
April 1998

WATER RESOURCES

Corps of Engineers' Actions to Assist Salmon in the Columbia River Basin





United States
General Accounting Office
Washington, D.C. 20548

**Resources, Community, and
Economic Development Division**

B-279309

April 27, 1998

The Honorable Max S. Baucus
The Honorable Patty Murray
The Honorable Harry M. Reid
United States Senate

As agreed with your offices, this report discusses the U.S. Army Corps of Engineers' (1) decision-making process for identifying, setting priorities for, and funding actions to help the recovery of salmon runs in the Columbia River Basin and (2) difficulties in implementing these actions. In addition, the report discusses the new direct funding agreement between the Corps and the Bonneville Power Administration for operations and maintenance costs at the Corps' hydroelectric facilities in the Pacific Northwest.

We are sending copies of this report to the appropriate congressional committees, the Secretary of Defense, and the Director, Office of Management and Budget. We will also make copies available to other interested parties upon request.

Any questions should be directed to me on (202) 512-9775. Major contributors to this report are listed in appendix V.

A handwritten signature in black ink that reads 'Barry T. Hill'. The signature is written in a cursive, flowing style.

Barry T. Hill
Associate Director, Energy, Resources,
and Science Issues

Executive Summary

Purpose

Columbia River Basin salmon runs were once the world's largest. Before 1850, an estimated 16 million salmon returned to the basin annually. By 1996, however, returning adult salmon had been reduced to about 2.5 million fish, of which only about 500,000 were wild or naturally spawning salmon. The remainder were hatchery-raised fish intended to supplement the declining wild stocks. A number of factors, including overharvesting, the degradation of spawning habitat, unfavorable ocean conditions, and the construction and operation of dams, have contributed to the decline of wild salmon stocks. Most of the decline, however, occurred before the completion of the first federal dam in 1938. Since 1949, federal agencies and regional organizations responsible for efforts to help the salmon recover in the Pacific Northwest have invested over \$3 billion in actions to improve salmon runs throughout the Columbia River Basin. Still, the salmon population continues to decline. The U.S. Army Corps of Engineers (Corps) operates eight multipurpose dams on the lower Columbia and Snake rivers as part of the Federal Columbia River Power System. The Corps' Columbia River Fish Mitigation¹ program focuses on improving the passage of adult and juvenile salmon around these dams. The Corps estimates that it will spend \$1.4 billion implementing its fish mitigation program. About \$908 million of this total will be spent on the construction of fish passage projects and related studies from fiscal year 1999 through the scheduled completion of the program in fiscal year 2007.

Concerned with how well the Corps is implementing its Columbia River Fish Mitigation program, Senators Max S. Baucus, Patty Murray, and Harry M. Reid asked GAO to provide information on (1) the Corps' decision-making process for identifying, setting priorities for, and funding actions to help the recovery of salmon runs and (2) whether the Corps has been completing its fish mitigation actions on schedule and within budget. In addition, GAO was asked to determine why the Corps had not entered into a direct funding agreement with the Department of Energy's Bonneville Power Administration (Bonneville Power) for the cost of operating and maintaining the Corps' dams in the Columbia River Basin. During the course of GAO's audit, the Corps completed such an agreement. Details on how this agreement will work are provided in appendix I of this report.

¹In this report, "fish mitigation" refers to efforts to mitigate the decline of salmon populations in the Columbia River Basin.

Background

The Federal Columbia River Power System includes all federally owned hydroelectric dams in the Columbia River Basin that are operated and maintained by the Corps and the Department of the Interior's Bureau of Reclamation. Bonneville Power is responsible for transmitting and marketing the hydroelectric power generated by these dams. The Corps' eight multipurpose dams on the lower Columbia and Snake rivers are a major source of hydroelectric power in the region and also provide flood control, navigation, recreation, irrigation, municipal and industrial water supply, and fish and wildlife benefits. However, the dams impede juvenile and adult fish migrations to and from the ocean by their physical presence and by creating reservoirs. For example, to migrate past the dams, juvenile fish must generally go through the dams' turbines, through the juvenile fish bypass systems, or over the dams' spillways. Each passage alternative has associated risks and contributes to the mortality of juvenile fish. Reservoirs formed behind the dams slow water velocities, alter river temperatures, and improve the habitat of predators.

In 1991, the Department of Commerce's National Marine Fisheries Service (NMFS) listed the Snake River sockeye salmon as an endangered species under the Endangered Species Act. In 1992, NMFS listed the Snake River spring/summer and fall chinook salmon as threatened. In accordance with the requirements of the act, beginning in 1992, NMFS issued Biological Opinions on the operation of the Federal Columbia River Power System. In its March 1995 Biological Opinion, NMFS concluded that the proposed operation of the hydropower system, including the Corps' eight dams on the lower Columbia and Snake rivers, jeopardized the continued existence of the listed Snake River salmon. NMFS recommended a "reasonable and prudent" alternative that identified immediate, intermediate, and long-term actions concerning the operation and configuration of the hydropower system. The reasonable and prudent alternative also includes time frames for completing certain fish mitigation actions. The Corps is responsible for implementing the fish mitigation actions that affect its eight dams on the lower Columbia and Snake rivers.

Results in Brief

Since 1995, the Corps' efforts to mitigate the decline of salmon stocks on the lower Columbia and Snake rivers have been guided by the National Marine Fisheries Service's 1995 Biological Opinion. Many of the monitoring, evaluation, research, design, and construction projects identified in the Biological Opinion are included in the Corps' Columbia River Fish Mitigation program. The Corps' decision-making process for selecting, setting priorities for, and funding specific projects and studies in

its fish mitigation program is a cooperative effort between the Corps and regional interests and is known as the Regional Forum process. The Regional Forum is a group with broad regional representation, including federal agencies, states, and Native American tribes located in the Columbia River Basin. The Forum, which includes the Corps, tries to reach consensus among its members in making decisions about fish mitigation actions. If consensus cannot be reached, the Corps is the decisionmaker on actions that affect its eight dams. Annually, the Corps, with input from the Regional Forum, estimates the costs of its fish mitigation actions and requests funding as part of its normal budget process. If the Congress appropriates less funding than the Corps requests, the Corps seeks recommendations from the Regional Forum to help it decide on which actions should be funded.

As of October 31, 1997, the Corps' Columbia River Fish Mitigation program consisted of 58 actions that included 29 studies and 29 projects, such as testing prototype fish passage facilities and making structural modifications to dams. The majority of these actions are being completed on time and within budget. However, the Corps identified 19 actions, or about 40 percent of the 47 actions the Corps has initiated, that were delayed, experienced cost increases, or both.

A variety of factors, mostly in combination, have contributed to the Corps' problems. For example, for at least three projects and one study, high water flows and floods have had an adverse effect on the completion of the projects. In at least four projects and three studies, delays and cost increases were the result of decisions by the Regional Forum that changed fish mitigation priorities. These changes were often necessitated by such factors as limited funding, the need for additional biological data, or the desire to test new technology. Finally, in about three projects, difficulties, including problems with engineering designs, were the result of the Corps' by-passing standard procedures for managing the project in an effort to implement required actions in the time frames established by the Biological Opinion. In some cases, the problems the Corps has experienced in implementing its fish mitigation actions have had significant impacts. These impacts include delays in the collection of data needed to make future decisions on salmon recovery, continuing high fish mortality rates, the loss of power generation and the related potential revenues, and increases in the Corps' operations and maintenance expenses. In addition, there are ongoing concerns about the overall effectiveness of the Regional Forum because, among other things, its members do not agree on how to pursue salmon recovery efforts.

Independent evaluations have found a number of deficiencies with the process followed by the Regional Forum, and proposals for replacing the Forum are being considered.

Principal Findings

Biological Opinion and the Regional Forum Guide the Corps' Fish Mitigation Actions

While the Corps has been conducting salmon mitigation actions under its Columbia River Fish Mitigation program since the mid-1980s, currently, the primary focus of the program is the implementation of the actions specified in the National Marine Fisheries Service's March 1995 Biological Opinion. Some operational actions called for in the Biological Opinion, such as river flow augmentation and spill, are implemented by the Corps but are not part of its fish mitigation program. That program includes projects related to the design and construction of fish passage facilities as well as studies that support the Federal Columbia River Power System's long-term decisions on the system's configuration and operation.

In response to the Biological Opinion, the Corps reiterated that it would work cooperatively with all interested parties, including state agencies and Native American tribes, in implementing its fish mitigation actions. The Corps' and other federal agencies' commitment to a cooperative regional approach to the federally led salmon recovery efforts evolved into the Regional Forum. The Regional Forum, working within the framework of the Biological Opinion, coordinates policy, sets priorities for selecting and funding projects, and reviews the designs for the salmon recovery projects. Two of the Corps' district offices are responsible for implementing the Columbia River Fish Mitigation program. They develop specific proposals, including scope, costs, and schedules, for the projects and studies in the program. The Corps then obtains the Regional Forum's review of and recommendations for these proposals before they become part of the Corps' fish mitigation program and budget request. Since the Corps' Columbia River Fish Mitigation program is funded by annual congressional appropriations and the program's projects and studies typically span more than one fiscal year, the Corps must seek funding for many of these actions during multiple appropriation cycles. Consequently, ongoing actions may be affected if the Corps receives a program appropriation that is less than its budget request. In these cases, the Corps seeks recommendations from the Regional Forum to help the Corps decide which projects are to be funded, and at what level, for the year.

A June 1997 consultant report, done at the request of a congressional conference committee, questioned the overall effectiveness of the Regional Forum and found a number of deficiencies with the process. For example, the study found that the members of the Regional Forum did not agree on how salmon recovery efforts should be achieved. In addition, the report stated that the Forum had difficulty obtaining consensus to make decisions, lacked a clear process to resolve disputes, and was often repetitive and contradictory in setting priorities for fish passage projects and studies. The report made a number of recommendations to improve the Regional Forum's process. Subsequently, the governors of the four Northwest states proposed replacing the federally led Forum with a process that would be jointly led by federal agencies, states, and Native American tribes.

The Corps Has Experienced Problems Implementing Some Fish Mitigation Actions

As of October 31, 1997, the Corps had started 47 of the 58 fish mitigation actions contained in its fish mitigation program. The start of the remaining 11 actions had not yet been scheduled. The majority of these actions have been, or are expected to be, completed on time and within budget. However, the Corps identified 19 actions (8 studies and 11 projects), or about 40 percent of the total actions the Corps had initiated, that were delayed, had encountered cost increases, or both. The actions include most of the Corps' larger fish mitigation projects as measured in terms of estimated costs to complete.

Of these 19 fish mitigation actions, 18 were delayed and 9 experienced cost increases (8 of the 9 actions incurred both delays and cost increases). Delays ranged from 3 weeks in starting a study on the effectiveness of a prototype juvenile fish surface bypass and collection system at the Lower Granite Dam to an indefinite delay for installing a juvenile fish bypass system at The Dalles Dam. Cost increases on the nine actions averaged over \$2 million, ranging from \$280,000 for the installation of extended-length submerged bar screens at Little Goose Dam to over \$7 million for the design and construction of a new juvenile fish sampling and monitoring facility at John Day Dam.

A variety of factors has contributed to delays and cost increases in the 19 fish mitigation actions. Some of the factors, such as changes in fish mitigation priorities, problems encountered in attempts to streamline project management, and effects of adverse weather on project implementation, were identified as the reasons for delays and cost increases in more than one study or project. Other factors, such as

contractors' performance problems, bid protests, and revisions of projects' scope, were identified as reasons only in individual actions. For most actions, a combination of these factors contributed to the Corps' not completing fish mitigation actions on time and within budget.

When fish mitigation actions encounter delays and cost increases, the impacts on migrating juvenile fish can be significant. For example, at The Dalles Dam on the lower Columbia River, juvenile fish use the dam's turbines, spillway, or ice and trash sluiceway—a waterway used to pass ice and trash around the dam—to migrate past the dam. However, juvenile fish that go through the dam's turbines experience mortality rates estimated to be as great as 15 percent. In addition, preliminary results of the Corps' ongoing study of spillway survival indicate that the mortality rate for juvenile fish going over the spillways—previously thought to be about 2 percent—may actually be as high as 12 percent. Furthermore, the Corps observed that hydraulic conditions in the ice and trash sluiceway, as well as large numbers of predator fish at the sluiceway's outfall, may make utilizing the sluiceway to bypass juvenile fish unacceptable. In March 1994, the Corps proposed the construction of a new juvenile fish bypass system that was to be fully operational by March 1998. However, the Regional Forum's decision to test new bypass technology at the dam, combined with subsequent funding limitations, have indefinitely delayed the decision on what type of bypass system to construct. Consequently, juvenile fish migrating down the river are still exposed to some of the same hydraulic conditions, predator densities, and mortality rates that the Corps found to be unacceptable in the mid-1980s.

Other impacts that can occur when fish mitigation actions are not completed on time and within budget include delays in the collection of data needed to make future decisions on salmon recovery, the loss of power generation and associated potential revenues, and increased expenses for dams' operations and maintenance. In addition, since the fish mitigation program is funded by annual appropriations, when one fish mitigation project or study incurs a cost increase, the opportunity to use those funds on other projects is lost.

Recommendation

GAO is making no recommendations in this report.

Agency Comments

GAO provided the Department of the Army with a draft of this report for its review and comment. The U.S. Army Corps of Engineers, in commenting

for the Department, stated that it agreed with the statements contained in the draft report and had no comments. (See app. II.)

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Abbreviations

CRITFC	Columbia River Inter-tribal Fish Commission
GAO	General Accounting Office
NMFS	National Marine Fisheries Service
PIT	Passive Integrated Transponder
USACE	United States Army Corps of Engineers

Introduction

The Columbia River Basin is North America's fourth largest, draining about 258,000 square miles and extending predominantly through the states of Washington, Oregon, Idaho, and Montana and into Canada. There are over 250 reservoirs and about 150 hydroelectric projects in the basin, including 18 mainstem dams on the Columbia and its primary tributary, the Snake River. One of the most prominent features of the Columbia River Basin has been its production of salmon. Specifically, the Columbia River Basin provides habitat for five species of anadromous¹ salmon: chinook, coho, chum, sockeye, and pink. Salmon spawn in fresh-water rivers and their tributaries. Juvenile salmon live in the fresh water for a year or two, migrate to and mature in the ocean, and return in 2 to 5 years to their place of birth as adults to spawn.

