DEPARTMENT OF THE ARMY
NORTHWESTERN DIVISION, CORPS OF ENGINEERS
12565 WEST CENTER ROAD
OMAHA, NEBRASKA 68144-3869

REPLY TO
ATTENTION OF

January 21, 1998

Mr. William W. Stelle, Jr.
Regional Director
National Marine Fisheries Service
Bin C15700, Building 1
7600 Sand Point Way, N.E.
Seattle, Washington 98115-0070

Dear Mr. Stelle:

On behalf of the U.S. Army Corps of Engineers (Corps), the Bonneville Power Administration (BPA), and the Bureau of Reclamation (Reclamation) (Action Agencies), I am hereby submitting the enclosed Biological Assessment on Federal Columbia River Power System (FCRPS) operations. The biological assessment addresses the effects of a proposed 1998 and future operations of the FCRPS on listed Upper Columbia and Snake River steelhead (Oncorphynchus mykiss), and the Lower Columbia River steelhead which is proposed for listing.

This Biological Assessment analysis is based on the operation of the FCRPS as contained in the coordinated package of Biological Opinions issued March 2, 1995 on Snake River spring/summer and fall chinook (Oncorhynchus tshawytscha) and sockeye (O. nerka), and March 1, 1995 on the Kootenai River white sturgeon (Acipenser transmontanus), five listed mollusc species endemic to the Upper Snake River Basin, and other species listed under the Endangered species Act (ESA) which reside in the Columbia River Basin. The Action Agencies believe that the proposed operation is consistent with the adaptive management framework of the 1995 biological opinions. Such flexibility in operations has been demonstrated during the past migration seasons. Submission of this Biological Assessment constitutes the Action Agencies' request for formal consultation and conference with National Marine Fisheries Service (NMFS) under ESA on the proposed operation of the FCRPS.

In addition, the Corps is preparing revisions to the Annual Fish Passage Plan which will address project specific operation and maintenance actions to minimize any adverse effects on the listed steelhead populations. The Corps will also be initiating the ESA Section 10 permit process for transportation of juvenile steelhead.

Reclamation has participated in the preparation of this Biological Assessment as an operating member of the FCRPS in conjunction with the Corps and BPA. However, Reclamation's involvement in the Biological Assessment should not be interpreted as an indication that all of the Department of the Interior (Interior) has thoroughly reviewed and concurred in all aspects of the enclosed document. Reclamation does not have inhouse expertise in many of the ecological areas which must be considered and generally defers to the other Action Agencies regarding the fish and wildlife issues addressed in this Biological Assessment.

The Action Agencies look forward to working with NMFS in the consultation process, and are prepared to provide and exchange other relevant information as appropriate. The Action Agencies recognize the continued scientific review on juvenile transportation and the recent efforts to bring this issue to the Northwest Power Planning Council's Independent Scientific Advisory Board (ISAB). Members of NMFS, Corps and other regional entities provided information to ISAB on December 17, 1997. We understand that there is some recent information that is still being reviewed by ISAB and the region. The action agencies are available to discuss this new information when available, and any recommendations of the ISAB during consultations. The Corps and BPA intend to consult with affected Tribes. Additionally, Reclamation will participate in government to government consultations with affected Tribes under the recently issued Secretarial Order, American Indian Tribal Rights, Federal-Tribal Trust Responsibilities, and the Endangered Species Act.

Decisions on future operations will be based on our consultation discussions, recommendations from ISAB and other regional entities, and NMFS Biological Opinion. Our hope is that the concerted efforts by all interests in the Pacific Northwest to improve conditions for all ESA-listed Columbia River Basin fish and wildlife resources will result in positive recovery trends.

Robert H. Griffin
Brigadier General, U.S. Army
Division Engineer

Enclosure

Copies Furnished:

Mr. John W. Keys, Regional Director
U.S. Bureau of Reclamation
Pacific Northwest Regional Office
1150 N. Curtis Road
Boise, ID 83706-1234

Mr. Jack Robertson, Acting Administrator
Bonneville Power Administration
905 N.E. 11th
Portland, Oregon 97232

Regional Director
U.S. Fish and Wildlife Service
911 N.E. Eleventh Avenue
Portland, Oregon 97232

BIOLOGICAL ASSESSMENT for

1998 AND FUTURE OPERATION OF THE FEDERAL

COLUMBIA RIVER POWER SYSTEM

Upper Columbia and Snake River Steelhead

Submitted to the National Marine Fisheries Service
by

US Army Corps of Engineers
Bonneville Power Administration
US Bureau of Reclamation

Section 1.0 -- Introduction

1.1 This Biological Assessment (BA) addresses the potential impacts of the coordinated operation of the Federal Columbia River Power System (FCRPS) from 1998 and future years on the continued existence of Columbia and Snake River steelhead (*Oncorhynchus mykiss*). The Biological Assessment (BA) is based on the operation of the FCRPS as contained the 1995 Biological Opinion (1995 BiOp (NMFS, 1995*)) for Snake River sockeye salmon (*O. nerka*) and Snake River spring, summer, and fall chinook salmon (*O. tshawytscha*), prepared by the National Marine Fisheries Service (NMFS), and the 1995 BiOp on Kootenai River sturgeon (*Acipenser transmontanus*) and Snake River snails, US Fish and Wildlife Service (USFWS). This biological assessment (BA) is prepared in compliance with the Endangered Species Act (ESA - 16 USC.1531 *et seq*., PL 93-205, as amended, 1973) and the National Environmental Policy Act (NEPA-42 USC. 4321 *et seq.*,PL 91-190).

1.2 Project Action Area

1.2.1. This BA represents a coordinated effort by the Bonneville Power Administration (BPA), the US Bureau of Reclamation (USBR), and the US Army Corps of Engineers (Corps), collectively referred to hereafter as the Action Agencies, which are responsible for the operation and maintenance of the FCRPS and the Federal Columbia River Transmission System in the Pacific Northwest. The primary area of consideration is the Snake River from its confluence with the Columbia River near Pasco, WA, to the head of Lower Granite Reservoir, and the Columbia River from the estuary to the head of Grand Coulee Reservoir (Lake Roosevelt). Additional consideration is given for the use of water from storage reservoirs upstream of the primary area for flow augmentation. The BA generally encompasses the area and actions reviewed in the System Operation Review (Corps, BPA, USBR, 1995*). The BA analysis is based on operation of the FCRPS as contained in the 1995 BiOp.

1.2.2 This BA is a coordinated effort and the term "Action Agencies" is used in this document to represent the three agencies coordinated system operations. However, use of that term does not constitute evaluation and support by all the agencies of proposed actions that are project specific or agency specific.

1.2.3. The survival of the listed steelhead is dependent on conditions beyond the confines of the FCRPS. Spawning and rearing habitat upstream of the FCRPS, survival in the estuary below the FCRPS, ocean conditions, harvest, hatchery production, and predation can all play a significant part in the survival of Columbia River salmon and steelhead populations. These effects are not directly tied to the operation of the FCRPS, but the welfare and ultimate recovery of the runs is directly dependent on these factors as well as on the operation of the FCRPS.

Section 2.0 Status of Listed Species

2.1 Snake River Steelhead

2.1.1 Historically, Snake River steelhead spawned naturally in tributaries or the mainstem of the Clearwater, Salmon, Weiser, Payette, Boise, and Bruneau rivers, and numerous smaller streams in Idaho, the Tucannon River, Asotin Creek and smaller streams in Washington, and the Grande Ronde, Imnaha, Powder, Burnt, and Owyhee Rivers and other smaller streams in Oregon. Construction of storage, mill, and power dams cut off access to most spawning areas (Wissmar, et al., 1994*; McIntosh, et al., 1994*).

2.1.2 By the mid-1930s, when construction of the FCRPS began, Columbia River steelhead runs were reduced to a fraction of their former abundance. Commercial harvest, followed by loss of upstream spawning areas to private dams, and degradation of spawning and rearing habitat by commercial and other human development, logging, mining, and agricultural practices caused the decline (Chapman, 1986*). According to the Annual Fish Passage Report, just over 107,000 adult steelhead were counted over Bonneville Dam (BON) in 1938 (Corps AR, 1997*). Approximately half of these fish were destined for the Snake River (NPPC, 1991*). With the construction of the FCRPS, obstacles and additional sources of mortality were placed between the remaining spawning and rearing areas and the ocean where steelhead grow to maturity.

