows for the Columbia River Basin
COMPASS	Comprehensive Fish Passage Model
COP	Configuration and Operational Plan
CORIE	
Corps	U.S. Army Corps of Engineers
CREST	Columbia River Estuary Study Taskforce
CRFG	Columbia River Forecast Group, formed by the Action Agencies and Fish Accord partners
CRFM	Columbia River Fish Mitigation
CRITFC	Columbia River Inter-tribal Fish Commission
CSS	Comparative Survival Study
CTCR	Confederated Tribes of the Colville Reservation
CTUIR	Confederated Tribes of the Umatilla Indian Reservation
CWA	Clean Water Act
DART	Data Access Real Time
DPS	Distinct Population Segment
EPA	U.S. Environmental Protection Agency
ERDC	Engineer Research and Development Center
ESA	Endangered Species Act
ESU	Evolutionary Significant Unit
ESP	Ensemble Streamflow Predicting
FCAP	Fall Chinook Acclimation Program
FCRPS	Federal Columbia River Power System
FFDRWG	Fish Facility Design Review Work Group
FGE	fish guidance efficiency
FOG	floating orifice gate
FOP	Fish Operations Plan
FPC	Fish Passage Center
FPOM	Fish Passage Operations and Maintenance
FPP	Fish Passage Plan
FTE	full-time equivalent
FWP	Fish and Wildlife Program
GBT	gas bubble trauma

GIS	geographical information system
GRTS	Generated Random Tessellated Sample
GSI	genetic stock identification
HGMP	Hatchery and Genetic Management Plan
HSRG	Hatchery Scientific Review Group
IDFG	Idaho Department of Fish and Game
IMW	intensively monitored watershed
ISAB	Independent Scientific Advisory Board
ISTM	Integrated Status and Trends Monitoring
ISEMP	Integrated Status and Trend Monitoring Program
ISS	Idaho Supplementation Studies
JBS	juvenile bypass system
JFF	juvenile fish facility
JSAT	Juvenile Salmonid Acoustic Tag
kaf	thousand acre-feet
kcfs	thousand cubic feet per second
ksfd	thousand second foot per day; k = kilo = thousand; ksfd = 1,000 cfs (cubic feet per second) per day. kfsd * 1.98347 = thousand acre-feet
LCRE	Lower Columbia River Estuary
LCREP	Lower Columbia River Estuary Partnership
LIDAR	light detection and ranging
LSRCP	Lower Snake River Compensation Plan
M&E	monitoring and evaluation
maf	million acre-feet
MCE	minimum control elevation
MOP	minimum operating pool
NED	Northwest Environmental Data
NEPA	National Environmental Policy Act
NFH	National Fish Hatchery
NPCC	Northwest Power and Conservation Council
NPMP	Northern Pikeminnow Management Plan
NPT	Nez Perce Tribe
NTS	non-treaty storage
NWEIS	Northwest Environmental Information Sharing
NWFSC	Northwest Fisheries Science Center
NWRFC	Northwest River Forecast Center
O&M	operations and maintenance
OBMEP	Okanogen Basin Monitoring and Evaluation Program
ODFW	Oregon Department of Fish and Wildlife
PCSRF	Pacific Coastal Salmon Recovery Fund
PH2	second powerhouse
PIT	Passive Integrated Transponder
PNAMP	Pacific Northwest Aquatic Monitoring Partnership
PNSHP	Pacific Northwest Salmon Habitat Restoration Project Tracking
POST	Pacific Ocean Survival Tracking Project
PTAGIS	PIT-Tag Information System
QA/QC	quality assurance/quality control
Reclamation	U.S. Bureau of Reclamation
rkm	river kilometer

RM	river mile
RME	research, monitoring, and evaluation
ROD	Record of Decision
RPA	Reasonable and Prudent Alternative
RRS	relative reproductive success
RSW	removable spillway weir
SAR	smolt-to-adult return
SBT	Shoshone-Bannock Tribe
SEC	Site Evaluation Cards
SLED	sea lion exclusion device
SNP	single nucleotide polymorphism
SOR	System Operational Request
SRWG	Studies Review Work Group
STEM	Status Trend and Effectiveness Monitoring
SURPH	Survival Using Proportional Hazards
SYSTDG	System Total Dissolved Gas
TDG	total dissolved gas
TMDL	total maximum daily load
TMT	Technical Management Team
TSP	Turbine Survival Program
TSW	top-spill weir
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VARQ	variable outflow flood control procedures
VSP	viable salmonid population
WDFW	Washington Department of Fish and Wildlife
WDOE	Washington Department of Ecology
WMP	Water Management Plan
WSF	Water Supply Forecast
YN	Yakama Nation