About 150 years ago, the Columbia River Basin returned the largest adult runs of wild salmon on earth—their annual populations were estimated at up to 16 million salmon. Since that time, however, total annual salmon returns have declined to only about 2.5 million in 1996. It is estimated that only about 500,000 of these returning adults are wild or naturally spawned fish. The remainder are hatchery-raised fish intended to supplement the declining wild runs.

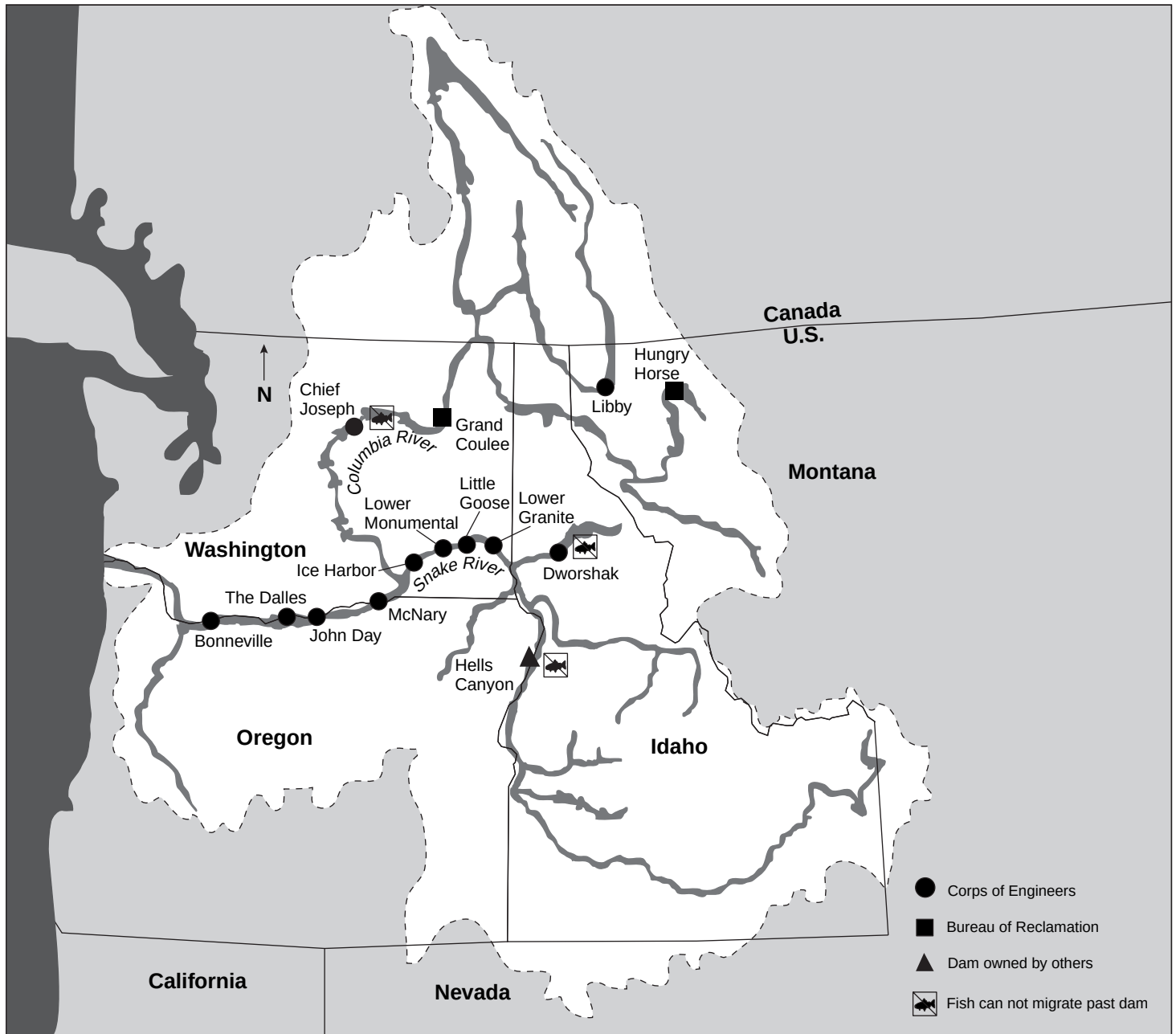
A number of factors have contributed to the decline of salmon stocks in the Columbia and Snake rivers. These include overharvesting in the late 1800s and the early 1900s, as well as the adverse effects on spawning habitat from farming, cattle grazing, mining, logging, road construction, and industrial pollution. A variety of ocean conditions including currents, pollution, temperature changes, and nutrient base, also affects the survival of salmon. In addition, dams have a significant impact on declining salmon stocks, particularly those dams that limit access to spawning habitat and those through which fish passage is provided but at reduced levels in comparison with natural conditions. However, most of the decline in wild salmon stocks—from the estimated 16 million in the mid-1800s to about 4 million in 1938—occurred before the first federal dam was completed in the Columbia River Basin in 1938.

¹Anadromous fish are those that hatch in fresh water, migrate to the ocean where they mature, and then return to fresh water to spawn.

The Federal Columbia River Power System and the Corps of Engineers' Dams

The Federal Columbia River Power System (the Columbia power system) includes all federally owned hydroelectric dams in the Columbia River Basin that are operated and maintained by the U.S. Army Corps of Engineers and the Department of the Interior's Bureau of Reclamation. These include 21 Corps dams and 8 Bureau dams. The Bonneville Power Administration (Bonneville Power) is responsible for transmitting and marketing the hydroelectric power generated by this system. Of the 21 dams operated and maintained by the Corps, eight are major, multipurpose dams located on the lower Columbia and Snake rivers that affect the habitat and migration of salmon. These are Bonneville, The Dalles, John Day, and McNary on the lower Columbia and Ice Harbor, Lower Monumental, Little Goose, and Lower Granite on the Snake.

Figure 1.1: Major Dams Affecting Salmon Migration in the Columbia River Basin



Source: U.S. Army Corps of Engineers.

These dams are a major source of hydroelectric power in the region and also provide flood control, navigation, recreation, irrigation, municipal and industrial water supply, and fish and wildlife benefits. However, the dams impede the migration of juvenile and adult fish to and from the ocean by their physical presence and by creating reservoirs. Reservoirs formed behind the dams slow water velocities, alter water temperatures, and improve the habitat of predators.

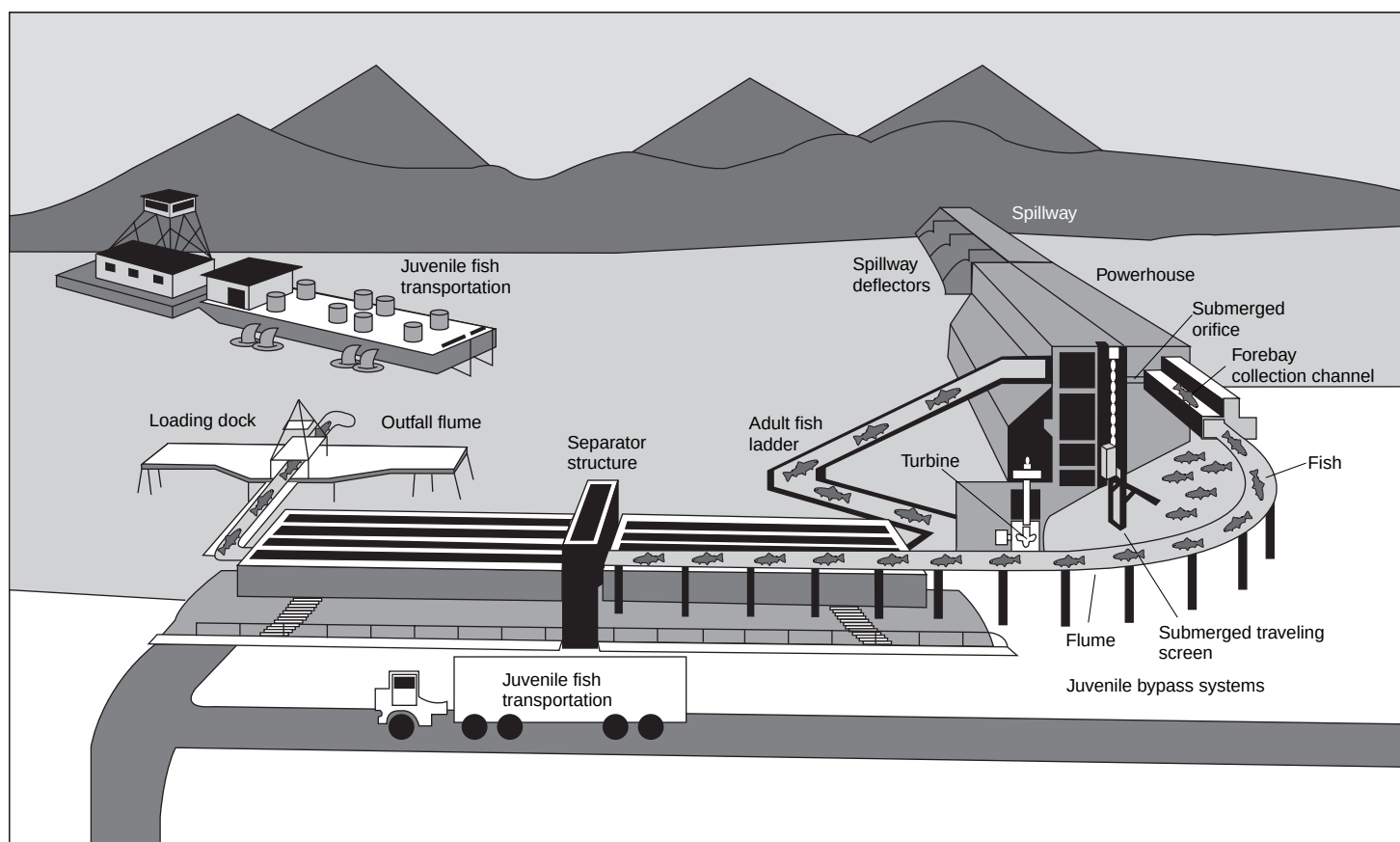
Dam Modifications Have Improved Fish Passage

The Corps has adult fish ladders at all eight of its dams on the lower Columbia and Snake rivers. Adult fish ladders were integrated into the design of the dams beginning with Bonneville in 1938. These ladders consist of a series of steps and water pools that provide a gradual upward climb over the dams for returning adults. To steer the adults to the ladders, “attraction” flows at the downstream ladder entrances simulate conditions that would be found at the base of natural waterfalls. The concept has proved effective for adult fish passage.

Generally, juvenile fish can migrate downstream past the dams by several routes, including through the dams’ turbines, through the dams’ juvenile fish bypass systems, or over the dams’ spillways. The Corps has juvenile fish bypass systems in place at seven of its eight dams. At The Dalles Dam, juvenile fish are bypassed through the dam’s ice and trash sluiceway—a waterway used to pass ice and trash around the dam. While each alternative passage has associated risks and contributes to fish mortality, passage through the bypass system or over the spillway has a lower mortality rate than through the turbines. Many juvenile fish are also collected and transported past the dams by barge and truck under the Corps’ juvenile fish transportation program.

The conventional juvenile fish bypass systems at the Corps’ dams guide fish away from turbines by means of submerged screens positioned in front of the turbines. The juvenile fish are directed up into a gatewell, where they pass through orifices into collection channels that transport the fish around the dam. The fish are then routed back out to the river below the dam, which is called “bypassing”; at the four dams with fish transport facilities, fish can be routed to a holding area for loading on to specially equipped barges and trucks for transport downriver to below the Bonneville Dam—the last dam on the lower Columbia River before the Pacific Ocean. Three of the Corps’ four Snake River dams and the McNary Dam on the Columbia River have fish transportation facilities.

Figure 1.2: Existing Fish Passage Systems at the Corps' Dams on the Lower Columbia and Snake Rivers



Source: U.S. Army Corps of Engineers.

The percentage of fish approaching a turbine intake that are guided by submerged screens into facilities that bypass the turbine is called fish guidance efficiency. This percentage varies from dam to dam and by type of fish. For example, according to the Corps, the current bypass systems for juvenile fish guide 60 to 70 percent of spring/summer chinook salmon away from the turbines and up through the bypass channel. However, the fish guidance efficiency for fall chinook salmon is only about 30 percent because they are smaller, swim deeper in the river, and migrate in different

water conditions. Dams equipped with extended-length screens can guide up to 66 percent of fall chinook into bypass systems.

River Operations Can Improve Anadromous Fish Passage

Hydropower operations can be modified to improve in-river migration conditions for fish. During the juvenile fish migration season, from April until fall, water can be spilled at the dams and flows in the river can be augmented to aid juvenile fish migration.

One operational measure designed to improve salmon passage at the Corps' dams is to spill water and juvenile fish over the dams' spillways, rather than putting the water through the powerhouses' turbines to produce electricity. However, spill has associated risks because when the water plunges into the spillway basins, it traps gases, such as nitrogen. Water that is supersaturated with nitrogen can be lethal to both adult and juvenile fish. Spillway deflectors have been installed at seven of the Corps' eight dams to limit the plunge depth of spilled water, thereby reducing the amount of supersaturated gases.

Figure 1.3: Spill at Corps' Dam on the Lower Columbia River



Source: General Accounting Office.

Another operational method of improving in-river fish migration is flow augmentation. Upstream storage dams hold water for flood control and other uses, interrupting the river's historical seasonal flow patterns. Seasonal releases of water from upstream storage dams, called flow augmentation, can aid salmon migration. The Corps operates two upstream storage dams in the Columbia River Basin, Dworshak Dam in Idaho and Libby Dam in Montana, from which water is released to aid juvenile fish as they migrate downriver.

Efforts to Improve Salmon Recovery Have Been Ongoing for Decades

Since 1949, federal and state agencies and regional organizations² responsible for efforts to enhance salmon have invested over \$3 billion in actions to improve salmon runs throughout the Columbia River Basin. Despite the studies and actions taken to improve fish passage, salmon runs in the Columbia River Basin have continued to decline: returning adult populations totaled about 4 million in 1938, 3 million in 1980, and 2.5 million in 1996.