2.1.3 At the time of construction of upstream dams (the Hells Canyon Complex - Idaho Power Company (IDP), for example and, to replace losses caused by the FCRPS dams, hatcheries were constructed to mitigate or compensate for fish loss due to dams. Dworshak National Fish Hatchery has been one of the more successful steelhead hatcheries, returning 12,000 to 43,000 adult steelhead annually to the Clearwater River (Miller, 1987*), and contributing 35,000 to 70,000 steelhead annually to down river sport and Indian gillnet fisheries over the past two decades (ODFW/WDFW, 1996*). Other hatchery steelhead are released in the Salmon, Snake, and Grande Ronde rivers as mitigation for the Hells Canyon dams and as compensation for the lower four Snake River dams.

2.1.4 In 1986, 379,891 adult steelhead were counted over BON, compared with 107,006 in 1938 and a 10-year average (1987 to 1996) of 256,520. The 1992 count over Ice Harbor Dam (IHR) was 160,614, the largest count since 1961 when the dam went in (Corps AR, 1997*). From 1938 through the mid 1960s, all returning steelhead were wild fish whereas by the 1990s, more than 80 % were hatchery fish (Corps AR, 1997*).

2.1.5 Juvenile Snake River steelhead reared in hatcheries have been marked since 1985 so they could be harvested while wild fish could be released. Currently, the states of Idaho, Oregon, and Washington limit the retention of steelhead caught by sport anglers to hatchery fish. Prior to implementation of the Lower Snake River Fish and Wildlife Compensation Plan (LSRFWCP) in 1976 (Corps, 1975*), roughly 15 % of the Snake River steelhead were from hatchery origin. In recent years, 85 % or more have been hatchery fish PATH, 1997*). At Lower Granite Dam (LGR), from 1992 through 1996, the percentage of wild fish collected has ranged from 7 to 13 %, averaging 9 % (Spurgeon, et al., 1997*). A 5-year average of 4,707,315 hatchery juvenile steelhead has been collected at LGR compared with 459,426 wild juvenile steelhead. Wild steelhead collection at LGR declined from over 580,000 to less than 322,000 juvenile steelhead during that period. Hatchery steelhead are not included in the Snake River evolutionarily significant unit (ESU).

2.1.6 As the Corps dams were being constructed on the lower Columbia and lower Snake Rivers, designs of fish protective facilities were continually being improved. Fish ladders for adult salmon and steelhead improved with the construction of each successive dam, culminating with the construction of LGR (Raymond, 1988*).

2.1.7 Juvenile fish facilities (JFFs) evolved from rudimentary bypasses, associated with adult fish ladders at BON and McNary (MCN) dams, to a powerhouse collection tunnel for juvenile fish within the dam first constructed in 1975 at LGR (Raymond, 1988*; Williams, 1989*). Powerhouse collection channels and/or associated bypass facilities were retrofitted into most of the Corps dams downstream of LGR in the 1980s and early 1990s. From a range of 1 to 30% in river survival of smolts through the FCRPS in the 1970s (Sims and Ossiander, 1981*), smolt survival increased to 33 to 49% by the 1990s (Williams, et al., 1997*).

2.1.8 Fish screens, collection facilities, fish trucks, and fish barges were also developed from the 1960s through the present for the Juvenile Fish Transportation Program (JFTP). The NMFS conducted research and developed this program between the 1960s through 1980 (Ebel, 1970* ; Ebel, et al., 1971-74*; Ebel, 1974*; Park and Ebel, 1975*; Park, et al., 1978-81*). NMFS studies during this period typically showed better than a 5 to 1 increase (transport/benefit ratios

(TBRs) = transport/control ratios (TCRs) = transport/in river ratios (TIRs) ranged from 1.7:1 to 17.53:1) in steelhead survival compared with in river passage (Park and Athearn, 1985*). In 1980, the NMFS declared the JFTP program operational, and turned the operation over to the Corps.

2.1.9 From 1977 to 1982, fish transport was maximized because NMFS studies showed that it provided higher juvenile survival and adult returns for steelhead (Park and Athearn, 1985). In 1982, as part of the Northwest Power Planning Council Fish and Wildlife Program (NPPC, 1982*), the fishery agencies and tribes adopted a "spread the risk policy" with flow targets that resulted in reduced transportation primarily of yearling chinook. The fishery agencies and tribes preferred to keep more spring/summer chinook in the river because they were less certain about the benefits of transport for these fish.

2.1.10 Bolstered by hatchery production and transportation (NPPC, 1991*), numbers of juvenile steelhead produced in the Columbia Basin increased significantly from the mid 1970s to the early 1980s, peaking at LGR and Little Goose Dam (LGS) in 1991 when 7,393,208 steelhead were collected (Spurgeon, et al., 1997*). However, adult steelhead populations continued to decline. From a high of 134,519 adult steelhead counted over LGR in 1986, the run declined to 47,500 in 1994. In 1996, 86,072 (9,583 wild fish) adult steelhead were counted over LGR (Corps AR, 1997*). Wild steelhead, dependent on declining habitat and being fished at rates set to harvest the more abundant hatchery fish, declined at a more rapid rate. Recent drought and fluctuating ocean conditions which have caused declines of steelhead and salmon returns along the coasts of Oregon, Washington, and British Columbia in recent years (Beamish and Bouillon, 1993*) have affected returns to the Columbia and Snake rivers as well .

2.1.11 As a result of the decline of Snake River steelhead, the National Marine Fisheries Service (NMFS) was petitioned in 1996, and, on August 17, 1997, announced their final ruling that wild Snake River steelhead would be listed as threatened under the ESA (NMFS, Federal Register, Vol 62. No 159, August 18, 1997).

2.2 Upper Columbia River Steelhead

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2.2.1 Upper Columbia River steelhead spawned in the Wenatchee, Entiat, Methow, Okanogan, Nespelem, Sanpoil, Pend Oreille and Spokane rivers and other streams in Washington, British Columbia, and to a lesser extent, northern Idaho. The Columbia River Basin salmon and steelhead runs were seriously depleted by commercial harvest in the late 1800s and early 1900s. Loss of spawning habitat caused further decline, but perhaps the most significant impact came with the construction of Grand Coulee Dam (GCL). This USBR dam blocked access to over 1,100 miles of salmon and steelhead spawning and rearing habitat upstream in Washington, British Columbia, and Idaho. Poorly screened or unscreened irrigation diversions on tributaries and the mainstem downstream of GCL, inadequate flows and damage to spawning and rearing areas by logging, livestock, and mining caused further decline of the steelhead and salmon runs.

2.2.2 The construction of GCL, completed in 1941, permanently blocked access to steelhead spawning areas upstream in Washington, Canada, and Idaho. Mitigation efforts and hatcheries for GCL met with limited success as most efforts were to relocate runs into underutilized tributaries downstream of the dam site. The Okanogan River is now the uppermost tributary of the Columbia used by steelhead.

2.2.3 Construction of Chief Joseph Dam (CHJ) by the Corps did not eliminate more steelhead spawning habitat because there were no tributaries between it and GCL.

2.2.4 Construction of Wells (WEL), Rocky Reach (RRD), Rock Island (RID), Wanapum

(WAN), and Priest Rapids (PRD) dams by public utility districts (PUD), resulted in passage problems for salmon and steelhead and loss of mainstem spawning habitat for salmon. Mitigation for these dams included additional hatchery and spawning channel construction.

2.2.5 Upper Columbia River steelhead traverse up to five PUD dams and four lower Columbia River Corps dams. Prior to 1995, most juvenile steelhead were transported from MCN downstream. Under the 1995 BiOp, the NMFS decided there would be no spring transport from MCN. Lack of effective size/species separation capability there resulted in both salmon and steelhead being returned to the river in keeping with the "spread the risk" desires of the state fishery agencies and tribes.

2.2.6 From a recent high of 34,589 steelhead in 1985, the run over PRD declined to 4,357 in 1995. Some 8,376 steelhead, many of which were hatchery fish, were counted over PRD in 1996 (Corps AR, 1996*). A target of 5,250 steelhead over PRD has been set. Steelhead currently spawn in the Wenatchee, Entiat, Methow, Okanogan/Similkameen, and smaller tributaries, but all of the upper Columbia subbasins are supplemented with hatchery fish from broodstock collected at Wells Dam (NPPC, 1991*). .

2.2.7 Current wild steelhead runs into the Wenatchee, Entiat, and Okanogan rivers reached such low levels by the mid 1990s that the NMFS listed them as endangered (NMFS, Federal Register, Vol 62. No 159, August 18, 1997). The Wells Hatchery steelhead are included in the ESU.

2.3 Lower Columbia River Steelhead

2.3.1 The lower Columbia River steelhead ESU occupies tributaries of the Columbia River between the Cowlitz and Wind rivers in Washington and the Willamette and Hood rivers in Oregon. Excluded are steelhead in the upper Willamette River Basin above Willamette Falls, and steelhead from the Little and Big White Salmon Rivers in Washington.