Over the past several decades, various federal and state agencies, the courts, and other entities have shaped the development and management of salmon policy in the Columbia River Basin. During the early period of the construction of the Corps' eight dams on the lower Columbia and Snake rivers, the state fisheries agencies, universities, and the U.S. Bureau of Fisheries (later called the U.S. Fish and Wildlife Service) conducted most fisheries research in the Columbia River Basin. In the early 1950s, the Corps' North Pacific Division (currently the Northwestern Division) organized the Fisheries Engineering Research Program, which—in coordination with the directors of federal and state fisheries agencies—reviewed research and discussed additional concerns and research opportunities to improve fish passage. Most early studies focused on adult migrants. By the late 1950s, the program's attention was drawn to studying the survival of juvenile fish and their diversion away from turbine intakes. In 1968, the Corps funded an experiment by the Department of Commerce's National Marine Fisheries Service (NMFS) at Ice Harbor Dam, using trucks to transport juvenile salmon around the four completed lower Columbia River dams. Encouraging results led to the installation of juvenile fish bypass systems that enable fish collection and transportation at some of the Corps' dams. The development of screens to divert juvenile fish from the turbine intakes began in 1969, and further research provided

²Agencies and organizations include U.S. Corps of Engineers, the National Marine Fisheries Service, the Bonneville Power Administration, the U.S. Fish and Wildlife Service; the Northwest Power Planning Council; state fish and wildlife agencies; public utilities districts and private power companies; local organizations; and nonprofit organizations.

the basis for the modification of river flows and dam operations beginning in the 1980s.

By the mid-1980s, the Corps developed its Columbia River Fish Mitigation Project to reduce the mortality of juvenile salmon. This project is part of the Corps' larger Columbia River Salmon Program that includes river operations, fish passage operations and maintenance, fish transportation, research, hatchery operations funded through the Corps' operations and maintenance appropriation, and fish passage improvements. The Corps' Columbia River Fish Mitigation Project includes individual actions related to the design and construction of improvements to fish passage facilities as well as studies that support the Columbia power system's long-term decisions on the system's configuration and operation. Today, the Corps refers to these fish mitigation actions collectively as the Columbia River Fish Mitigation Project. However, for purposes of this report, we refer to the Corps' Columbia River Fish Mitigation Project as a program and individual fish mitigation actions as projects or studies.

In 1980, the Congress passed the Pacific Northwest Electric Power Planning and Conservation Act, now called the Northwest Power Act, which envisioned salmon as an equal partner with hydropower operations for dams in the Columbia River Basin. The act called for elevating energy and fish planning to a regional level by establishing greater involvement of state and local governments, Native American tribes, and the public in power planning through an interstate Pacific Northwest Electric Power and Conservation Planning Council—now called the Northwest Power Planning Council. The Council, which consists of two members from each state appointed by the governors of Washington, Oregon, Idaho, and Montana, was formed in 1981. The act directed the Council to ensure an adequate long-term supply of power for the Pacific Northwest and to develop a basinwide comprehensive Fish and Wildlife Program to rebuild resources that had been harmed by hydroelectric development. While the act gave the Council the authority to plan, the primary implementors and funding source for the Fish and Wildlife Program are federal agencies. Under the act, federal agencies that manage, operate, or regulate hydroelectric facilities in the Columbia River Basin are required to take the program into account “. . . at each relevant stage of decisionmaking processes to the fullest extent practicable.”³ These obligations are intended to help integrate federal agencies' fish mitigation actions with a regionally supported fish and wildlife program. In 1982, the Council completed its first Fish and Wildlife Program. During 1982 through 1994,

³16 U.S. C. 839b(h)(11)(A)(ii).

the program was amended several times, calling for an integrated approach to fish restoration efforts, designating “protected areas” for fish and wildlife, adopting a mainstem-dam spill agreement, and concentrating on improving the survival of juvenile salmon migrating downstream.

Other key entities in salmon recovery efforts in the Pacific Northwest are the Native American tribes. Tensions between Native Americans and other users of the Columbia River Basin have existed since before the 19th century. In the mid 1800s, the federal government negotiated treaties with the Native Americans in the Columbia River Basin which granted the Indians the right to take fish at all the usual and accustomed fishing grounds and stations in common with all citizens of the Territory. Although relations improved in the 1980s, today, the Native Americans, with some support, generally argue that salmon recovery can be accomplished most efficiently by returning the Columbia and Snake rivers to “natural” flow conditions and that interim expenditures that evaluate other potential remedies are unnecessary and costly. Specifically, the Native American tribes call for the removal of a portion (breach) of the Corps’ four dams on the Snake River and support releases of water to increase river flows to aid salmon migration. The tribes also support the use of hatcheries to rebuild salmon runs. The tribes are opposed, however, to the Corps’ programs that transport juvenile fish past the dams. Transportation of fish, some tribes argue, is unnatural.

Certain Salmon Stocks Are Listed as Endangered or Threatened

In March 1990, a regional Native American tribe, the Shoshone-Bannock, petitioned NMFS to list the Snake River sockeye salmon as endangered under the Endangered Species Act. Later in 1990, a coalition of environmental groups requested protection for the spring/ summer and fall runs of the Snake River chinook salmon and the lower Columbia River coho salmon. In 1991, NMFS declared the Snake River sockeye salmon as endangered under the Endangered Species Act. In 1992, NMFS declared the spring/summer and fall runs of the Snake River chinook salmon as threatened. This Endangered Species Act listing required the Corps, Bonneville Power, and the Bureau of Reclamation to consult with NMFS to determine whether river flow improvements and planned fish mitigation measures associated with the operation of the Federal Columbia River Power System would further jeopardize the existence of the listed species.

Under the Biological Opinion, the Columbia power system encompasses those dams and reservoirs owned and operated as a coordinated system for the purpose of power production by the three action agencies (the

Corps, Bonneville Power, and the Bureau of Reclamation) on behalf of the federal government. For purposes of the Biological Opinion, these dams and reservoirs are the Dworshak, Lower Granite, Little Goose, Lower Monumental, and Ice Harbor in the Snake River Basin; Hungry Horse, Libby, and Grand Coulee on the upper Columbia River; and McNary, John Day, The Dalles, and Bonneville on the lower Columbia River. The Biological Opinion takes into account the operation of these dams as a unified hydropower system and as individual projects. For example, flow augmentation, the survival of juvenile and adult salmon, and total dissolved gas issues can involve both the hydropower system as a whole or just individual dams in any given case.

Previous Biological Opinions issued by NMFS in 1992, 1993, and 1994 (the 1994 Opinion addressed the operations of the hydropower system through 1998) stated that the proposed operations of the Columbia power system during those years would not jeopardize the continued existence of Snake River salmon. NMFS's 1993 Biological Opinion finding of "no jeopardy" was challenged in U.S. District Court by the Idaho Department of Fish and Game, the State of Oregon, and four Native American tribes. On March 28, 1994, the court ruled that NMFS' 1993 Biological Opinion was inadequate because it relied too much on the status quo for improving listed stocks of salmon that continued to dwindle in numbers. The 1993 Biological Opinion dealt with the operation of the Federal Columbia River Power System in 1993, a system that had been completed by the time of the court's decision. Thus, the court permitted NMFS, the Corps, and the Bureau of Reclamation to address the court's concerns by reconsidering the March 16, 1994, Biological Opinion.

In accordance with the court's decision, on March 2, 1995, NMFS issued a Biological Opinion on the operation of the Columbia power system for 1995 and future years. The 1995 Biological Opinion concluded that the proposed operation of the hydropower system, which included planned fish mitigation actions, was likely to jeopardize the continued existence of the listed Snake River salmon protected under the Endangered Species Act. NMFS recommended a "reasonable and prudent" alternative that included immediate, intermediate, and long-term actions concerning the operation and configuration of the Columbia power system to avoid jeopardizing the protected salmon. Subsequently, the Corps issued a Record of Decision⁴ that stated its intention to carry out the reasonable and prudent alternative contained in the 1995 Biological Opinion.

⁴U.S. Army Corps of Engineers' Record of Decision for Reservoir Regulation and Project Operation, 1995 and Future Years (Mar. 1995).

The Corps’ Implementation of Fish Mitigation Actions

The Corps’ Columbia River Fish Mitigation program was initiated in the mid-1980s to focus efforts on finding ways to improve fish passage at the Corps’ eight dams on the lower Columbia and Snake rivers. The program has evolved into a regionally coordinated direction for the Corps’ actions in the furtherance of both regional and NMFS fish mitigation efforts. The fish mitigation program is the largest construction program in the history of the Corps’ Northwestern Division. The Corps’ current estimates place the cost to complete the program by the end of fiscal year 2007 at \$1.4 billion.

The fish passage structural improvements done under the fish mitigation program are considered civil works projects and, as such, would normally follow the Corps’ standard procedures for project management. The life cycle of a civil works project passes through two distinct phases—general investigations and construction. The general investigation phase of a project is intended to review and evaluate alternatives to a project and to prepare the National Environmental Policy Act documentation needed for a project to proceed to construction. The general investigation phase of a major federal project can cost millions of dollars and take years to complete.

The construction phase of a project incorporates the traditional engineer-construction activities. There are three primary elements: the feature design memorandum, plans and specifications, and construction. The feature design memorandum evaluates the project’s individual elements, describes the detailed design alternatives, and identifies the selected design for incorporation into the total design package. Plans and specifications are the engineering drawings, calculations, standard documents, and engineers’ estimates, which, when assembled, are the documents used by the construction contractor to build the project. Finally, construction of a Corps project usually involves many specialty subcontractors managed by a general contractor who is responsible for the construction of the overall project. Generally, the Corps’ fish mitigation projects on the Columbia River have been multiyear projects.

Objectives, Scope, and Methodology

Concerned about how well the U. S. Army Corps of Engineers was implementing its Columbia River Fish Mitigation program at its dams on the lower Columbia and Snake rivers in the Pacific Northwest, Senators Max S. Baucus, Patty Murray, and Harry M. Reid asked that we provide information on (1) the Corps’ decision-making process for identifying, setting priorities for, and funding fish mitigation actions and (2) whether

the Corps has completed its fish mitigation actions on schedule and within budget. In addition, we were asked to determine why the Corps had not entered into a direct funding agreement with the Bonneville Power Administration for certain costs of operating and maintaining the Corps' dams in the Columbia River Basin. During the course of our audit, the Corps did complete such an agreement. Appendix I of this report provides information on how the direct funding agreement will work.

To provide information on the Corps of Engineers' decision-making process for identifying, setting priorities for, and funding fish mitigation actions, we interviewed and obtained documents and data from officials at the Corps' Northwestern Division and District offices in Portland, Oregon, and Walla Walla, Washington; National Marine Fisheries Service officials in Portland, Oregon; and additional Regional Forum members, such as the Columbia River Inter-tribal Fish Commission and staff of the Northwest Power Planning Council. We reviewed the Memorandum of Agreement between the Department of the Army, the Department of Commerce, the Department of Energy, and the Department of the Interior concerning funding of fish mitigation actions and the Regional Forum's procedures and minutes of meetings. We also reviewed a June 13, 1997, report prepared by Science Applications International Corporation and HDR Engineering, Inc., for the Department of the Army, Seattle District, Corps of Engineers, entitled Independent Review and Evaluation of Processes Utilized to Implement Structural Improvements at Columbia and Snake Rivers Fish Passage Projects.

To determine whether the Corps of Engineers completed its fish mitigation actions on schedule and within budget, we initially relied on officials at the Corps' Northwestern Division in Portland, Oregon, and its Portland and Walla Walla District offices to identify fish mitigation actions that were delayed and/or had incurred cost increases as of October 31, 1997. To determine the actual length of any delay and the amount of any cost increase, we reviewed individual project and study contracts, contract modifications, and reports and interviewed project managers, program managers, and Corps construction personnel to obtain planned completion dates and cost estimates. We then compared the planned completion dates and cost estimates to the scheduled completion dates and cost estimates as of October 31, 1997. We also reviewed NMFS' March 1995 Biological Opinion, attended meetings of the Regional Forum, and reviewed the minutes and documentation of various Regional Forum meetings discussing fish mitigation implementation actions.

The Corps officials at the Northwestern Division and District offices identified 58 fish mitigation actions as of October 31, 1997. Of these 58 actions, Corps officials identified 19 projects and studies that experienced delays, cost increases, or both. To determine why these actions had encountered delays and/or cost increases, we reviewed documentation, including feature design memorandums, construction contracts, contract modifications, correspondence between the Corps and its contractors, funding and priority schedules, and other relevant reports. To obtain additional information on the reasons for cost increases and/or delays and to determine the impacts of the delays and/or cost increases on fish mitigation actions, we discussed the status of each activity with Corps personnel, such as project managers, contract and construction personnel, and fisheries biologists.

To determine how the Corps' recent direct funding agreement with the Bonneville Power Administration for the power costs of operating and maintaining the Corps' dams will work, we interviewed and obtained documents from officials at the Bonneville Power Administration in Portland, Oregon; the Corps of Engineers headquarters in Washington, D.C.; and the Corps' Northwestern Division and District office in Portland, Oregon. We reviewed the Corps' current budget process, operations and maintenance budget needs, and prior direct funding agreements with Bonneville Power. We also reviewed Bonneville Power's funding requirements for reimbursing the Corps for power-related operations and maintenance costs. Finally, we interviewed officials of the Northwest Power Planning Council in Portland, Oregon, and Bureau of Reclamation officials in Boise, Idaho, for their views on direct funding for power-related operations and maintenance costs.

We performed our audit work from July 1997 through March 1998 in accordance with generally accepted government auditing standards. GAO provided the Department of the Army with a draft of this report for its review and comment. The U.S. Army Corps of Engineers, in commenting for the Department, stated that it agreed with the statements contained in the draft report and had no comments. (See app. II.)

NMFS' 1995 Biological Opinion and the Regional Forum Guide the Corps' Fish Mitigation Actions

Since 1995, the Corps' efforts to mitigate the decline of salmon stocks on the lower Columbia and Snake rivers have been guided by NMFS' 1995 Biological Opinion. Many of the monitoring, evaluation, research, design, and construction projects and studies identified in the Biological Opinion are included in the Corps' Columbia River Fish Mitigation program. The Corps' decision-making process for selecting, setting priorities for, and funding specific fish mitigation projects and studies is a cooperative effort between the Corps and regional interests and is known as the Regional Forum process. The Regional Forum is a group with broad regional representation, including federal agencies, states, and Native American tribes from the Columbia River Basin. The Forum, which includes the Corps, tries to reach consensus among its members in making decisions on fish mitigation actions. However, if consensus cannot be reached, the Corps, as the action agency responsible for implementing its fish mitigation program, makes the decisions. Annually, the Corps, with input from the Regional Forum, estimates the costs of its fish mitigation actions and requests funding for their implementation as part of its normal budget process. If the Congress appropriates less money than the Corps requests, the Corps seeks recommendations from the Regional Forum to help the Corps make its decisions on which projects and studies should be funded, at what levels, and in which years.

NMFS' Biological Opinion Guides the Corps' Fish Mitigation Program

In March of 1995, NMFS issued its Biological Opinion on the operation of the Federal Columbia River Power System proposed by the Corps, Bonneville Power, and the Bureau of Reclamation for 1995 and future years. The Biological Opinion concluded that the proposed operation, which included planned mitigation activities, was likely to jeopardize the continued existence of the three species of Snake River salmon protected under the Endangered Species Act. Pursuant to the act's requirements, the Biological Opinion recommended a "reasonable and prudent" alternative to the proposed hydropower system's operation. NMFS concluded that implementing the reasonable and prudent alternative would not jeopardize the survival of the listed salmon. The reasonable and prudent alternative includes time frames for completing certain fish mitigation projects and studies and identifies the Corps as one of three action agencies responsible for implementing the fish mitigation activities identified in the Biological Opinion. Bonneville Power and the Bureau of Reclamation are the other action agencies.¹ In response to the Biological Opinion, in March 1995, the Corps issued its Record of Decision for Reservoir

¹They are responsible, in part, for improving water flows in the Columbia and Snake Rivers to optimize juvenile fish survival and for monitoring the survival of juvenile fish as they migrate to the ocean.

Regulation and Project Operation, 1995 and Future Years. In the Record of Decision, the Corps stated its intention to carry out the requirements of the Biological Opinion. The Corps carries out many of the measures it is responsible for under the Biological Opinion through its Columbia River Fish Mitigation program. While the Corps has been conducting salmon mitigation efforts under its fish mitigation program since the mid-1980s, currently, the primary focus of the program is the implementation of the actions specified in the Biological Opinion. Some operational measures called for in the Biological Opinion, such as river flow augmentation, spill, and juvenile fish transportation, are implemented by the Corps, but not as part of the Columbia River Fish Mitigation program. The fish mitigation program includes projects related to the design and construction of fish passage facilities, as well as studies that support long-term configuration and operational decisions for the hydropower system.

The Biological Opinion identifies immediate, intermediate and long-term actions designed to improve the operation and configuration of the hydropower system for the benefit of salmon. It employs an approach that calls for taking immediate and intermediate actions to increase salmon survival while conducting other activities to determine the benefits of, need for, and feasibility of long-term structural modifications to the hydropower system. In keeping with this strategy, the Biological Opinion required the Corps to take a variety of actions. Some of these consist of designing and constructing facilities to improve salmon passage at the Corps' dams. Other actions are operational in nature, such as augmenting river flows to aid the migration of juvenile salmon. Finally, some actions consist of conducting studies and collecting the information needed for decisions on the hydropower system's long-term configuration. It should be noted that the Biological Opinion is a mitigation plan whose required actions are designed to avoid jeopardizing the continued existence of listed species. Although the required actions will generally benefit many anadromous fish in the Columbia River Basin, the Biological Opinion is not a salmon recovery plan. A recovery plan has a goal of returning the listed species to a point where protection under the Endangered Species Act is no longer necessary.

The following are specific examples of the immediate and intermediate actions the Biological Opinion required of the Corps:

Immediate Actions

- Augmenting Columbia and Snake river flows to help juvenile salmon migrate downstream, which requires releasing water from upstream

storage reservoirs during the spring and summer juvenile salmon migration.

- Spilling river flows at the Corps' dams rather than passing them through hydropower turbines where juvenile salmon experience higher mortality rates.
- Collecting juvenile salmon at certain of the Corps' dams and transporting them downstream by barge or truck, past remaining dams, where they are released back into the Columbia River.
- Evaluating the feasibility, costs, and benefits of drawing down certain reservoirs behind the Corps' dams to levels significantly below normal operating range.
- Designing and testing surface collection facilities at certain dams, a relatively new technology that may more efficiently and effectively bypass juvenile salmon at the dams.
- Conducting studies and making facility improvements that will achieve an 80-percent fish passage efficiency (the percentage of fish that pass dams without going through turbines) and an overall 95-percent passage survival rate at each dam.

Intermediate Actions

- Developing a gas abatement program, including appropriate structural modifications, to reduce gas supersaturation.
- Prototype testing and installation of extended-length screens to direct juvenile salmon away from turbines.
- Planning and implementing improvements to the juvenile bypass facility at Lower Granite Dam on the Snake River.
- Designing and constructing facilities at John Day and Bonneville dams to improve sampling and monitoring of juvenile salmon as they migrate past these dams.
- Relocating the outfall structure from which juvenile salmon exit the bypass facility at Bonneville Dam to reduce mortality caused by predator fish.
- Designing and installing a juvenile bypass system at The Dalles Dam.
- Determining the appropriate number and size of additional transportation barges to provide direct loading of juvenile salmon, a measure designed to avoid the stress associated with keeping juvenile salmon in holding areas until barges are available.

In addition to these immediate and intermediate actions, the Biological Opinion also called for decisions on the long-term operation and configuration of the hydroelectric power system. For example, the Corps is currently studying three alternatives for the long-term operation of its

four dams on the lower Snake River. Two of these alternatives would require major system configuration changes. The alternatives under consideration are (1) maintaining current structures and operations as prescribed in the Biological Opinion, including juvenile fish transportation and improvements to existing bypass facilities; (2) permanently drawing down the reservoirs behind the four dams to natural river levels by removing a section of each dam; and (3) making major system improvements other than drawdown, such as construction of new surface bypass facilities, structural measures to reduce gas supersaturation, and improvements to turbines to reduce salmon mortality. The Biological Opinion provides for the Corps to make a recommendation in 1999 on which of the alternatives is preferred.

The Corps is also considering long-term options for fish passage at dams on the lower Columbia River. These options include installing surface bypass collection facilities at the Corps' dams and drawing down the reservoir behind John Day Dam to the level of the spillway or to the natural river level. These decisions are not part of the 1999 scheduled recommendation for the operation of the lower Snake River dams.

The Corps Coordinates Its Fish Mitigation Actions Through the Regional Forum

The Corps' decision-making process for selecting, setting priorities for, and funding specific fish mitigation projects and studies is a cooperative effort between the Corps and the Regional Forum. In 1995, NMFS, noting the disjointed nature of previous efforts to help the salmon recover, stated that institutional, jurisdictional, state, and federal boundaries make timely fisheries management decisions difficult and that the differing objectives of each organization lead to conflicts in interpretation, lengthy arguments, and decision paralysis. Regional salmon recovery experts recognized that an organization was needed to efficiently manage the salmon recovery program throughout the Columbia power system, and considering its role for listed salmon stocks under the Endangered Species Act, NMFS led this regional effort. As a result, the Corps, NMFS, and the U.S. Fish and Wildlife Service adopted a joint policy that provided for participation by appropriate regional agencies and affected interests in the review and implementation of fish mitigation actions.

Historically, the Corps has coordinated with regional interests its research, design, and construction activities related to improving fish passage at its dams. The Corps reiterated that it would work in a cooperative regional approach in its Record of Decision issued in response to NMFS' 1995 Biological Opinion and in a Memorandum of Agreement among the

Department of the Army, the Department of Commerce, the Department of Energy, and the Department of the Interior. The agreement sets forth Bonneville Power's responsibilities for funding fish and wildlife actions and reinforced the roles and responsibilities of regional interests in setting priorities and budgeting for these actions. The Corps' and other federal agencies' (NMFS, Bonneville Power, Reclamation, and the Fish and Wildlife Service) commitment to a cooperative regional approach in the federally led salmon recovery efforts has evolved into the Regional Forum.

The Regional Forum develops policy guidelines, sets priorities for selecting and funding projects, and reviews project proposals for the salmon mitigation efforts in the Columbia River Basin related to the operation and configuration of the Federal Columbia River Power System. Membership in the Regional Forum is open to five federal agencies, including the Corps, five states, the Northwest Power Planning Council, Columbia River Basin Native American tribes, a private utility, and public utilities. The Regional Forum tries to reach a 100-percent consensus among its members in making decisions concerning fish mitigation actions. However, if consensus cannot be reached, the Corps makes the decisions on actions contained in its fish mitigation program. Details on the Regional Forum's membership, goals, and organizational structure are provided in appendix III of this report.

The Corps coordinates its fish mitigation actions through the Regional Forum. Specifically, the Corps' Walla Walla and Portland District offices are responsible for implementing the Columbia River Fish Mitigation program. These offices develop the proposals, including the scope, costs, and schedules, for the projects in the fish mitigation program. They do this by initially making proposals to the technical committees that provide support to the Regional Forum. For example, the Fish Facilities Design Review Work Group reviews proposals for fish passage projects. The District offices can propose projects and suggest changes in funding levels at any time during the year. Other members of the Regional Forum are also free to propose projects; however, this is not very common. After the proposals have been discussed and reviewed by the technical committees, they are evaluated by the Regional Forum's System Configuration Team. The configuration team is a technical group responsible for planning and overseeing the fish passage structural improvements and related studies called for in the Biological Opinion. During the spring of each year, the configuration team begins discussing and refining a list of projects to be undertaken in the fiscal year beginning in about 18 months. After the configuration team completes its review and develops its

recommendations on which projects and studies to fund, the appropriate Corps district offices make formal cost estimates for the actions and provide them to the Corps' Northwestern Division as part of the district's overall operating budget. The division then compiles the budgets from each district and packages them into a division budget request that is submitted to Corps headquarters by the end of June. This is the basis for the fish mitigation program actions and budget request for the fiscal year beginning in about 15 months.

The Corps' Fish Mitigation Program Is Funded by Annual Appropriations

The Corps' Columbia River Fish Mitigation program is funded by annual appropriations from the Congress. Specifically, funding for the fish mitigation program is provided through the Corps' "construction, general" appropriation. The Corps receives additional funding for the operations and maintenance of fish passage facilities and for the transportation of juvenile salmon through the Corps' "operations and maintenance, general" appropriation. For fiscal year 1998, the Corps requested \$127 million for its fish mitigation program but received an appropriation of \$95 million. Also, the Corps received an additional \$14 million in fiscal year 1998 to fund operations and maintenance of its fish passage facilities and juvenile fish transportation operations. The Corps has estimated that the funding required to implement the fish mitigation program through the end of fiscal year 2007 will total about \$1.4 billion.² About \$908 million of this total will be spent in fiscal year 1999 through the scheduled completion of the program in fiscal year 2007. The \$908 million is for future construction of fish passage projects and related studies and does not include operations and maintenance costs for fish passage facilities.

Since fish mitigation projects typically span more than one fiscal year, the Corps must seek funding for many projects during multiple appropriation cycles. Consequently, ongoing projects may be affected if the Corps receives a fish mitigation appropriation that is less than its budget request. In these cases, the Corps seeks recommendations from the Regional Forum to help the Corps make its decisions about which projects are funded, and at what level, for the year.

²This amount represents total expenditures for the fish mitigation program that began in fiscal year 1988 and are projected through fiscal year 2007. Funding for the fish mitigation program for fiscal years 1988 through 1998 totaled about \$468 million. The Corps estimates it will require about \$908 million in additional funds for this program through fiscal year 2007. The allocation of about \$500 million of this amount depends on long-term decisions for configuration and operation of the hydropower system.

Bonneville Power's Reimbursement of Costs for Fish Mitigation Actions

Although the Corps initially receives funding for its fish mitigation activities through the congressional appropriation process, the Bonneville Power Administration is responsible for reimbursing the U.S. Treasury for the majority of these expenditures. Specifically, Bonneville Power repays the Treasury for the Corps' fish mitigation expenditures at its dams in proportion to the hydropower share of each dam's purposes, which also include navigation, irrigation, and flood control. While the hydropower share varies by dam, it averages about 80 percent. Bonneville Power collects the revenues necessary to repay these costs through its electricity rate structure.

Concerns about Bonneville Power's ability to continue funding rising fish and wildlife costs, including those associated with the Corps' fish mitigation actions, led the agencies responsible for operating the Columbia power system (the Corps under the Department of the Army, Bonneville Power under the Department of Energy, and the Bureau of Reclamation under the Department of the Interior), as well as NMFS and the Fish and Wildlife Service, to negotiate a Memorandum of Agreement that limits Bonneville Power's fish and wildlife funding responsibilities each year. This limit is independent of the amount the Corps will receive through annual congressional appropriations. According to Corps officials, the agency has yet to receive an appropriation that is as high as the amount established as Bonneville Power's maximum contribution under the Memorandum of Agreement.

Specifically, the agreement states that Bonneville Power will provide an average of \$252 million annually for direct, reimbursable, and capital fish- and wildlife-related costs during fiscal years 1996-2001. The agreement allocates the \$252 million as follows:

- \$100 million for noncapital fish and wildlife program activities that Bonneville funds directly, such as research, predator control, hatcheries, and habitat restoration. These activities are called for in NMFS' 1995 Biological Opinion and the Northwest Power Planning Council's Fish and Wildlife Program.
- About \$40 million for reimbursement payments to the Treasury for the operations and maintenance of fish passage and hatchery facilities and other noncapital expenditures.
- \$112 million for capital investment repayments to the Treasury for such projects as constructing fish passage facilities at federal dams, including the Corps' dams, and hatcheries.

During these fiscal years, Bonneville Power also estimates forgone annual hydropower revenues of approximately \$183 million that are associated with providing water for flow augmentation and spill. As such, under the agreement, Bonneville Power will provide an average of \$435 million annually for fish- and wildlife-related costs during fiscal years 1996-2001.

The agreement also recognized the United States' trust obligation to Columbia River Basin Native American tribes and committed the federal signatory agencies to consult and cooperate with the tribes when planning and conducting fish and wildlife mitigation actions. It also recognized the Northwest Power Planning Council's Fish and Wildlife Program and required the parties to discuss planned mitigation actions with the Council in an attempt to reach a common viewpoint.