2.3.2 Access to spawning habitat on some of these rivers was cut off by municipal and power dams and habitat was degraded by logging, agriculture, and other municipal and urban causes. Construction of BON and other, non-Federal dams further affected juvenile and adult steelhead in this ESU.

2.3.3 Currently, the NMFS is still considering the status of these steelhead runs, and has extended the deadline to February 9, 1998 for potential ESA listing.

2.4. Other Affected Listed Species

2.4.1 Other species that are listed under the ESA are inextricably commingled with the steelhead populations of the Columbia Basin. Chinook salmon spawn and rear in similar areas, juvenile chinook and sockeye migrate downstream during periods that overlap the steelhead migration, and adult chinook and sockeye migrate upstream overlapping steelhead migrations. Other listed fish, for example the Kootenai River white sturgeon (*Acipenser transmontanus*), are affected by FCRPS operations that may be intended to benefit listed chinook, sockeye, or steelhead. The decision on listing bull trout (*Salvelinus confluentus*), scheduled for June 1998, may also affect use of flows from up-river storage projects for steelhead protection.

2.4.1 Snake River Chinook Salmon

2.4.1.1 Historically, Snake River spring chinook spawned in the upper tributaries of the Snake River below Shoshone Falls or other natural barriers. Summer chinook spawned in lower tributaries or the mainstems of major streams (Matthews and Waples, 1991*). Fall chinook spawned in the main tributaries or in the Snake River itself (Chapman, et al., 1991*).

2.4.1.2 Over harvest in the lower Columbia River in the 1860s began the decline of Snake River salmon runs. Spring chinook declined first, followed by summer chinook, sockeye, and later by fall chinook as canners and processors progressed from the fattest, best canning fish to the lesser quality fall chinook, chum salmon (*O. keta*), and pink salmon (*O. gorbuscha*) in the early 1900s (Netboy, 1974*). Localized commercial fisheries around the turn of the century in tributaries (in the Payette River for example) further decimated salmon runs and misguided egg taking operations (the Wallowa River in 1898-1903 for example) eliminated salmon from some streams (Swart, 1992*). Mining, logging, agricultural, and urban impacts further reduced anadromous fish habitat and its quality.

2.4.1.3 Small dams for mills, irrigation diversion, or municipal water supplies cut off segments of spawning habitat before the turn of the century, but passage of the Reclamation Act of 1905 initiated major dam construction in the Columbia Basin (Wissmar, et al., 1994*). In the early 1900s, construction of Black Canyon Dam (Payette River), Owyhee Dam (Owyhee River), Barbur Dam (Boise River), and others, eliminated much salmon and steelhead spawning habitat. Many dams constructed prior to the Dam Passage Act of 1915 were constructed without fish facilities. By the 1930s, half of the historic spawning habitat had been lost to private dams and diversions.

2.4.1.4 With the Great Depression in the 1930s, came the Federal civil works projects. BON and Grand Coulee dams fall in this category. BON affected Snake River chinook, while GCL ended the existence of Columbia River salmon originating from tributaries above that dam.

2.4.1.5 Construction of the Idaho Power Hells Canyon Complex in the late 1950s and early to mid 1960s cut off access for Snake River chinook and steelhead above those dams. Hatcheries were constructed to mitigate spring chinook and steelhead losses, but it was not until Lyons Ferry Hatchery was constructed in the early 1980s for the Lower Snake River Fish and Wildlife Compensation Plan that Idaho Power became involved in fall chinook mitigation. Lyons Ferry hatchery production was increased from 7.6 million to 9.2 million fall chinook fingerlings to accommodate mitigation for the Idaho Power dam. This mitigation was never realized, for Lyons Ferry Hatchery has never had enough adults return to produce more than 2.3 million fall chinook (Mendel et al., 1996*). Coded-wire tag studies show that fall chinook ocean harvest, primarily by Canadian fishers, had exceeded 70%, and has recently declined to 55% as a result of re-negotiation of the catch (NPPC, 1992*).

2.4.1.6 The four lower Snake River Dams (IHR, Lower Monumental (LMN), (LGS), and LGR) were impediments to spring, summer, and fall chinook, and inundated the lower river fall chinook spawning area. To compensate for losses to chinook and steelhead, 11 hatcheries were modified or constructed to produce sufficient juvenile chinook and steelhead to replace those lost passing through dam turbines, or lost by inundation of spawning habitat (Corps, 1996).

2.4.1.7 While construction of the hatcheries proceeded, the Corps, collaborated with the NMFS, USFWS, state fishery agencies, tribes, and others, to upgrade and improve juvenile fish passage facilities at the dams. Based on research from the mid 1960s to 1980, the NMFS developed and operated what in 1981 became the JFTP. Since 1981, the Corps has operated the program, first from LGR, LGS, and MCN and, since 1993, from LMN. While the majority of transport research showed higher adult returns for transported spring/summer and fall chinook than for in river migrants, many fishery agency and tribal biologists opposed the program. Starting in 1982, state and tribal fishery managers adopted a "spread the risk" policy of keeping more fish in the river, either by bypassing collected fish back to the river or by increasing spill to prevent fish from being collected.

2.4.1.8 Subsequent research in 1986 and 1989 again showed 1.6 to 1 and 2.5 to 1 increases in survival by transport compared with in river survival, respectively, for spring/summer chinook (Matthews, et al., 1987-92*). The 1995 BiOp called for more transport research, the preliminary results of which showed 2.0 to 1 increase in survival for transported hatchery spring/summer chinook, and 2.4 to 1 for wild fish (Marsh, et al., draft report 1997*).

2.4.1.9 Analysis by the NMFS also suggests there is virtually no difference in adult return rates for those fish PIT tagged at hatcheries versus fish PIT tagged at LGR (Schiewe, 1 August 1997 memo, NMFS*).

2.4.1.10 Despite all the hatchery production, the modifications at the dams, which have significantly increased fish survival since the 1970s, and despite the benefits of transport, recent drought and poor ocean conditions reduced the Columbia River spring/summer chinook runs to a record low of about 10,000 fish (less than 1,000 wild fish) by 1994. The run increased to over 20,000 in 1995, over 60,000 in 1996, and over 130,000 counted past BON in 1997. Yet, wild fish remain low and implementation of the 1995 BiOp measures continues.

2.4.2. Snake River Sockeye Salmon

2.4.2.1 Historically, Snake River sockeye salmon spawned by the tens of thousands in the Payette, Wallowa, and upper Salmon rivers - wherever a lake provided the essential rearing habitat for juvenile produced from shoreline spawning in the lakes or tributaries to the lakes (Richards, 1990*; Chapman, et al., 1990*).

2.4.2.2 Runs were initially reduced by lower river commercial fisheries, but to meet the demands for food for miners, commercial fisheries expanded to the Payette system, at least. As mentioned above, misguided fish culturalists dammed some streams to take salmon eggs, and in the case of the Wallowa River, eliminated the sockeye as well as chinook and coho (*O. kisutch*) runs from that river. In the Salmon River, Sunbeam Dam eliminated most if not all access to the upper basin from 1910 to 1934 when it was blown out. This may have restored sockeye access to the Salmon Basin Lakes (Redfish, Pettit, Yellow Belly, etc.), but other diversions like the Breckinridge Diversion below Alturas Lake diverted most if not all of the water from the stream when sockeye needed it for access to their historic spawning habitat. Fish management practices by Idaho Department of Fish and Game (IDFG) targeted sockeye for removal so the lakes could be managed for west slope cutthroat (*O. clarkii*). This further reduced sockeye populations so that, by the time of their listing (1992), only a small remnant (and then it was uncertain whether they were Snake River sockeye or a remnant from reintroduction of Canadian sockeye) remained (Chapman, et al., 1990).

2.4.2.3 Construction of the lower Columbia and Snake River dams contributed to the decline of Snake River sockeye. More than 1,300 were counted over IHR in 1961, but the number reduced to zero by 1990. It is uncertain how much of this decline was caused by the Corps dams and how much by over harvest as Snake River sockeye were caught in mixed-stock fisheries with their more abundant upper Columbia River, Frazer River, and other northern stocks. It is also uncertain how much of the decline was caused by climatic and ocean changes. The effects of fish protective measures such as transportation on sockeye are not known because research was designed to limit handling of the far more abundant chinook and steelhead smolts.

2.4.2.4 While no hatcheries or other mitigation measures were requested by the fishery agencies to mitigate the effects of the lower Snake River dams on sockeye (USFWS/NMFS, 1972*), an extensive captive broodstock program was initiated under the BPA Fish and Wildlife Program when sockeye were listed as endangered. The broodstock program was expected to return 0 to 9 adults in 1997, but only two marked adults traversed LGR; neither of them arrived at Redfish Lake. Of the other 16 sockeye counted over LGR (thought to be strays from the large 1997 British Columbia sockeye runs), none arrived at Redfish Lake.