The Corps Has Experienced Problems Implementing Some of Its Fish Mitigation Actions

As of October 31, 1997, the Corps' Columbia River Fish Mitigation program consisted of 58 actions, including those required by NMFS' 1995 Biological Opinion. While the majority of the Corps' fish mitigation actions have been or are expected to be completed on schedule and within budget, the Corps has encountered difficulties implementing many of its fish mitigation actions. About 40 percent of the 47 fish mitigation actions the Corps has initiated, including most of its larger projects, have experienced delays, cost increases, or both. A variety of factors, mostly in combination, have contributed to the Corps' problems. Some of these factors, such as high water flows and floods, had an adverse effect on completing projects. In other cases, delays and cost increases have resulted from decisions by the Regional Forum that changed fish mitigation priorities. These changes were often necessitated by such factors as funding limitations, the need for additional biological data, or the desire to test new technology. While the Corps coordinates its fish mitigation actions with the Regional Forum, the overall effectiveness of the Forum has been questioned because, among other things, members do not agree on how to pursue salmon recovery efforts and do not uniformly support the actions required by the Biological Opinion. Differing goals are not conducive to implementing actions, especially when consensus is sought to make decisions.

In addition, other difficulties, such as problems with engineering designs, were the result of the Corps' by-passing standard procedures for project management in an effort to implement required actions in the time frames established by the Biological Opinion. In some cases, the problems the Corps has experienced in implementing its fish mitigation actions have had significant impacts. These include delaying the collection of data needed to make future decisions on salmon recovery, continued high fish mortality rates, the loss of power generation and related potential revenue, and increased operations and maintenance costs.

Many Fish Mitigation Actions Are Behind Schedule and Incurring Cost Increases

The 1995 Biological Opinion identified various actions the Corps must implement to improve fish passage at its eight dams on the lower Columbia and Snake rivers. The Corps expanded its existing fish mitigation program to include these requirements. As of October 31, 1997, the fish mitigation program consisted of 58 fish mitigation actions that included 29 studies and 29 projects. The Corps' evaluation and monitoring studies are designed to give the region better biological information and insights related to fish passage and survival at hydropower dams. Specific studies include, among other things, the effectiveness of fish guidance devices and surface collection prototypes and the feasibility of abating

dissolved gas supersaturation. The 29 projects include such actions as designing and constructing extended-length submerged screens in front of turbine intakes to increase fish guidance efficiency, constructing additional barges for the juvenile fish transport program, constructing spillway flow deflectors to reduce gas supersaturation, and constructing new outfalls to reduce predation of juvenile fish at bypass system discharge points. (See app. IV of this report for a list of the Corps' fish mitigation projects and studies and their status as of Oct. 31, 1997.)

As of October 31, 1997, the Corps had started 47 of the 58 fish mitigation actions contained in its fish mitigation program. The remaining 11 actions had not yet been scheduled to start. The majority of the 47 actions have been, or are expected to be, completed on time and within budget. However, the Corps identified 19 actions (8 studies and 11 projects), or about 40 percent of the total actions the Corps has initiated, that were delayed, had encountered cost increases, or both. The actions include most of the Corps' larger fish mitigation projects as measured in terms of estimated costs to complete.

As of October 31, 1997, 18 of the 19 fish mitigation actions have been delayed. The delays ranged from 3 weeks in starting a study on the effectiveness of a prototype surface bypass and collection system at the Lower Granite Dam to an indefinite delay for installing a juvenile fish bypass system at The Dalles Dam. In addition to delays, 9 of the Corps' 19 fish mitigation actions experienced cost increases (8 of the 9 actions incurred both delays and cost increases). As of October 31, 1997, cost increases on the 9 actions averaged over \$2 million, ranging from \$280,000 for the installation of extended-length submerged bar screens at Little Goose Dam to over \$7 million for the design and construction of a new juvenile fish sampling and monitoring facility at John Day Dam.

Reasons for Delays and Cost Increases Vary

A variety of factors has contributed to delays and cost increases in 19 of the Corps' fish mitigation actions. Some of the factors, such as changes in fish mitigation priorities, problems encountered in attempting to streamline project management, and the effects of adverse weather on project implementation, were identified as the reasons for delays and cost increases in more than one study or project. Other factors, such as problems with contractors' performance, a contract bid protest, and revisions to project scope, were identified as reasons only in individual actions. In most actions, a combination of these factors were the reason

for the Corps' inability to complete fish mitigation actions on time and within budget.

**Problems Caused by
Changing Fish Mitigation
Priorities**

For at least four projects and three studies, the revision of fish mitigation priorities by the Regional Forum resulted in delays and/or cost increases. Most of these actions involved changing project priorities—changes that were necessitated by funding limitations, the need for additional biological information, or the desire to test new technology.

An example of the Regional Forum's changing project priorities because of funding limitations occurred at the Corps' Bonneville Dam located on the lower Columbia River. The Biological Opinion specified that improvements to the existing juvenile fish bypass system at the dam's second powerhouse should be completed by the spring of 1999. Survival studies conducted by the Corps in the late 1980s showed high juvenile fish mortality rates in the existing bypass system as well as downstream at the location of the system's juvenile fish transportation release site. Improvements to be made to the existing bypass system included (1) a variety of measures to reduce juvenile fish delay and mortality in the fish collection channel; (2) relocation of the transportation flume to an area located approximately two miles downstream from the second powerhouse, which is a habitat less conducive to predators; and (3) construction of a monitoring facility near the relocated transportation flume outfall so that juvenile fish using the bypass system can be sampled and evaluated in order to gain information on the Columbia River system's fish survival rate. According to Corps officials, completion of the juvenile fish monitoring facility will be delayed 1 year because of a shortage of funds. The Regional Forum reviewed the funding shortage and decided that the Corps should relocate the transportation flume and make improvements to the juvenile fish collection channel by March 1999 because these changes would have the most impact on improving juvenile fish survival at the second powerhouse. The Regional Forum also decided that the monitoring facility should be completed in the year 2000. According to Corps officials, the Corps constructed a temporary facility in 1997 to evaluate tracking tags placed in the migrating juvenile fish. However, the temporary facility will not provide as comprehensive a sample or evaluation of the juvenile fish as will occur once the permanent facility is in operation. Corps officials also noted that while funding limitations may adversely affect individual projects and studies, the region is attempting to provide its limited funds to those projects and studies that have the potential to provide the greatest benefit.

An example of a delay that occurred because the Regional Forum decided to wait for additional biological information occurred at the Corps' Lower Granite Dam on the Snake River. This dam has a juvenile fish bypass system and a juvenile fish holding and loading facility that were included when the dam was completed in 1975. The Biological Opinion stated that the Corps should improve this facility by widening the collection channel, replacing the existing 1,000-foot pipe that connects the collection channel with the downstream holding and loading facility and bypass outfall, improving the system's capability to separate juvenile fish by size, and updating features at the holding and loading facility. In June 1996, the Corps' Walla Walla District issued a feature design memorandum on the project that included descriptive criteria for modifying the existing facility. The project's total cost, including design and construction, was estimated at almost \$19 million. Work was to begin in 1997, and the upgraded facilities were scheduled to be fully operational by March 1999. However, after about \$450,000 had been spent on this project, principally to prepare and publish the feature design memorandum, the Regional Forum recommended that no fiscal year 1998 funds should be committed to this project and that all work should be deferred, possibly until fiscal year 2000. According to the Corps, the decision to defer work was based on the pending 1999 decision on whether or not to draw down or breach the dams on the lower Snake River. Specifically, the expenditure of up to \$19 million on the improvements could be negated if the drawdown option is selected for the Snake River dams. According to Corps biologists, delays in implementing the modifications to the Lower Granite juvenile fish bypass modifications forestall some interim benefits from new state-of-the-art design features; however, the existing bypass system has a less-than-1-percent direct mortality measure, and improvements over that rate are hard to quantify.

An example of a project delay caused by the Regional Forum's desire to test new technology occurred at The Dalles Dam located on the lower Columbia River. In appropriation legislation (Public Law 100-371) for fiscal year 1989, the Congress directed the Corps to design, test, and construct a juvenile fish bypass system for improving the efficiency of juvenile fish passage at The Dalles Dam. A juvenile fish bypass system was not originally installed when The Dalles Dam was completed in 1957. The dam's turbines, spillway, and ice and trash sluiceway—a waterway used to pass ice and trash around the dam—have been used to bypass juvenile fish around the dam. The lack of an efficient bypass system resulted in significant mortality rates in juvenile fish. Specifically, juvenile fish that go through the turbines experience mortality rates estimated to be as great as

15 percent. In addition, preliminary results of the Corps' ongoing spillway survival study indicate that the mortality rate for juvenile fish using the spillway—a rate the Corps had earlier assumed to be approximately 2 percent—may actually be as high as 12 percent. Likewise, observed hydraulic conditions in the ice and trash sluiceway and observed predator densities—such as excessive numbers of squawfish—at the sluiceway outfall have led the Corps to conclude that utilizing the existing ice and trash sluiceway to bypass juvenile fish may be unacceptable. In March 1994, the Corps issued a feature design memorandum providing for the design, construction, and operations and maintenance of a juvenile fish bypass system consisting of an extended-length submerged bar screen at The Dalles Dam. Construction was to have begun in October 1995, and the bypass system was to have been fully operational by March 1998 at a cost of more than \$123 million. However, in November 1994, with approximately \$20 million already invested, the Corps indefinitely deferred the project. The new bypass system was deferred because of intense congressional and Regional Forum interest in the feasibility and benefits of a new technology—a surface collection bypass system for juvenile fish. In addition, according to the Corps, it was assumed that in the interim, spilling juvenile fish over the dam's spillway would be a suitable and effective means of fish passage when used in conjunction with the ice and trash sluiceway.

The Corps, in response to the Regional Forum, was to start testing this new technology at The Dalles Dam either in conjunction with, or in place of, the bypass system consisting of an extended-length submerged bar screen. However, a lack of funding for studies of the effectiveness of the surface collection bypass prototype has delayed the decision on whether or not to construct the extended-length submerged bar screen system. The current plan is for the Corps to test surface collection bypass prototypes at The Dalles Dam in 2001 and 2002. However, the prototype tests have already been delayed 2 years because of the low priority assigned by the Regional Forum for funding the project, and no funds have been allocated for surface collection studies at the dam in 1998. As a result of the decision to indefinitely defer construction of an extended-length submerged bar screen system pending results of the Corps' evaluation of the effectiveness of a prototype surface collection bypass system at The Dalles Dam, juvenile fish now attempting to pass the dam must still either go through the turbines, go over the spillway, or utilize the existing ice and trash sluiceway. Consequently, juvenile fish migrating down the river are still exposed to some of the same hydraulic conditions, predator densities, and mortality rates that the Corps found to be unacceptable in the mid-1980s.

**Concerns About the Regional
Forum**

According to Corps officials, interim juvenile bypass measures, such as reducing the volume of water released over the spillway by more than 50 percent so that the mortality rate of juvenile fish going over the spillway may be reduced, are being considered for The Dalles Dam until a new bypass system is installed.

There have been ongoing concerns about the effectiveness of the Regional Forum's process. For example, the fiscal year 1996 Congressional Conference Committee for Energy and Water Resource Appropriations called for an independent evaluation of the management practices of the Corps, Bonneville Power, NMFS, and other federal and sovereign entities and their various programs for restoring salmon runs on the Columbia and Snake River systems in the western United States. The Corps' Seattle District contracted with Science Applications International Corporation with support from HDR Engineering, Inc., to conduct this study. In a June 13, 1997, report,¹ the study found a number of deficiencies with the Regional Forum's process.

First, the study found that the members of the Regional Forum do not share a common vision or goal for salmon recovery efforts. As a result, the actions required by the Biological Opinion are not uniformly supported. For example, through the Biological Opinion, NMFS has directed the implementation of structural and operational actions that may benefit listed salmon without removing dams. These actions are not uniformly supported by Regional Forum members as the most effective means of increasing fish survival. Several members of the Forum, primarily the Native American tribes with some concurrence by states, support drawdown to the natural river level as the most effective technique for listed species survival and recovery. The report states that differing goals are not conducive to implementing actions, especially when consensus is sought to make decisions. The study recommended that the Forum develop a single strategic recovery plan based on a consensus of its members. Second, the study found that the Regional Forum does not have a clearly defined process for making decisions on the implementation of fish passage projects when consensus is not possible. The report states that the net result is that minority views sometimes prevail and technical and policy decisions are not always made at the appropriate level within the Regional Forum. The study states that decisions should still be made by consensus, but not defined as a vote of 100 percent of the participants.

¹Independent Review and Evaluation of Processes Utilized to Implement Structural Improvements at Columbia and Snake Rivers Fish Passage Projects. Prepared by Science Applications International Corporation and HDR Engineering, Inc., for the Department of the Army, Seattle District, Corps of Engineers, June 13, 1997.

The report recommends that consensus be defined as agreement that the parties can “all live with the decision and will not actively work to undermine it.” The study further pointed out that although a new definition of consensus and the development of a common vision through a strategic plan will assist in reaching agreements, it will not always ensure the agreement of all parties. The study further recommended the establishment of a clear process to resolve disputes.

Finally, the study found that setting priorities for projects, studies, and other fish passage activities has been repetitive and often contradictory. Fish mitigation activities, particularly those with multiple-year schedules, are brought before the appropriate Regional Forum subcommittee each year when appropriations are sought. Each time, the opponent(s) of a project has an opportunity to delay or cancel it, even if several years’ investment has already occurred. The study recommended that project priorities and funding decisions be made at a specifically designated level in the Regional Forum. Furthermore, the report states that the priorities for projects should not be re-set unless new science would substantively alter an approach. The study team believes that these actions would reduce costs because projects that have started will not as likely be halted and/or have to be re-initiated.

Responding to the criticisms directed at the overall effectiveness of the Regional Forum by many regional interests, in mid-1997, the Governors of Oregon, Washington, Idaho, and Montana called for the replacement of the federally led Regional Forum with one that would be jointly led by federal agencies, states, and Native American tribes. The proposed new panel has been referred to as the Three Sovereigns Forum. As of February 1998, a draft plan for the establishment of the new Forum was being developed by the three sovereign entities in anticipation of circulating it to the public for review.

Problems Caused by Attempts to Streamline Project Management

We found that problems the Corps has experienced during attempts to streamline its project management process resulted in delays and/or cost increases in two projects and one study. For example, when the Corps’ John Day Dam on the lower Columbia River was originally completed in 1971, it did not contain facilities for sampling and monitoring migrating juvenile fish. A sampling and monitoring facility was added to the dam in 1986. However, the Biological Opinion called for the installation of a new facility to improve the Corps’ ability to monitor juvenile salmon migrating downstream. The Biological Opinion directed that the project be

completed no later than 1997. In 1992, an NMFS contractor had completed a report addressing the feasibility and basic design of an updated facility. In August 1994, a Corps architect-engineer contractor began detailed design of the project using the concept presented in the NMFS feasibility report. In October 1994, the Corps, its architect-engineer, and NMFS determined that the design developed in the NMFS feasibility report was not workable because resulting hydraulic conditions could be harmful to juvenile fish. The Corps then directed its contractor to develop alternative designs for a new facility. In September 1995, the contractor completed the feature design memorandum for the alternative chosen by the Corps.

The feature design memorandum, which presented a significant redesign of the project, estimated that the new facility would be fully operational by April 1997. However, the Corps encountered additional difficulties during the construction phase of the project. For example, after the construction of the project foundations was under way, the contractor encountered subsurface conditions different from those specified in the contract drawings. The different subsurface conditions resulted in the Corps' making changes in foundation designs, drilling procedures, and construction materials. The problems the Corps encountered during the design and construction of the new facility contributed to significant cost increases and project delays. The cost of the design contract increased from an initial award amount of about \$755,000 to over \$2.8 million. Work related to the redesign of the project after October 1994 accounted for about \$407,000 of this increase. The cost of the construction contract increased from an initial award of about \$16 million to a completion cost of over \$21 million. The additional work the construction contractor performed because of differing site conditions accounts for the largest portion of the increase—about \$3.8 million. This work also delayed the contract completion date by almost 4 months. Reasons for the remaining cost increases include design deficiencies, project features that were changed or added after construction started, and additional services the contractors were required to perform, such as planning and performing on-site facility testing.

In an effort to meet the March 1997 operational date, the Corps completed the design phase for the new facility on an expedited basis. However, according to Corps officials, the Corps' efforts to accelerate the normal design process contributed to cost increases and delays. For example, the Corps did not perform a formal technical review of the original NMFS feasibility report, as it would under normal procedures. Moreover, the Corps relied on geotechnical data collected in 1983 that did not accurately

reflect subsurface structures and soil conditions in the project area. Finally, because the facility was not operational during the 1997 fish migration season, the Corps lost the ability to collect improved data on the juvenile fish migrating that year.

According to Corps officials, the two projects and one study that encountered problems during unsuccessful attempts to streamline standard project management procedures were technically complex actions. They noted that problems can occur when accelerating the design of cutting-edge technology and that the main reason that procedures were bypassed or accelerated was to meet the time frames set forth in the Biological Opinion. The Corps also cited two examples of projects in which accelerating the design process was successful. Specifically, in these two projects—one involving the installation of flow deflectors at Ice Harbor Dam and the other the design of a surface bypass prototype at Lower Granite Dam—the Corps was able to complete the design phase on an expedited basis, thus saving substantial time. However, both of these projects were subsequently delayed for reasons unrelated to accelerating project design.

Problems Caused by Adverse Weather

Weather played a significant role in delaying and/or increasing the cost of at least three projects and one study. The Corps' project to install flow deflectors at Ice Harbor Dam illustrates the impact that adverse weather can have on a project. In order to improve juvenile salmon passage, the Biological Opinion required the Corps to spill additional water over its eight dams during the fish migration season rather than passing those flows through turbines. The Corps also spills water on an involuntary basis when flows are high and exceed the powerhouse flow capacity at the dams. However, spilling river flows can cause the water below and downstream of the dams to become supersaturated with gases, such as nitrogen, normally found in the air. High levels of total dissolved gases can damage or kill salmon and are harmful to other aquatic organisms. Therefore, the Biological Opinion stated that the Corps should implement a gas abatement program at its dams. The program was to include structural modifications, such as the installation of flow deflectors² at Ice Harbor Dam.

The Corps awarded a construction contract for the Ice Harbor flow deflector project in July 1996 at a cost of over \$2.7 million. It provided for

²Flow deflectors are concrete structures attached to the face of spill bays. They deflect river flows passing over the spillway in a more horizontal direction so that the water does not plunge deeply into the spill basin below the dam and cause total dissolved gas levels in the water to increase.

the installation of deflectors on the dam's eight center spill bays by March 1997. On December 30, 1996, the control room operator at Ice Harbor Dam advised the contractor that, because of unusually high river flows, the Corps would begin releasing water over the spillway. Accordingly, the contractor was advised to remove construction equipment from the spill basin. The Corps began spilling river flows the next day at a rate of about 20,000 cubic feet per second. Discharge over the spillway reached 100,000 cubic feet per second early in the morning of January 1, 1997.

On February 6, 1997, after having installed four deflectors, the Corps and the contractor agreed that because of high river flows, the need to continue spilling at the dam, and the upcoming juvenile fish migration season, construction activities would be discontinued until September 1997. From September to November 1997, the contractor completed the remaining four deflectors and removed equipment from the construction site. However, the delay in project completion of about 7-1/2 months led to a significant cost increase. Specifically, the Corps agreed to pay the construction contractor about \$895,000 for costs associated with the delay, including the cost of one additional construction mobilization and demobilization to complete the remaining flow deflectors and standby costs associated with keeping equipment available until construction could resume. According to Corps officials, they recognized and were concerned about the risks associated with performing this work in such a tight time frame in the winter. Therefore, they asked the Regional Forum for permission to begin this work in early August. However, the Regional Forum denied this request on the basis of their need to continue spill during the entire month of August, as provided for in the Biological Opinion.

Because the contractor installed only four instead of the eight flow deflectors planned before demobilizing because of high river flows, the Corps did not achieve the full reduction on total dissolved gas in time for the 1997 juvenile salmon migration. The Corps projected that the installation of the remaining four deflectors would provide a further reduction in total dissolved gas levels of 3 percent to 5 percent. However, the Corps did not have sufficiently refined data to determine the survival gain that will result from this increment in total dissolved gas reduction. Even so, the additional reduction was expected to be biologically beneficial.

The Impacts of Project Delays and Cost Increases Can Be Significant

When fish mitigation projects encounter delays and cost increases, the impacts can be significant. Specifically, the collection of data needed to make future decisions on salmon recovery can be delayed, high fish mortality rates can continue, there can be a loss of power generation and related potential revenues, and dam operations and maintenance costs can increase. In addition, with a fixed annual program budget, when one fish mitigation action incurs a cost increase, the opportunity to use those funds on other projects or studies is lost.

Delays in Collecting Data Can Hinder Future Decisions on Fish Mitigation

Project delays can result in lost opportunities to collect biological data needed to make more informed regional decisions on such issues as what are the most effective ways to bypass juvenile fish. For example, in the 1980s, the Corps installed a juvenile fish bypass system consisting of submerged screens, collection channels, and outfall flumes³ on the Bonneville Dam. Subsequently, numerous Corps and NMFS fish passage studies identified significant problems with the bypass system. Among other things, the studies showed that the juvenile fish were using the bypass system less than 50 percent of the time. A goal of the Biological Opinion is to have at least 80 percent of the downriver migrating juvenile fish pass around each dam, including Bonneville Dam, either through a bypass system or over a spillway, and at least 95 percent of these bypassed juvenile fish are to survive. Recognizing that the existing Bonneville Dam bypass system could not meet this standard, Corps and NMFS fish biologists and engineers determined that the installation of a surface collection bypass system at Bonneville Dam could potentially assist in meeting the efficiency goals of juvenile fish guidance as specified in the Biological Opinion.

In August 1995, the Corps' prototype development program for surface collection bypass systems specified that installation of the prototypes at Bonneville Dam's two powerhouses and spillway was to start in 1996. However, the start of the prototype installations at the first and second powerhouses has been delayed until 1998 and 2000, respectively, and the installation of the prototype at the spillway has been deferred indefinitely. According to the Corps, these delays and deferral occurred for a variety of reasons. Specifically:

- Installation of the bypass system prototype at the first powerhouse was delayed because (1) model testing had not been performed to assess the hydraulic conditions within the area, (2) a detailed biological study plan

³A channel or pipe that transports fish to a place of discharge in the river.

for testing the prototype had not been completed, (3) the potential location of the prototype in relationship to the turbines had not been modeled and completed, and (4) there was a lack of regional support because hydraulic conditions within the prototype had not been completely modeled.

- Installation of the bypass system at the second powerhouse was delayed because the Regional Forum made the recommendation to limit funds at Bonneville Dam in order to implement juvenile fish bypass projects at the Corps' seven other dams on the lower Columbia and Snake rivers.
- After coordinating with the Regional Forum, the Corps deferred indefinitely the bypass system prototype at the Bonneville Dam spillway because the results of recent biological tests suggested that juvenile fish approaching the spillway pass the dam with minimal delay or injury.

Furthermore, according to the Corps, the Regional Forum's low funding priority for surface collection bypass studies in 1998 has already delayed the completion of surface collection prototype studies at the dam's first powerhouse until 2001. As a result, a major decision on which bypass concept to pursue at the first powerhouse may be based, in part, on the results of limited studies of surface collection prototypes. According to the Corps, the amount of information available on surface bypass efficiency, balanced by the cost of additional prototypes and the likelihood of success, as well as the improved guidance efficiency obtained from the extended-length screen tests, will be considered before implementation decisions are reached. In the interim, juvenile fish attempting to pass Bonneville Dam must rely on existing juvenile bypass systems that are successful less than 50 percent of the time.

Delays Can Result in Continued High Fish Mortality Rates

The Corps' fish passage efficiency studies showed that Ice Harbor Dam's bypass system, utilizing the dam's ice and trash sluiceway, provided for the passage of only about 35 to 50 percent of the juvenile fish migrating downriver. In an effort to improve fish passage efficiency, in December 1990, the Corps proposed to construct a high-flow juvenile fish bypass system at Ice Harbor Dam that would include submerged screens to guide juvenile fish away from the dam's turbines, a fish collection channel, and a transportation channel to pass fish around the dam and release them back into the Snake River. The proposed bypass system was approved by federal and state fish agencies (the Regional Forum did not exist yet), including NMFS, as well as by affected Native American tribes. The system was to be completed by February 1994. In June 1992, the fish agencies and tribes expressed two major concerns about the approved high-flow

system. First, there was a significant area of shallow water—prime predator habitat—downstream from the juvenile fish bypass release site. Second, the speed of the water in the high-flow bypass flume would not allow for the sampling of all juvenile fish bypassing the dam. As a result of these concerns, the Corps redesigned the bypass system from a high-flow to a low-flow system and extended the length of the bypass flume to the downriver side of the shallow water area. According to Corps officials, the need to redesign the bypass system resulted in a 2-year delay in the planned construction completion date. In addition, according to the Corps, the 2-year delay could have had a significant negative impact on the juvenile fish that attempted to bypass Ice Harbor Dam because they may have gone either through the dam's turbines or over the dam's spillway, where they could have experienced mortality rates of 15 percent and 2 percent, respectively. However, another Corps official pointed out that impacts associated with the delay were at least partially offset by the installation of submerged traveling screens in 1993 under a separate contract. In addition, this official said the delay resulted in a better outfall flume in terms of design and discharge location, providing juvenile fish with survival benefits that exceeded the impacts associated with the 2-year delay.

Delays Can Result in Lost Power Generation and Related Potential Revenues

Problems with completing fish mitigation projects can also lead to a loss of potential power generation and the associated potential revenues. Early evaluation of the juvenile fish bypass system at the Corps' dams, including the McNary Dam on the lower Columbia River, revealed the need for refinements to improve fish guidance efficiency. For example, the McNary Dam studies indicated that the existing 20-foot bar screen guidance system in front of the turbines directed only about 40 percent of the fall chinook salmon away from the dam's turbines and into the bypass collection channel. As a result, in March 1994, after years of study and testing, the Corps recommended the installation of new extended-length (40-foot) screens to optimize fish guidance. The Corps planned to install the new screens by December 1996. In addition, the Biological Opinion called for the completion of this project in time for the spring 1997 juvenile chinook salmon migration. In response to the Biological Opinion, the Corps accelerated its design and contracting process to meet the implementation date. In March 1995, the Corps entered into a contract for the construction and installation of 42 extended-length submerged bar screens (one for each of the three gatewells over each of the dam's 14 turbines); all screens were to be in place and fully operational by December 27, 1996. However, shortly after the installation of the first batch of new screens, dam

operations personnel found frequent problems with the brush arm control—the device used to control the extent of movement by the brush arm as it removes debris from the screen. Fixing the problem required the operators to take the turbine off line and raise the screen in the gateway to reset the control limit switch—a half-day operation. In response to the problems and increased maintenance costs, the installation of the remaining screens was delayed until the design problem was fixed. In May 1996, a new design utilizing different technology was adopted for controlling the sweep arm. Project personnel replaced the original control devices, began installing the remaining 30 screens, and completed the installation of the screens in March 1997—3 months later than originally planned.

According to Corps officials, problems with the sweep control device were experienced during prototype testing and a new, untested design was proposed for the contract. However, the pressure to meet the Biological Opinion's completion date required expedited contracting procedures to finalize design drawings for the contract solicitation package which left no time for additional testing. A major impact stemming from the failure of the sweep control device was the loss of power generating capacity during the spring 1996 salmon migration season. Project personnel reported that there were 2,422 hours of forced turbine outage at McNary in 1996 directly attributable to problems with the sweep control devices. At the Bonneville Power Administration's estimated revenue of \$2,000 per generating hour, the outage equates to about \$5 million in potential lost power revenue in 1996. A Corps official noted, however, that this amount of potential lost revenue would only be realized if the powerhouse was operating at capacity—which seldom occurs. As such, the official believed the potential lost revenue was likely to be much less than \$5 million.