2.4.3. Kootenai River Sturgeon

2.4.3.1 White sturgeon, historically, were loosely anadromous in the Columbia River. Some migrated to and from the ocean, but it was not a requisite of their life history.

2.4.3.2 With the construction of dams across the mainstem or major tributaries, segments of the white sturgeon population became isolated. Sturgeon populations continued to reproduce, though in many cases, habitat was marginal for populations to flourish. In some areas, like the middle and upper Snake River, white sturgeon persist, but not at population levels that can sustain harvest. In other areas, like the lower Snake and mid-Columbia rivers, populations support harvest. In some areas, like the lower Columbia River and the estuary, populations are sufficient to support extensive sport fisheries and limited commercial fisheries.

2.4.3.3 The Kootenai River is a Columbia River tributary with segments in British Columbia, Montana, and Idaho. The Kootenai River white sturgeon were isolated above Bennington Falls in British Columbia during the last ice age about 10,000 years ago (Northcote, 1973*). They are genetically distinct (Setter and Brannon, 1990*). Despite their isolation, the has population persisted.

2.4.3.4 Construction of Libby Dam in 1973 resulted in river operations that are believed to have been adverse to the sturgeon. In September 1994, as a result of studies that indicated little juvenile recruitment into the population since the 1960s (Apperson and Anders, 1991*), they were listed under the ESA as endangered. Since that time, a Sturgeon BiOp (USFWS, March 1, 1995) has been implemented. A draft Recovery Plan has been prepared with a final plan scheduled for release by the end of 1997. Thus far, sturgeon spawning has been evident under the BiOp mandated dam operations, but recruitment has been difficult to document.

2.4.3.5 Operational requirements for Libby Dam differ for salmon and sturgeon. The 1995 BiOp calls for enhanced flows in spring from the Kootenai even in low flow years. The Sturgeon Recovery Plan calls for a tiered flow regime where spring flows are based on runoff forecasts. The 1995 BiOp calls for flow augmentation in August. This would raise Libby outflow above inflow in many years, and would draft Lake Koocanusa (Libby Reservoir) in midsummer to the detriment of reservoir biota and recreational interests. Thus far, August flows have been partially provided by swapping drafts at the Keenleyside project in Canada.

2.4.3.6 The action agencies assume that the Technical Management Team (TMT) will continue to recommend adjustment of upper Columbia River flows among the needs of the endangered or threatened salmon, steelhead, and sturgeon.

2.4.4 Bull Trout

2.4.4.1 Bull trout (*Salvelinus confluenteus*) are proposed for listing under the ESA in many areas by the USFWS. If bull trout are listed, consideration will be required for the impact of operations to protect other listed species on bull trout. For example, if bull trout are listed in the North Fork of the Clearwater River, this may effect releases of water from Dworshak Reservoir for flow augmentation or temperature control in the Snake River for chinook salmon.

Section 3.0 1995 Salmon Biological Opinion

3.01. As stated in the introduction, this BA is keyed to and supplements the 1995 BiOp. It was developed on the premise that the NMFS had identified a broad array of Reasonable and Prudent Alternatives (RPAs), Incidental Take Statement (ITS), and Conservation Recommendations (CRs) measures intended to recover the Snake River chinook and sockeye salmon runs. Except as noted, measures recommended for Snake River chinook and sockeye are anticipated by the action agencies to provide equal or greater benefits for Snake River and upper Columbia River steelhead while migrating through the FCRPS. The RPAs, ITSs, and CRs from the 1995 BiOp are discussed below with implications described for steelhead where warranted.

Section 4.0 Operation of the FCRPS under the 1995 Biological Opinion as it relates to listed steelhead

4.0 The action agencies have previously adopted Records of Decision based upon the 1995 BiOp (RODS) which specify the manner in which the FCRPS will be operated. Recent developments in relevant science in the view of the action agencies may warrant changes in those operations for the benefit of steelhead. The action agencies propose to continue the operation of the FCRPS as described in the 1995 BiOp and Records of Decision (ROD). In addition, they also recommend the consideration of certain alternative operations decribed herein in the consultation with NMFS or through the Adaptive Management Process (AMP) created by the 1995 BiOp (which includes both the management teams and the PATH and other processes designed to make long term decisions for the FCRPS).

4.1 Regional Coordination of 1998 and Future Operations

4.1.1 RPA 26 called for the creation of a process to review progress on planning and engineering studies, modification to facilities or operations, collection of research data, and where appropriate, to review schedules for implementation of measures under the 1995 BiOp. This resulted in the formation of the System Configuration Team (SCT), Implementation Team (IT), and Executive Committee (EC), three levels of interagency review. In each respective group, representatives of the COE, BPA, USBR, NMFS, USFWS, the States of Idaho, Montana, Oregon, and Washington, the NPPC and Indian tribes meet for the purpose of reviewing and guiding the 1995 BiOp implementation process. Other committees like the Corps' Anadromous Fish Evaluation Program (AFEP), the Corps' Fish Passage Operation and Maintenance (FPOM) Coordination Team, and the Corps' Fish Facility Design Review Work Group (FFDRWG) provide the opportunity for fishery agencies, tribes, and other agencies to make technical input into the regional decision making process. The NPPC's Independent Scientific Review Group and the AFEP Studies Review Work Group provide further opportunities for scientific and peer review and input. All of these committee and work group meetings are open to the public, and are sometimes attended by representatives of other interest groups. These committees and work groups have coordinated and provided all of the various groups the opportunity for input into the decision making process for the protection of Snake River chinook and sockeye salmon. The action agencies believe these committees and work groups will provide an opportunity for all interests to review and understand the scientific information that is being generated to aid in recovering Snake River salmon and upper Columbia River and Snake River steelhead. The action agencies strongly support making decisions based on solid science and objective reasoning and propose to continue to coordinate with these committees and work groups in the future. Per the "Framework for Implementing and Modifying Actions in the 1995 FCRPS Biological Opinion" between the Corps and NMFS, the Corps also suggest that it would be appropriate to include effects of steelhead in that framework.

4.1.2 RPA 27 calls for the BPA, Corps, and USBR to review plans for operation of the FCRPS and, if variations from the 1995 BiOp are proposed, to coordinate with the NMFS. This will be accomplished by the appropriate action agency through consultation with the NMFS.

4.1.3 ITS 1 calls for the Corps and BPA to incorporate flow objectives and other relevant provisions of the 1995 BiOp into the Pacific Northwest Coordination Agreement annual planning. This has been accomplished and will continue to be incorporated in to the annual planning process.

4.1.4 Another management team established by the 1995 BiOp (RPA 1.f) was the TMT. This team, comprised of representatives from the Corps, BPA, USBR, NMFS, USFWS, NPPC, states, tribes, and other interest groups, meets weekly during the fish passage season to coordinate potential FCRPS operations and make operational recommendations to the Action Agencies. Adaptive management, as described in the 1995 BiOp, provides for modification of operations by the TMT. Since it was adopted in 1995, the TMT has adaptively managed the system operation from what was initially described in the 1995 BiOp. The action agencies expect that the TMT will continue to provide recommendations relative to real-time operation of the FCRPS, weighing the best interests of the threatened and endangered steelhead with the best interests of the Snake River chinook and sockeye and Kootenai River sturgeon.

4.1.5 Operation of the FCRPS for 1998, upon completion of this consultation with NMFS, will be described in the TMT Annual Water Management Plan, and in the Corps North Pacific Region's Fish Passage Plan (FPP). These plans will be coordinated with regional interests by the TMT and FPOM, respectively. In addition to taking into account 1995 BiOp measures for the protection of Snake River chinook and sockeye, these documents will incorporate the measures recommended by NMFS and adopted in the Action Agencies ROD's for the protection of upper-Columbia River and Snake River steelhead.

4.1.6 RPA 17 calls for the BPA and NMFS to coordinate the use of regional models and to test the hypotheses used to drive those models for the purpose of evaluating measures implemented from the 1995 BiOp. A regional Process for Analyzing and Testing Hypotheses (PATH) work group was formed for this purpose. Fishery biologists and computer modelers from the state and Federal fishery agencies, CRITFC, BPA, University of Washington, and other contractors make up a workgroup that has endeavored to reach consensus on the various parameters used in or driving various models. The PATH team is being relied upon heavily for input and analysis for the Lower Snake River Juvenile Fish Migration Feasibility Study (SRFS).