**Problems Implementing
Fish Mitigation Actions
Can Increase Operations
and Maintenance Costs**

The inability to complete fish mitigation projects can also result in an increase in dams' operations and maintenance costs. For example, in 1995, the Corps awarded a contract for the construction and installation of extended-length submerged bar screens at the Little Goose Dam located on the lower Snake River. As was the case at McNary Dam, the Corps encountered numerous problems with the new screens, and completion of the project was delayed about 11 months. One of the major problems with the Little Goose extended-length screens was that steel plates, perforated with holes to ensure uniform water flow through each screen, failed because of broken high-tension bolts. The broken bolts, which allowed perforated plates to fall off some of the screens, forced the Corps to

remove each of the 18 screens from the river for repair. Consequently, the Corps' operations and maintenance costs were increased by about \$24,000. In addition, according to Bonneville Power, hydroelectric power production at Little Goose Dam was reduced because the turbines behind the removed screens had to be taken out of operation until the screens were repaired and replaced. This resulted in lost power revenues of about \$745,000 to Bonneville Power. The extended-length screen bolt problem is being investigated by the Corps, and the results of the analysis should be available by December 1998. In the interim, the Corps is monitoring the screens and periodically removing them from the river to ensure that the perforated plates remain in place and to replace bolts that break. This monitoring effort, however, continues to reduce hydroelectric power production and power revenues at the dam and increases the Corps' operations and maintenance costs.

Cost Increases Can Result in Project Changes and Lost Opportunities

Of the 19 fish mitigation actions we reviewed, 9 had cost increases that totaled over \$20 million. Since the Corps' fish mitigation program receives an annual appropriation, when one fish mitigation action incurs a cost increase, the opportunity to use those funds on other projects may be lost. In addition, the Corps may have to revise the scope or implementation schedules for certain projects or studies. For example, the Biological Opinion requires the Corps to conduct a feasibility study of ways to improve the migration of juvenile salmon through its lower Snake River dams. The study focuses on three alternatives: existing condition, drawdown of the dams, and system improvements that could be accomplished without a drawdown. Because of changes in the scope of this study, primarily expanding the analysis of the social and economic impacts of the alternatives being considered, the Corps incurred a cost increase of about \$4 million. As a result, the Corps reduced the scope of other study components such as water quality analyses. Moreover, since the overall study will now consume a larger portion of the total funding available to the fish mitigation program, the Corps, in conjunction with the Regional Forum, made adjustments in the funding of other lower priority fish mitigation actions. For example, funding for the Corps' study of potential improvements to auxiliary water supply systems for adult fish ladders at Snake River dams was reduced.

Observations

While the majority of the Corps' fish mitigation actions have been or are expected to be on schedule and within budget, the Corps has encountered difficulties implementing many of its fish mitigation projects. Projects

have encountered delays and cost increases because of adverse weather conditions, such as high river flows and flooding. Furthermore, the Corps' agreement to work cooperatively with regional interests through the Regional Forum has, on occasion, subjected it to changing fish mitigation priorities, including which projects or studies are to be funded, when they are to be funded, and at what funding level. However, the effectiveness of the Regional Forum has been questioned because, among other things, members do not agree on how to pursue salmon recovery efforts and do not uniformly support the actions required by the Biological Opinion. Differing goals are not conducive to implementing fish mitigation actions, especially when consensus is sought to make decisions.

In addition, some delays and cost increases have been caused by the Corps' unsuccessful attempts to streamline its project management process in order to meet deadlines imposed by the Biological Opinion. In these cases, there appears to be a trade-off. According to the Corps, by accelerating the design phase of some projects, it completed this phase expeditiously. However, efforts to streamline the management of other projects cost the Corps both time and money and negatively affected the Corps' ability to safely bypass juvenile fish around its eight dams on the lower Columbia and Snake rivers.

The Corps' Direct Funding Agreement With Bonneville Power Administration for Operations and Maintenance Costs at Hydropower Dams in the Pacific Northwest

The U.S. Army Corps of Engineers' operations and maintenance activities at its dams have historically been funded by congressional appropriations. However, in 1992, the Congress enacted the National Energy Policy Act of 1992 authorizing the Secretaries of the Army and of the Interior to accept funds provided directly from the Bonneville Power Administration for hydropower activities in the Pacific Northwest. Since that time, Bonneville Power has entered into agreements with the Corps to fund a substantial portion of the Corps' power operations and maintenance costs at the Corps' dams. These agreements, when fully implemented, should provide the Corps with greater assurance of an appropriate level of funding for maintenance of power facilities, thereby reducing the frequency of costly overhauls and increasing the reliability of Bonneville Power's power supply to its electric rate payers.

Background

The Corps' hydropower system in the Pacific Northwest includes 21 dams in the Columbia River Basin whose operations and maintenance activities have been funded historically by congressional appropriations. Specifically, repairs and maintenance of the hydropower dams are funded from either the Corps' "construction, general" appropriation or "operations and maintenance, general" appropriation, depending on the scope of the work.

Funds from the "construction, general" account are used for nonroutine¹ and other major rehabilitation projects that exceed \$5 million, including work pertaining to the designs, plans, and specifications for such projects. Major rehabilitation projects are identified at the Corps' dam sites, and the ensuing budget proposals are justified, examined, and ranked by the Corps' field offices and headquarters. The Department of the Army's Assistant Secretary for Civil Works decides whether or not to include the projects in the Corps' budget request, which is then forwarded to the Office of Management and Budget for inclusion in the President's Budget.

Funds from the "operations and maintenance, general" appropriation are used for nonroutine and routine repairs, replacements, and maintenance and for emergency repairs of hydroelectric and other facilities at the dams. The nonroutine work is generally less than \$5 million. While the annual budgets are tight, the Corps has reprogramming authority that allows for some flexibility. The Corps' budget is included in the President's Budget to the Congress, and subsequently, funds are appropriated by the Congress.

¹Nonroutine activities include repair and replacement maintenance items that are not on a repetitive schedule.

In fiscal year 1997, the Corps' Northwestern Division, responsible for its Columbia River Basin dams' operations, received appropriations for operations and maintenance activities and major rehabilitation projects totaling about \$135 million.

The appropriated funds from these two accounts that are expended on repairs and maintenance for hydropower activities and the power portion of the joint-use cost² at the Corps' dams are repaid to the U.S. Treasury by the Bonneville Power Administration. Bonneville Power markets the electric power produced at the Corps' dams in the Pacific Northwest. Bonneville Power collects the revenues necessary to repay these costs through its electricity rate structure and has a vested interest in reliable and continuous power generation at the Corps' dams.

New Funding Procedure Provided in 1992

Section 2406 of the National Energy Policy Act of 1992 (P. L. 102-486, 16 U.S.C. 839d-1) authorizes the Secretaries of the Army and of the Interior to accept funds provided directly by Bonneville Power for hydropower activities in the Pacific Northwest. Under this authority, in December 1994, the Department of the Army and Bonneville Power signed a Memorandum of Agreement giving the Corps responsibility for identifying nonroutine hydropower maintenance projects that need additions, improvements, and replacements at the Corps' 21 hydroelectric dams in the Pacific Northwest. Under the agreement, Bonneville Power may choose to directly fund these nonroutine maintenance projects, which would then no longer be funded through the annual appropriation process. The Corps and Bonneville Power signed subagreements allowing Bonneville Power to directly fund nearly \$37 million for specific activities, including generator repair, studies, turbine improvements, and repairs under an electrical system reliability improvements program. The reliability improvements program was in response to the July 2-3 and August 10, 1996, West Coast electrical system disturbances. However, other nonroutine and routine operations and maintenance hydropower costs as well as major rehabilitation costs were still funded by congressional appropriations.

²Joint-use costs are costs for labor, materials, and expenses incurred in the operations and maintenance, repair, replacement, additions, and efficiency improvements to the dams' structures, reservoir, buildings, grounds and utilities, and appurtenant equipment and accessories that are shared among the multipurpose users of the dam. Dams' purposes include hydropower, navigation, and irrigation. The Corps has a cost allocation study that is used to allocate these costs to the authorized purposes. On average, 80 percent of all joint costs are allocated to hydropower.

Factors Leading to a Broader Direct Funding Agreement

In the fall of 1996, Bonneville Power and the Corps began pursuing a broader agreement to directly fund all operations and maintenance hydropower costs including routine,³ other nonroutine, and major rehabilitation, and the portion of the joint-use costs that are allocated to power at the Corps' dams. Specifically, both Bonneville Power and the Corps were concerned that insufficient funds were available under the current budget and congressional appropriation process to meet the minimum requirement to maintain power projects at a justifiable level of service. The Corps stated that without sufficient maintenance funds, it was reasonable to expect increases in forced outages and higher costs to the power customer in the very near future. Also, the Corps was concerned about the estimated \$190 million in accumulated deferred maintenance requirements for hydropower and joint-cost work items for the 21 dams. Bonneville Power stated that it has a vested interest in reliable and continuous power generation and that a direct funding agreement would provide more stability and certainty to the outlay of funds over a period of years and thus provide a stable basis for customer rates.

Furthermore, in July 1997, a report by the Senate Committee on Appropriations strongly urged the Corps to consider the potential benefits and savings of entering into a direct funding agreement with Bonneville Power for operations and maintenance costs. Specifically, such an agreement would provide greater assurance to the Corps of an appropriate level of funding for the maintenance of power facilities, thereby reducing the frequency of costly overhauls and increasing the reliability of Bonneville Power's power supply to the rate payers of the Federal Columbia River Power System's electricity.

However, prior to entering into a broader direct funding agreement, several issues had to be resolved between Bonneville Power and the Corps. First, and most important to the Corps and Bonneville Power, was the disagreement over the level of direct funding: Bonneville Power wanted full funding for both routine and nonroutine work; the Corps wanted to expand the existing 1994 Memorandum of Agreement to cover all nonroutine work only. The Corps' concern was the need to ensure that it would maintain control of the decision-making process for the Corps' multiple-purpose dams. The Corps ultimately agreed to Bonneville Power's directly funding its routine work after both parties agreed that the Corps has the responsibility (1) to operate the dams to serve multiple purposes and (2) for the technical integrity and public safety associated with the

³Routine costs include personnel costs, small supplies and materials, custodial contracts, and costs associated with the routine, day-to-day operations and maintenance of the reservoir systems.

dams and their facilities. In addition, both agencies agreed to collaborate for planning, designing, and constructing operations and maintenance activities at the dams.

Two other issues needed to be resolved: the use of binding arbitration in the event of any unresolved disagreement between the two agencies and the use of monetary performance incentives to measure the Corps' ability to meet operations and maintenance standards. To resolve the arbitration issue, the agencies mutually agreed that in the event that good faith efforts failed to resolve a dispute relating to hydropower costs, the matter would be sent to the Office of Management and Budget for resolution. In matters related to interpreting relevant statutes, the agencies agreed to send issues of interpretation to the Department of Justice for resolution. To resolve the issue of monetary performance incentives, both agencies agreed that performance goals would be part of the agreement but that the Corps would use its existing personnel incentives program for monetary awards.

New Direct Funding Memorandum of Agreement

In December 1997, the Assistant Secretary of the Army (Civil Works) and the Acting Administrator and Chief Executive Officer for Bonneville Power Administration signed a new agreement for direct funding of both routine and nonroutine power operations and maintenance costs at the Corps' dams. The agreement calls for funding to start in fiscal year 1999 for the Corps' hydroelectric facilities in the Pacific Northwest. Under this agreement, the Corps and Bonneville Power have agreed to a first-year funding level of \$106 million. Over a 5-year period, fiscal years 1999 through 2003, Bonneville Power will provide \$553 million in direct funding to the Corps. The operations and maintenance cost directly funded by Bonneville Power will no longer be part of the Corps' budget submission and will enable the Corps to realize discretionary appropriations savings in its "operations and maintenance, general" appropriation beginning in fiscal year 1999.

Provisions of Final Agreement

The Corps of Engineers and the Bonneville Power Administration, under the authority of section 2406 of the National Energy Policy Act of 1992, agreed to the following general principles in the direct funding agreement:

- Bonneville Power Administration has a business interest in formulating, setting priorities for, and efficiently executing the hydropower operations and maintenance program, and the Corps has a business interest in the impacts of Bonneville Power's market decisions.

Appendix I
The Corps' Direct Funding Agreement With
Bonneville Power Administration for
Operations and Maintenance Costs at
Hydropower Dams in the Pacific Northwest

- The Corps is responsible for operating dams to serve their authorized multiple purposes, including the generation of power, and for the technical integrity and public safety associated with the dams and associated facilities.
- The Corps and Bonneville Power will collaborate in the planning, design, construction, operation, and maintenance activities; the Corps will retain the responsibility to ensure the integrity of the power generation facilities.
- The Corps' and Bonneville Power's strategic visions shall serve as a basis for establishing an effective partnership while serving the general public interests inherent in the dam authorities.

The agreement

- will be in effect through September 30, 2008, with provisions for termination and 5-year term extensions;
- covers all operations and maintenance power costs for activities performed at the Corps' dams, including (1) power expense costs incurred by the Corps, which include hydropower specific costs and the power portion of joint-use costs, and (2) power capital items funded under the annual power budget;
- establishes 5-year budget cycles, which identify the amount of the annual power budget for 5 consecutive fiscal years beginning on October 1, 1998, and an annual power budget that specifies total operations and maintenance costs categorized by major line items for each dam;
- creates a Joint Operating Committee with representation by both agencies to establish performance objectives, develop and review budgets, and approve funding levels;
- contains provisions for the transfer of funds to meet the Corps' expenditure requirements; and
- provides for the resolution of disputes and audit rights for both agencies.

Also, the agreement provides for the Joint Operating Committee to review the practices and procedures of each agency to identify areas in which changes could improve the overall efficiency of the hydropower program in the region by incorporating more businesslike processes and decision-making.

The 1997 agreement does not cover all operations and maintenance costs. Specifically, the nonpower portion of joint costs (the President's Budget includes \$20.3 million for fiscal year 1999) will continue to be funded through the annual appropriation process because Bonneville Power can only fund power costs. In addition, two ongoing major rehabilitation

Appendix I
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projects at Bonneville Dam and The Dalles Dam (the President's Budget includes \$8.9 million for fiscal year 1999) will continue to be funded through the appropriation process. According to a Corps official, for fiscal years 2000-2005, an estimated \$58 million will be needed to complete the Bonneville Dam project. In addition, for fiscal years 2000-2007, an estimated \$88 million will be needed to complete The Dalles Dam project. When asked, Bonneville Power stated that if appropriated funds were no longer received for these two projects, it would consider directly funding them. However, the Corps questioned Bonneville Power's ability to fund the projects with its existing borrowing authority limits and stated that the option exists for future major rehabilitation work to be financed by direct funding.

Finally, the existing 1994 Memorandum of Agreement discussed earlier will remain in effect as the mechanism to directly fund the larger capital investments in the future. This would include the funds associated with any subagreements that are currently in effect.

Agency Comments



DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
WASHINGTON, D.C. 20314-1000

REPLY TO
ATTENTION OF:

Audit Office

6 April 1998

Comptroller General
General Accounting Office
ATTN: Mr. Ned Smith, RCED
441 G Street, N.W.
Washington, D.C. 20548

Dear Sir:

We have reviewed Water Resources: The Corps' Implementation of Fish Mitigation Actions in the Columbia River Basin, and agree with the statements contained in the draft report.

Sincerely,

A handwritten signature in black ink, appearing to read "Albert J. Genetti, Jr.", is written over a circular stamp.

Albert J. Genetti, Jr.
Major General, USA
Chief of Staff

The Regional Forum

Membership in the Regional Forum is open to five federal agencies (the National Marine Fisheries Service, the Corps of Engineers, the U.S. Fish and Wildlife Service, the Bureau of Reclamation, and the Bonneville Power Administration); five states (Alaska, Idaho, Montana, Oregon, and Washington); the Northwest Power Planning Council; Columbia River Basin Native American tribes, including the Burns Paiute Tribe, Confederated Salish and Kootenai Tribes of the Flathead Reservation, Confederated Tribes of the Colville Reservation, Confederated Tribes of the Umatilla Indian Reservation, Confederated Tribes of the Warm Springs Reservation, Coeur d' Alene Tribe of Idaho, Kalispel Tribe, Kootenai Tribe of Idaho, Nez Perce Tribe, Shoshone-Bannock Tribes of Fort Hall, Shoshone-Paiute Tribes of Duck Valley Reservation, Spokane Tribe of Indians, and the Yakama Indian Nation; the Idaho Power Company; and the Mid-Columbia River public utility districts. The Columbia River Inter-tribal Fish Commission (CRITFC) attends Regional Forum meetings as a representative of the Yakama Indian Nation, Nez Perce Tribe, Confederated Tribes of Umatilla and the Confederated Tribes of Warm Springs. In May 1997, the state of Montana and the four tribes represented by the inter-tribal fish commission formally withdrew from participation in the Regional Forum. The state of Montana withdrew because it did not believe that releasing water from federal dams for improving downstream juvenile fish migration would benefit the state. The tribes withdrew because they believed the Regional Forum was unable to (1) address the federal government's trust responsibilities to the tribes, (2) protect treaty-reserved resources, and (3) implement the tribal salmon restoration plan. According to a Corps official, although CRITFC members have formally withdrawn from the Forum, they continue to attend meetings, enter into discussions, make recommendations, and provide written materials to other Forum members.

The focus of the Regional Forum is on the implementation of the National Marine Fisheries Service's Biological Opinion and related funding matters. Specific Regional Forum goals include ensuring broad technical and policy input in planning, funding, and implementation decisions; developing agreement and resolving disputes on actions to be taken by the federal agencies on the Federal Columbia River Power System; ensuring that the basis for federal decisions is fully explained when agreement is not reached; and promoting coordination in the implementation of the Biological Opinion and actions taken under other related regional plans and forums to restore fish in the Columbia River Basin.

The Regional Forum organization is hierarchical and consists of four levels (see fig. III.1). Three technical teams, including the Fish Passage Operation and Maintenance Coordination Team, the Fish Facility Design Review Work Group, and the Anadromous Fish Evaluation Program group, comprise the bottom level and report to the System Configuration Team. The System Configuration Team, the Technical Management Team, and the Dissolved Gas Team make up the next technical level. The System Configuration Team is responsible for planning and oversight of structural improvements to fish passage facilities and related studies called for in the Biological Opinion. Each fiscal year, the System Configuration Team goes through a process of selecting, setting priorities for, and budgeting fish passage projects and related research. Since the Corps is responsible for carrying out these projects, it typically provides the configuration team with project proposals, schedules, and costs. The System Configuration Team then produces a list that documents decisions on projects and provides the basis for the Corps' fish mitigation program and budget.

The Technical Management Team is responsible for coordinating dam and reservoir operations to comply with NMFS' Biological Opinion. It meets weekly during the fish passage season to adjust spill and flow levels at Federal Columbia River Power System dams. The Technical Management Team also develops an annual water management plan that addresses runoff forecasts and flood control operations, as well as Biological Opinion requirements.

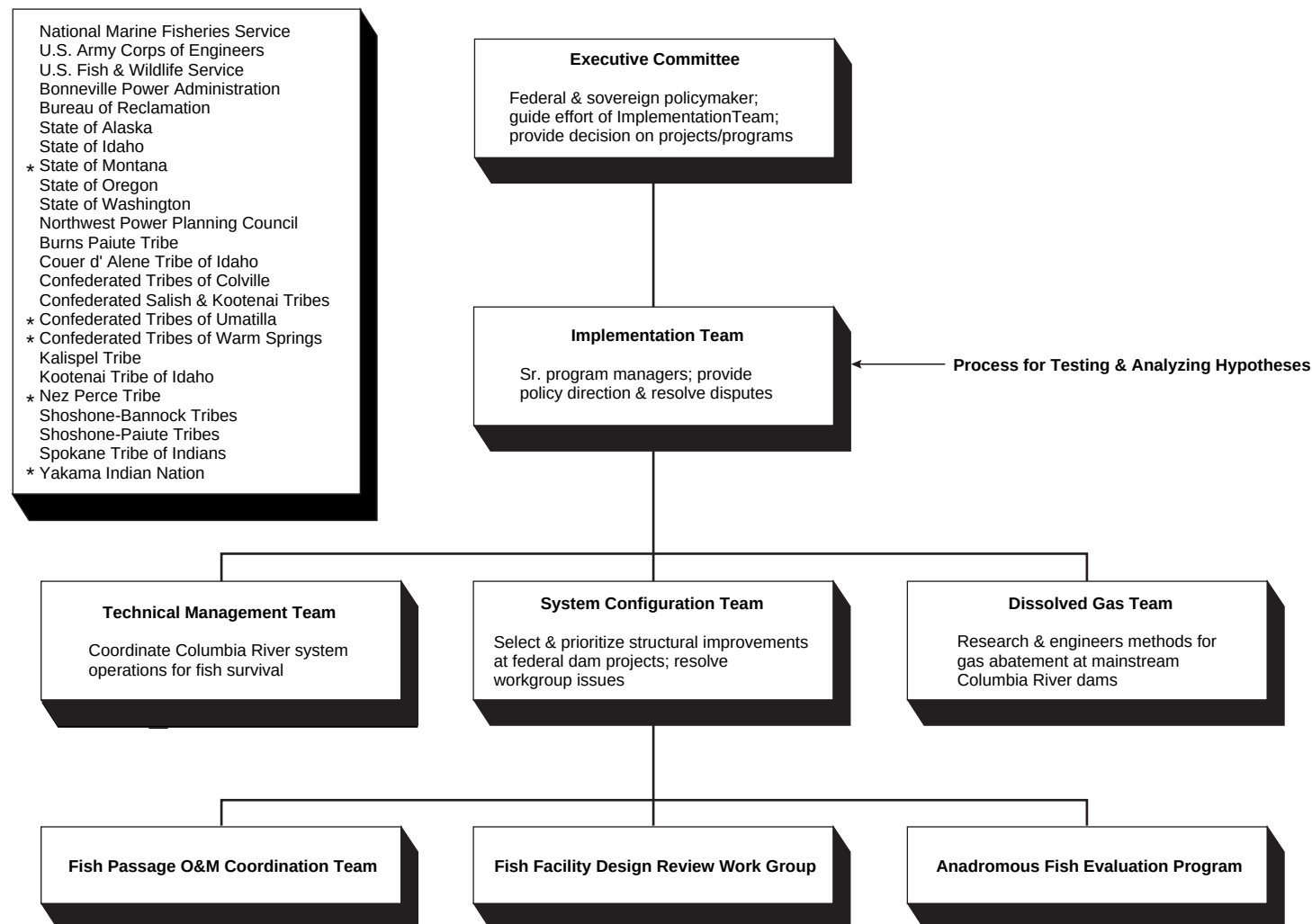
The Dissolved Gas Team develops research projects and abatement measures to address the impacts of gas supersaturation on salmon and other aquatic wildlife. Finally, the Process for Testing and Analyzing Hypotheses group, which reports to the Implementation Team, provides a forum for coordinating analyses and developing hypotheses about how juvenile and adult salmon will respond to the various alternatives under consideration for the long-term operation and configuration of the hydropower system.

The Implementation Team makes up the next level of the Forum. Its members are senior program managers from federal, state, and tribal agencies. The Implementation Team directs the work of the technical teams, resolves disputes elevated from the Technical Management Team and System Configuration Team involving hydropower system operations and selection/implementation of fish passage projects, and provides general policy direction to the technical teams. The Executive Committee occupies the top level of the Forum. It is comprised of senior regional

policymakers from five federal agencies, four states, Columbia River tribal associations, and the Northwest Power Planning Council who consider issues relating to the implementation of hydropower system-related actions required in the Biological Opinion. It also provides guidance to, and resolves disputes elevated from, the Implementation Team. Both the Implementation Team and Executive Committee are chaired by representatives from the National Marine Fisheries Service. Additional technical/advisory groups provides support to the Regional Forum on an as-needed basis.

Figure III.1: Organization of the Regional Forum

Forum Members



* These entities formally withdrew from the Regional Forum in May 1997.

Source: U.S. Army Corps of Engineers.

Status of U.S. Army Corps of Engineers' Columbia River Fish Mitigation Actions as of October 31, 1997

Action by dam	Action type		Status ^a				Delay/cost increase		
	Project	Study	Complete	Ongoing	Canceled /deferred	Not started	Delay	Cost increase	Primary reasons ^b
Lower Granite									
Extended-length screens	√		√ ¹						
Juvenile bypass facility	√				√ ²		√		P, PB, PC
Picketed lead fences	√		√						
Surface bypass program		√		√			√	√	W, O
Fish ladder temperature control	√					√			
Little Goose									
Extended-length screens	√		√ ¹				√	√	O
Outfall pipe	√		√						
Picketed lead fences	√		√						
Fish ladder temperature control	√					√			
Lower Monumental									
Barge loading facilities modification	√		√						
Gate raise modifications	√			√					
Gantry crane	√			√					
Fish ladder temperature control	√					√			
Ice Harbor									
Juvenile bypass facility	√		√ ¹				√	√	O
Flow deflectors	√			√			√	√	W
Surface collection		√			√ ³				
Fish ladder temperature control	√					√			
McNary									
Extended-length screens	√		√ ¹				√	√	S, O
Maintenance facility	√				√ ³				
Juvenile fish facility completion	√		√						
Fish ladder exit modifications	√				√ ²				
Gate raise modifications	√			√					
John Day									
Juvenile fish monitoring facility	√			√			√	√	S, O
Flow deflectors	√			√			√	√	W, O
Surface bypass		√		√					

(continued)

Appendix IV
Status of U.S. Army Corps of Engineers'
Columbia River Fish Mitigation Actions as
of October 31, 1997

Action by dam	Action type		Status ^a				Delay/cost increase		
	Project	Study	Complete	Ongoing	Canceled /deferred	Not started	Delay	Cost increase	Primary reasons ^b
Drawdown study		√				√			
Mitigation relocation evaluation (Ringold)		√		√					
Extended-length screens tests		√		√			√		O
Extended-length screens implementation	√					√			
The Dalles									
Emergency auxiliary water supply study		√		√					
Adult channel dewatering		√		√					
Spillway and sluiceway survival study		√		√					
Surface bypass		√			√ ²		√		P, PA
Juvenile bypass	√				√ ²		√		P, PA, PC
Bonneville									
Power distribution	√			√					
Powerhouse 2 juvenile bypass improvements	√			√			√		P, PA
Powerhouse 1 juvenile bypass improvements	√			√			√		P, O, PA, PB
Surface bypass		√		√			√		S, P
Powerhouse 1 fish guidance efficiency		√		√					
Flat plate PIT ^c tag detector		√		√					
Powerhouse 2 fish guidance efficiency		√				√			
Adult fallback		√				√			
System Projects									
Gas abatement study		√		√			√		P, PA
Turbine passage survival		√		√			√		P, PA, PB
Acoustic technology		√			√ ²				
Adult passage improvements		√		√					
Lower Snake feasibility study		√		√				√	O
Turbine model study		√		√					
Auxiliary water supply in fish ladders/Lower Snake River projects		√		√			√		P, O, PA
Lower Snake fish ladder entrance modifications		√				√			

(continued)

**Appendix IV
Status of U.S. Army Corps of Engineers'
Columbia River Fish Mitigation Actions as
of October 31, 1997**

Action by dam	Action type		Status ^a				Delay/cost increase		
	Project	Study	Complete	Ongoing	Canceled /deferred	Not started	Delay	Cost increase	Primary reasons ^b
Fish ladder temperature control evaluations		√		√					
Separator evaluation		√		√					
Barge exit modifications	√		√						
Additional barges	√			√			√	√	W, O
Dispersed release (short haul barging)		√				√			
Implementation independent review		√	√						
Test flume at John Day		√			√ ²				
Fish guidance efficiency - Little Goose		√				√			
Total	29	29	11	28	8	11	18	9	Not applicable

^aStatus Legend:

¹Project is operational and providing intended benefits; construction and completion are scheduled for fiscal year 1999.

²Project was started but is now deferred.

³Project has been canceled.

^bPrimary Reasons Legend:

P - Regional Forum's decision to lower priority—

PA - funding limitations

PB - need additional biological data

PC - desire to test new technology

S - Problems relating to streamlining action

W - Adverse weather and high flows

O - Other—contractor performance problem, contract bid protest, revisions in project/study scope, design deficiencies, lack of resources, lack of contractor materials, addition of features or services not included in original contract, upward revision in estimated study costs.

^cPIT - Passive Integrated Transponder

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