4.1.7 The PATH Work Group is concentrating on evaluation of in river passage, fish transportation, and draw down of the reservoirs. According to their recent schedule (Path Workshop, 20-23 October , 1997), the PATH Work Group will analyze steelhead survival in the spring of 1998 as they have yearling chinook survival, and results will be used to evaluate protective measures for steelhead. The action agencies strongly believe that a unified approach to analyzing the impacts of measures being taken or proposed for the recovery of salmon and steelhead is essential for success, and encourage the PATH Work Group to work toward that end.

4.2 Flow Augmentation Measures

4.2.1 In the 1995 BiOp, RPA 1.a. describes the operation of FCRPS projects to optimize flow for the protection of Snake River chinook and sockeye. The criteria were based on probability of refill of FCRPS reservoirs (Libby, Hungry Horse, Grand Coulee, Albeni Falls, and Dworshak) rather than on fixed volumes used in the NPPC Fish and Wildlife Program or in the 1992, 1993 or 1994-1998 BiOps. This change was in response to the IDFG v. NMFS law suit challenging the adequacies of previous BiOps. As established by the NMFS, potential reservoir operations are discussed in the TMT which makes recommendations to the action agencies. The measures contained in RPA 1.a are the same as proposed in this BA for the protection of steelhead.

4.2.2 RPA 1.b.. calls for the USBR to continue to release 427 thousand acre-feet (kaf) of water from upper Snake River storage in compliance with the NPPC's Strategy for Salmon in 1995 -97. The USBR is encouraged by NMFS to investigate and try to obtain additional water to augment Snake River flows. Though current Idaho State law and policy would seem to preclude the addition of any water to Snake River flow augmentation volumes, it is being considered in the SRFS and the PATH team has been asked to evaluate the benefits of this alternative. The USBR and the SRFS will investigate the impacts of providing additional flow augmentation. For the purposes of this BA, it is assumed that any waters made available as a result of selecting an alternative evaluated in the SRFS requiring additional flow augmentation would be released as recommended by the TMT following the 1999 decision.

4.2.3 RPA 1.c. calls for the Corps and USBR to evaluate flood control operations to provide more storage for flow augmentation waters. The Corps completed a study of changes in flood control storage requirements at major flood control projects in the United States and Canada, and analysis of the effects of those changes on flood flows, stages, and damages. Overall, operation of the Columbia River system flood control to higher controlled flow levels to benefit listed species would increase average annual flood damages at many locations in the Columbia River Basin, especially in the lower Columbia River below BON. The report did not identify any changes in the flood control operation of the system for implementation. (Corps, 1997c*). However, the 1995 BiOp included reallocation of flood storage from Arrow to Mica reservoirs, and changes to flood control rule curves for the operation of Grand Coulee Reservoir. The US agreed with the Columbia River Treaty Operating Committee (CRTOC) to shift some flood control storage from Arrow to Mica reservoir. There was no change in flood control allocation at Grand Coulee Reservoir.

4.2.4 RPA 1.d calls for renegotiation of storage agreements relative to the 1995 operation of the Columbia River Treaty Canadian Storage. In years when the addition of approximately one million acre feet of water was called for, there have been agreements signed by the CRTOC that made the additional storage available. The actions taken by the CRTOC have been reported to the TMT.

4.2.5 RPA 1.e calls for the NMFS to work with IDP to shift flood control from Brownlee Reservoir to the Columbia River reservoirs. An agreement has been reached whereby flood control capacity can be shifted in low water years. No changes are proposed in this BA.

4.2.6 RPA 1.g sets flow targets for spring and summer flows at LGR and at MCN for Snake River salmon migration. No changes are proposed to the current salmon flow augmentation requirements, however, prior to the spring period at McNary, the action agencies propose that in this consultation, NMFS should consider the FCRPS should be operated in a manner that allows maximum collection and transportation of steelhead outmigrants. In the opinion of the action agencies, to be most effective, spill should be avoided to prevent mid-Columbia River steelhead juveniles that tend to migrate down the Washington shore from passing through open spill bays. With all main units available, maximum powerhouse capacity at McNary Dam is about 180 kcfs. Once spring flow augmentation for salmon begins on April 20, flows could be increased to 220 to 240 kcfs, depending on the runoff volume forecast.

4.3 Reservoir Operations

4.3.1 Operation of Reservoirs to Minimum Operating Pool (MOP)

4.3.1.1 RPA 4 calls for operation of the lower Snake River reservoirs within 1 foot of MOP. The premise for this operation is that reducing reservoir volume will increase the rate of juvenile fish migration and improve their survival through the reservoirs. Some limitations have been placed by the TMT on this operation because of navigation constraints (areas in the navigation channel where depths are less than the authorized limit because of shoaling or accumulation of bottom materials within the navigation channel). While most adult fish facilities (AFFs) and JFFs are designed to operate over the full range of reservoir levels, some (such as the IHR north powerhouse and spillway fish ladder entrances) do not meet current fish passage criteria when the reservoir is operated at MOP.

4.3.1.2 No definitive evidence has been obtained to indicate that the small increase in velocity or slightly reduced theoretical passage time for juvenile salmon caused by the MOP operation has increased adult fish returns. For adult fish, there is evidence that operation at MOP, especially during low flow periods, causes adult fishways to be out of criteria. This is particularly true at LMN, LGS, and LGR where main AFF entrance weirs may be shallower than the current 8-foot depth required by the fishery agencies and tribes. However, recent research for adult fish passage (Bjornn, 1997*) has not identified this to be a problem.

4.3.1.3 On the other hand, operating at MOP reduces head on the orifices of the juvenile bypass systems, and more orifices must be operated to provide design flows. Therefore, operating at MOP may increase the efficiency of passing juvenile fish from gatewells to collection channels. Reduced head also reduces the velocity of water through the orifices, and may reduce stress to fish passing through the orifices (Spurgeon, et al. 1997*).

4.3.1.4 For this BA, the Corps and BPA propose that NMFS in this consultation consider, in order to support maximization of transportation, operations outside of MOP may be appropriate at times when flows are such that remaining at MOP would force short duration spill to occur due to lack of market. This operation would be minimized to the extent possible in order to operate near MOP as much time as possible. When such overgeneration conditions do not exist, the reservoirs could return to a one foot operating range specified by the TMT. This is believed to be consistent with the 1995 BiOp.

4.3.1.5 RPA 5. calls for operation of John Day Reservoir (JDA) within 1.5 feet of the minimum elevation that does not disrupt irrigation (El. 262.5 MSL or greater, depending on river flow) and continued study of further drawdown of JDA to MOP and to spillway crest. Regarding operation of JDA, the action agencies propose that in this consultation, NMFS consider maximization of transportation, operations outside of the 1.5 foot operating range should occur to avoid short duration spill at the collector projects which would occur due to the lack of market and forebay restrictions. When the overgeneration conditions do not exist, the reservoir would return to a 1.5 foot operating range specified by the TMT.

4.3.1.6 Regarding JDA drawdown, all drawdown planning, engineering, and implementation actions related to MOP and spillway crest draw down were deferred pending development of "scientific justification of the projects as an effective means of salmon recovery," as directed by the Energy and Water Appropriations Conference Committee in the FY 96 Appropriations Act. NMFS, in a letter dated December 23, 1996, provided information to support continued evaluation of a range of drawdown operations at JDA. The Assistant Secretary of Army for Civil Works notified congressional committees, in a letter dated February 25, 1997, that the Corps intended to evaluate drawdown and, with the concurrence of the committees, initiate such studies in FY 1997. In the 1998 Energy and Water Development Appropriation Bill, "the Committee approved the Corps' February 25, 1997, reprogramming request related to a study of the biological, social, and economic impacts of a drawdown of John Day Reservoir consistent with the terms and conditions specified in its June 6, 1997 letter" (Congressmen Pete V. Domenici, Chairman, and Harry Reid, Ranking Member, Subcommittee on Energy and Water Development to H. Martin Lancaster, Assistant Secretary of the Army, Civil Works). The letter directed the Corps to provide a final scoping document for the Committee's approval no later than 90 days from the date of enactment of the act. The Committee's letter directed that the study be limited to only study drawdown of John Day Reservoir to spillway crest and to the natural river level. The study will address social and economic impacts of each proposed drawdown level, including how each would impact irrigation operations, hydraulics and hydrology, fisheries, flood control, hydropower production, navigation, transportation, structural changes to Federal projects, and other impacts related to cultural resources, recreational activities, and municipal water supplies. The Corps is completing the requested scoping document. Future action will be based on further Congressional direction. In the meantime, the Action Agencies do not propose any change to the lower pool operation at JDA during the juvenile fish migration season.

4.3.1.7 For this BA, it is assumed that Snake River and upper Columbia River steelhead would be less impacted than chinook by passage through JDA since the principal cause for concern is predation. Steelhead smolts, especially hatchery fish, are larger than yearling or subyearling chinook, and juvenile steelhead tend to migrate when water temperatures are lower, particularly for subyearling chinook. Juvenile steelhead also tend to migrate in mid-channel which would cause them to be less susceptible to predation by squawfish, walleye, or bass in the reservoir. Drawdown of John Day Reservoir could force predators into the reduced river channel, bringing them into closer proximity with salmon and steelhead smolts. And increased predation could occur until the predator population reached a new balance with the prey base and the predator habitat created by drawdown.

4.3.1.8 PIT tag studies with yearling chinook and, to a lesser extent with steelhead, have indicated higher survival through reservoirs than previously documented. From an average of 84 % (Iwamoto, et al., 1994*), recent studies show closer to 95 % in PIT tag studies (Smith, et al. 1997*). It is likely that improved research techniques have resulted in better measurement of fish survival.. Other factors like reduced predator populations may have been a contributing factor (Cramer, 1996*).

4.3.2 Temperature Control in Reservoirs

4.3.2.1 ITS 17 calls for the Corps to monitor river water temperatures and implement water temperature control measures in the lower Snake River. Historically, the lower Snake River reached temperatures in the high 70s (76° Fahrenheit at IHR), (Corps AR, 1962-97). With construction of the lower Snake River dams, the peak high temperatures were lowered (71 to 75 ° F) , but the warm water extended more into the fall (See Table 2) . In accordance with RPA 1.g., the TMT has recommended regulating flow out of Dworshak Reservoir for juvenile fish migration. This has resulted in reduced late summer and early fall temperatures in the Snake River presumably for the benefit primarily of adult fall chinook salmon migrating upstream, although negative effects have been identified for juvenile fall chinook migration timing and rearing (Conners, et al., 1997). This temperature regulation measure has held peak Snake River temperatures, measured at IHR (Corps AR, 1993, 94, 95, 96*), to 70° F or lower for the past four years. For this BA, the Action Agencies assume that the TMT will continue to recommend this type of regulation and that such regulation will continue in the foreseeable future.

Table 2. High water temperatures in degrees Fahrenheit measured at Ice Harbor Dam (turbine scroll case) 1962 through 1996 (multiple occurrences marked by start and end dates - inclusive).

YEAR	TEMP	START	END	START	END	START	END
62	76	28-Jul	1-Aug				
63	76	13-Aug	18-Aug				
64	72	28-Jul	30-Jul	1-Aug	3-Aug	17-Aug	19-Aug
65	75	7-Aug	8-Aug	11-Aug	18-Aug		
66	75	4-Aug	11-Aug	13-Aug	19-Aug		
67	76	18-Aug	29-Aug	1-Sep	1-Sep		
68	75	12-Aug	12-Aug				
69	73	5-Aug	7-Aug				
70	73	21-Aug	30-Aug				
71	74	5-Aug	5-Aug	12-Aug	24-Aug		
72	73	30-Aug	31-Aug				
73	72	2-Aug	4-Aug	13-Aug	21-Aug		
74	72	2-Aug	2-Aug	4-Aug	5-Aug		
75	71	15-Aug	17-Aug	22-Aug	23-Aug		
76	71	6-Aug	10-Aug	3-Sep	4-Sep		
77	73	19-Aug	19-Aug	26-Aug	29-Aug		
78	72	12-Aug	16-Aug				
79	73	3-Aug	19-Aug	23-Aug	29-Aug		
80	72	16-Aug	18-Aug				
81	73	31-Aug	2-Sep				
82	72	24-Aug	3-Sep				

83	73	2-Sep	4-Sep				
84	72	12-Aug	28-Aug				
85	75	28-Jul	1-Sep				
86	75	31-Aug	31-Aug	1-Sep	1-Sep	6-Sep	6-Sep
87	72	12-Aug	13-Aug	13-Sep	14-Sep		
88	72	19-Aug	11-Sep				
89	71	11-Aug	27-Aug				
90	73	16-Aug	20-Aug	23-Aug	28-Aug	6-Sep	9-Sep
91	74	31-Aug	3-Sep				
92	71	18-Jul	28-Jul				
93	68	15-Aug	27-Aug	9-Sep	12-Sep		
94	70	17-Jul	21-Jul				
95	70	5-Aug	6-Aug	8-Aug	11-Aug		
96	70	28-Jul	30-Aug				

4.3.2.2 Incidental Take Statement (ITS) Measure 5 discusses temperature problems encountered at MCN Dam in the past. The problem stemmed from Columbia River waters typically having maximum summertime temperatures 5 to 7 °F cooler than Snake River waters and the lack of mixing of the two plumes until they pass MCN. Two changes have acted to lessen this problem. The first was modification of the JFF when a new facility was installed in 1994. This modification resulted in reversing the flow in the collection channel so that fish were being guided into warming water rather than cooling water. The second modification was the change in Snake River temperatures described above. This change has slightly lessened the temperature gradient between the Columbia and Snake River plumes at MCN.

4.3.2.3 ITS 5.a. called for definition of parameters for operation of the MCN JFF. These parameters have been defined and incorporated into the FPP.

4.3.2.4 ITS 5.b. called for collection of thermal profile data. This has been incorporated into the Task Order of the WDFW, who provide biological oversight and smolt monitoring capability at MCN.

4.3.2.5 ITS 5.c. called for avoidance of abrupt changes in turbine operations at MCN. This has been incorporated into the FPP for MCN Dam.

4.3.2.6 ITS 5.d. called for daily transport of fish during high temperature periods. This precaution has been incorporated into the FPP.

4.3.2.7 ITS 5.e. calls for evaluation of north end powerhouse loading. As stated above, the flow in the collection channel has been reversed so this problem has not recurred since 1995.

4.3.2.8. ITS 5.f. calls for adding JFF operating staff during swing and graveyard shifts. The Corps has added automatic warning devices and increased monitoring of dewatering facilities by project operators the need to increase JFF staff. Routine inspection of facilities been included for the JFFs as a standard operating procedure.

4.3.2.9. ITS 5.g. requires consultation with the NMFS when mortality levels exceed 6%. This has been included in the FPP as a standard operating procedure.

4.3.2.10 ITS 5.h. calls for evaluation of an emergency water source for the JFF. This was accomplished in the winter of 1995-96 and an emergency water source was added in the winter of 1996-97.

4.3.2.11 ITS 5.i. calls for reevaluation of the design of the primary de-watering screen. This has been underway since 1995. Due to failure of structural members, the primary de-watering screen was redesigned and strengthened in the fall of 1995. Studies are continuing on other approaches to improving the de-watering screen system.

4.3.2.12 ITS 5.j. calls for the Corps and BPA to coordinate plans for changing turbine loading or initiating spill when temperature problems require such actions. This has been incorporated in the FPP.

4.3.2.13 ITS 5.k. calls for installation of shading over the JFF raceways by 1995. Raceway covers were installed in the winter of 1995-96.

4.3.2.14 ITS 5.l. calls for de-watering the JFF collection channel and de-watering screens between the spring and summer outmigrations so screens can be inspected and cleaned. This has been accomplished each year since 1995 and will continue.

4.3.2.15 ITS 5.m. calls for developing a method of inspecting de-watering screens without de-watering the facility. This has been accomplished with the use of an underwater video system.

4.3.2.16 For the purpose of this BA, the Action Agencies will assume that steelhead will benefit from the above-stated temperature related actions as well as the chinook and sockeye.

Section 4.4 Dam Operations

4.4.1 Turbine Operations for Fish

4.4.1.1 RPA 6. calls for operation of turbines at Corps dams to be operated within 1% of peak efficiency. The Corps and BPA have incorporated such operations in the FPP, and the majority of time the turbines are operated within 1% of peak efficiency. Excursions outside the 1% range have been limited and occur primarily as agreed to by the TMT for the purpose of dissolved gas abatement. However, the biological rationale behind operating within 1 % of peak efficiency is limited. Recent assessments have shown no significant difference in juvenile fish survival when passing through turbines operating within 1% of peak efficiency versus turbines operating outside this range (Mather and Skalski., 1997). Furthermore, turbine specialists have noted that changes in efficiency at higher turbine outputs is largely a result of frictional losses associated with flow through scroll cases and draft tubes, not changes in hydraulic conditions or pressure that are typically associated with fish survival. It has been hypothesized that operating some turbines (e.g. LGR, LGS, and JDA) at peak efficiency results in reduced water velocity which may increase the likelihood of blade strike when compared to higher output levels (Voigth, 1997; Bell - 1981*). Finally, researchers have suggested that any potential differences between survival within 1% of peak efficiency and higher output levels are so small that they cannot be easily discerned. The Action Agencies do not propose any changes to operating turbines in the 1 % efficiency range at this time.

4.4.1.2 For adult fish passage, FPP criteria typically require turbine units 1 and 2 (nearest the shore fishway entrances of the powerhouse) to be operated as priority units. Flows from these turbines were thought in the past to optimize adult fish passage into main shore powerhouse entrances of the fish collection system. These criteria have been modified as additional information on adult fish passage has been obtained (Bjornn, 1997) and as different turbine loading criteria have been established by for night time operations for juvenile fish passage (CBFWA letter, 1991). Bjornn's (1997) results show no significant difference in adult passage when Units 1 and 2 are operating versus when units at the other end of the powerhouse are operating. Therefore, the Action Agencies intend to revise the FPP to reflect these findings, and operate the AFFs according to the FPP.

4.4.2 Adult Fish Facility (AFF) Operations

4.4.2.1 RPA 7. calls for operation of fish facilities within criteria. AFFs are operated within criteria as much as possible with exceptions when operation at MOP causes deviations at LMN, for example, or where facilities break down or get out of calibrations, at BON for example. The Corps has reviewed fish facility operations and will take corrective actions for conditions, such as the steelhead jumping at JDA, as required. These will be coordinated with the region through the FPOM. This measure also calls for automation of AFF controls. This has been accomplished at all Lower Snake River dams and McNary dams, and is being completed at the three lower Columbia River dams in 1997-98. The measure also calls for relocation of staff gages and installation of flow meters so that fishery biologists and project operators can better monitor AFF operations. This was accomplished in the Lower Snake River and McNary dams, and is being accomplished in the three lower Columbia Rivers in 1997-98. The AFF operations are monitored by Corps biologists, by state agency biologists working under contract to the Corps, by fishery agency biologists, and by NMFS biologists or hydraulic engineers. Large numbers of adult steelhead are often found in fish ladders when they are de-watered in the winter. Numbers of fish requiring removal are minimized by reducing flow in the ladders the day before they are de-watered. Salvage plans have been developed whereby Corps and state agency biologists remove fish back to the river. De-watering plans are covered in the FPP. Fish facility operations are reviewed each year by Corps and agency representatives on the FPOM, and the FPP is revised annually to reflect improved operations. Every effort is made to keep AFFs operating correctly and, for this BA, the Action Agencies assume that steelhead will benefit from the effort.

4.4.2.2 Conservation Recommendation (CR) 2 calls for the Corps, BPA, and USBR to investigate improving adult fish passage at the dams. The Corps has funded a comprehensive study (Bjornn, 1997) since 1991 evaluating adult passage at the dams. This study has shown relatively low inter-dam losses and minimal delay in passing over the dams. The measure also calls for investigation of installing of additional fish ladders at LGR and LGS dams. Given that adult fish passage at LGR and LGS is comparable to passage at other dams with two fish ladders, this has been assigned low priority by the SCT in comparison with other studies. The Action Agencies propose to NMFS that this measure be deferred.

4.4.2.3 ITS 15 calls for the Corps to procure spare parts for critical components of AFFs. Spare parts for many components have been acquired. Some parts are available from local vendors on short notice, while some costly, long lead time parts require design time and prolonged procurement. The Action Agencies propose to continue procuring and maintaining a spare parts inventory for AFF facilities as deemed necessary.

4.4.2.4 ITS 16 calls for the Corps to develop emergency auxiliary water supplies at dams where the Corps and NMFS determine they are necessary. Studies have been completed for MCN, JDA North Ladder, and The Dalles Dam (TDA) North Ladder. Alternative studies of emergency water supplies at BON2 and at TDA East Ladder are in progress. At MCN, emphasis will be placed on maintenance and upgrading of three existing electric pumps. These pumps have extra capacity at full operating level. Studies will be completed in September 1998 evaluating the need for emergency auxiliary water supplies at the Snake River Dams. The Action Agencies propose to take appropriate action when each of these studies is completed.

4.4.3 Fish Counting Procedures

4.4.3.1 Adult salmon, steelhead, shad, and lamprey are counted as they pass each of the eight Corps dams. Human visual counting is utilized at major counting stations. Videotape fish counting is utilized at some dams and at off times to obtain more complete passage information at major counting stations. Fish counting procedures are reviewed and approved by the FPOM and fish counting is carried out by the WDFW under a Cooperative Agreement funded by the Corps. The Action Agencies assume that fish counting procedures currently in effect will meet the needs for listed steelhead as well as listed salmon.

4.4.3.2 ITS 13 calls for 24-hour fish counting at IHR and LGR and counting during off periods at BON. Corps counting procedures have been modified, in collaboration with the fishery agencies and tribes through the FPOM committee. The Action Agencies believe this meets the intent of ITS 13.

4.4.4 Juvenile Fish Operations

4.4.4.1 RPA 2 calls for spill at Corps dams to achieve 80 % juvenile fish passage efficiency (FPE) or 95% dam survival during the main migration season. Percentages of spill to meet this level for Snake River chinook and sockeye salmon have been specified by NMFS for the eight Corps dams but it is assumed that these spill levels will be reviewed and modified as changes are made to facilities or operations and new information becomes available. Because steelhead are guided from turbine intakes at higher FGEs than salmon, the spill requirement to achieve 80% FPE is lower than the 1995 BiOp levels. Hence, when spilling at specified levels to achieve 80% FPE for salmon, FPE for steelhead would exceed 80%. At many FCRPS dams, FGEs are greater than 80% for steelhead, so no spill would be required for steelhead. The Action Agencies agreed to provide 1995 BiOp spill so long as TDG levels stayed within state water quality standards. The NMFS petitioned state water quality agencies to have the standards temporarily modified from 110% to 120% TDG for fish spill. This action was strongly supported by the fishery agencies and tribes and the Action Agencies provided spill up to the 120% TDG modified standards. Subsequent analysis of PIT tagged fish indicated that such spill decreased system survival (Cramer, 1996*; Smith, 1996*, Smith, 1997*). Higher than average flows in 1996 and record high flows in 1997 caused uncontrolled spill and TDG levels greater than 120%. The Corps and BPA recommend that the maximization of transportation and minimization of spill at LGR, LGS, LMN, and MCN will provide greater benefits for steelhead. At LWG, no spill is recommended because of SBC tests that will be conducted which will probably divert most of the juvenile fish over the spillway. At LGS, fish bypassed at LWG could be collected at a higher rate, so no spill is proposed at LGS either. At BON, TDA, JDA, and IHR, we propose consideration by NMFS of spill to reach the 80 % FPE or 95 % dam survival criteria, assuming they are the same for steelhead as for salmon, within the modified TDG criteria.

4.4.4.2 The 1995 BiOp specified 64 % spill at TDA to obtain 95 % dam survival. Research results show that PIT tagged fish passing the spillway during 64 % spill survived at 85.9 +/- 6.4 % for coho salmon, and 92.5 +/- 7 % for subyearling chinook in comparison to releases at the proposed JFF outfall location (Dawley, et al., in press*). Spill levels greater than 30 % cause flows over the rocky shelf downstream of TDA, potentially increasing predation. BioSonics (1997b*) indicated that the efficiency of spill in bypassing fish was not decreased at 30 % spill and that sluiceway efficiency increased at lower spill levels; few days of low spill occurred in 1997. The Action Agencies propose that rigorous spill efficiency and survival tests are necessary to ensure maximum survival through the project. Tests are scheduled at TDA for 30 and 64 % spill levels in 1998.

4.4.4.3 To maintain transfer capability on the California transmission intertie, commencement of BiOp fish spill at JDA will be sequenced in a manner that allows four main units to convert from generation to a synchronous condensing mode. It is estimated that it could take as much as 3 hours to complete the transition. Spill would step up from the specified 1800 hour spill amount to the full amount as determined by FPE requirements and to the limit imposed by the modified TDG standard over that 3 hour period. This sequencing would allow for change in mode of the turbine generators, which can only be completed one unit at a time. It takes approximately 1 hour to charge the pressure tanks with compressed air which is used to depress the water to a level below the turbine runner. This operation is required to provide a smooth transition elsewhere in the power system by allowing intertie support to be maintained, or less abruptly decreased, and avoids short-term spill increases at other dams caused by a more abrupt drop in intertie support.

4.4.4.4 Flow augmentation and flood control releases from GCL can cause spill there and at CHJ. The Corps and USBR have investigated means of reducing TDG from spill at CHJ and GCL. However, gas levels above 130% have been detected in the GCL forebay and in various parts of Lake Roosevelt. Improvements were made by adjusting the spill pattern. At this time, no directed effort is underway beyond annual monitoring of TDG levels during the spill season. Sensors are located in both the forebay and tailwater areas and full automation of the

TDG reporting system is scheduled for the spring, 1998.

4.4.4.5 Research shows that steelhead are guided much better by fish screens, suffer lower mortality in collection and transportation facilities, return at higher rates when transported than chinook, and may be more susceptible to gas bubble trauma (GBT) than yearling chinook. Therefore, the Action Agencies recommend that fish spill should be curtailed at the four dams from which fish are transported and that transportation be maximized. At the other dams, the efficacy of spilling to provide 80 % FPE should be re-evaluated using current research information on spill effectiveness, FGE, and TDG/GBT. Because many modifications have been made to FCRPS facilities and operations since the 1995 BiOp, the Action Agencies recommend that the "spread the risk policy" be reconsidered.

4.4.4.6 RPA 3 calls for transportation of all fish collected at LGR, LGS, and LMN and transport of fish after the spring outmigration from MCN. This plan was adjusted to some degree by the TMT and for transport research conducted by the NMFS. In 1997, spill was used to increase in-river passage in an attempt to limit transport to 50 % of the outmigration measured at LGR. Over 20 years of research by the NMFS show that transport generally returned 1.5 to 2.5 times as many spring /summer chinook, 3 to 5 times as many fall chinook (McNary research), and 2.5 to 3.5 times as many steelhead compared to in-river survival. Definitive results are not available for Snake River sockeye because too few juvenile migrants were available for statistically reliable tests (Park and Athearn, 1985). Because spring/summer chinook do benefit from transport and steelhead benefit even more and, because upper Columbia River steelhead could be afforded more benefit by spring transport from MCN, maximized transport from all four dams should be adopted throughout the juvenile fish migration.

4.4.4.7 RPA 16 calls for the BPA, Corps, and USBR to develop an extensive dissolved gas monitoring program. This has been accomplished. Remote monitoring stations have been established in the fore bays and tailraces of the FCRPS dams, and at other strategic locations in the Columbia River hydropower system. All TDG data is available through the INTERNET on a real-time basis for these monitoring stations. Availability of this information has allowed the TMT to manage operation of spill in the system to alternate words: achieve the 1995 BiOp requirements within the modified state TDG standards . The TDG data is also used for management of involuntary spill during periods of high runoff, such as those experienced in 1996 and 1997.

4.4.4.8 RPA 18 calls for installation of spillway deflectors at IHR and JDA and investigation of gas abatement alternatives at all projects. Installation of spillway deflectors was studied for both projects in 1995 and 1996 and installation began at both projects in the winter of 1996-97. Installation is to be completed in the winter of 1997-98. At IHR, a decision on whether to install deflectors in the end bays (Spill Bays 1 and 10) is contingent on model studies ongoing at this time at the Waterways Experiment Station. Installation of spillway deflectors altered flow conditions at the entrance to the navigation lock and downstream in the navigation channel to the detriment of navigation. Corrective measures are being evaluated at this time. Upon completion of deflector installation at both dams, higher spill volumes will be possible before the 120 % modified standard will be reached. As stated in 4.4.3.3., the Action Agencies recommend the "spread the risk" policy and the spill for fish passage program should be revised.

4.4.4.9 Based on TDG studies related to IHR spillway deflector installation, the Corps is also considering installation of a training wall between spillway bays 9 and 10 at IHR. LGS, LMN, MCN, and BON Dams do not have deflectors in the outboard one or two spillway bays. Adult radio tracking studies (Bjornn, et al., 1997) indicate that installation of deflectors in the end bays and a training wall between bays 9 and 10 will have little effect on adult fish passage.

4.4.4.10 The Corps initiated a gas abatement study in response to RPA 18. Based on results of Phase I, the Corps agreed to install the IHR and JDA deflectors. The Corps also recommended Phase II of the study to evaluate long term strategies for reducing gas both at specific projects and system-wide. The Corps is scheduled to complete Phase II in 1999 or 2001 depending on ISAB recommendations for related research. If biological studies are required, Phase II will be completed in 2001. At the conclusion of Phase II, specific gas abatement strategies will be developed for reducing gas system-wide.

4.4.4.11 The gas abatement program is also evaluating the potential of incrementally reducing TDG by installation of flow deflectors in the end bays at Snake and Columbia river dams. The assessment, to be completed in 1999, will evaluate installation of deflectors in the end bays of spillways at LGS, LMN, MCN, TDA, and BON.

4.4.4.12 RPA 19 calls for installation of extended-length submerged bar screens (ESBSs) at LGR, LGS, and MCN. They were installed at LGR for the 1996 season, LGS for 1997, and phased installation occurred at MCN during 1996 and 1997. Consideration of installing ESBSs at LMN and IHR is on hold pending the 1999 decision on the LSRFS. Also, ESBSs are planned for installation at JDA in 1999 - 2001 and ESBS are being considered for BON and TDA.

4.4.4.13 At BON, the broad, shallow, segmented forebay leads to fish distributions that may not be conducive to passage by traditional JFF or by SBC. If is doubtful that FGE improvements will meet FPE goals. It is likely that intake screens, SBC, and spill will be required to meet the 80 % FPE and 95 % survival goals. Therefore, the BON1 SBC, BON2 corner collector, and BGS all need to be vigorously pursued.

4.4.4.14 Although TDA currently has no screened powerhouse intake system, 80% FPE can be achieved by sluiceway operation plus 64% spill although limited information suggests 30% spill may be sufficient (BioSonics, 1997b). The 95% survival goal is likely not being met by the current spill operation. Survival of PIT tagged fish passing through the spillway at 64% spill in 1997 was 85.9 +/- 6.4 % for coho and 92.5 +/- 7% for subyearling chinook (Dawley, et al., in press). Further study of FPE and survival at 30% spill is needed. Model studies indicate that relocation of the sluiceway outfall should provide high survival.

4.4.4.15 Research has shown that FGE for steelhead with ESBSs is typically 85 to 95%, 10 to 20% higher than with STSs. Therefore, the Action Agencies anticipate steelhead will benefit from ESBS installation.

4.4.4.16 ITS 2 calls for the Corps to evaluate spill patterns for juvenile fish passage at JDA in 1996. This has been accomplished and spill patterns were revised in 1996 and 1997. Installation of flow deflectors in 1997 and 1998 will require re-evaluation of the spill patterns. With ESBSs and flow deflectors installed, the BiOp FPE and survival goals may well be reached.

4.4.4.17 ITS 3 calls for providing separate station service for BON 1 and BON 2 so that either powerhouse can be operated to provide optimal juvenile fish passage over a range of river discharge levels. This action is scheduled to be completed in 1998.

4.5 Juvenile Fish Facility Operations for Adult Fish Passage

4.5.1 RPA 8 calls for extended operation of JFFs to minimize the mortality of adult salmon that fall back through the facilities. Facilities at the Snake River projects and MCN operate from 1 March through 31 October for juvenile fish passage and from 1 November through 15 December to protect adult fallbacks. It is not considered feasible to extend operation further because it is necessary to use the down time (16 December through February) for maintenance of the screens and facilities in preparing for the upcoming outmigration. This is reasonable because salmon migrations are essentially past the dams during the down time. Steelhead are present during the down periods, but cold water temperatures usually reduce their movement to practically nil. Therefore, the Action Agencies intend that the down time be retained so the facilities can be kept in good working condition and operated as intended during the primary fish passage times for juvenile steelhead, as well as salmon.

4.5.2 Some steelhead will survive after spawning and return downstream as kelts. Since the transportation program became operational in 1981, there has been sporadic discussion of the efficacy of transporting kelts that fallback through JFFs downstream. There is generally opposition to transporting kelts together with the same vessel with juvenile salmon or steelhead. Recent research (Kelsey, 1997) would indicate that their presence alone could be detrimental to salmon. It is also possible that they may prey on juvenile salmon in the barges or trucks. Consideration has been given to installing special tanks on barges for kelt transportation. However, it has been generally agreed that so few kelts would survive back to the ocean migrating in-river or by transport that the cost and interference with juvenile fish transport may make transport of kelts impractical. Kelt survival in passing through turbines or over spillways is unknown at this time. Unless the fishery agencies demonstrate there is a benefit from transporting kelts and there is strong regional support, the Action Agencies do not recommend modifying transport equipment and procedures for kelt transportation. Kelt passage information will continue to be generated by using adult fallback counts at collector dams and at dams where sampling facilities allow inspection of fallback adult salmon and steelhead.

4.6 Temperature Control in Fish Ladders

4.6.1 ITS 18 states that the Corps shall provide water temperature control in fish ladders and it required a prototype test. The Corps proposed, and the regional forum concurred, to delay the schedule for this measure. The delay was necessary to gather additional fish ladder temperature data to better define whether there were temperature related fish passage problems and, if there were, to determine what type of prototype test was needed. Studies were initiated in the Snake River (Bjornn et al., 1997) and lower Columbia River (Dalen, et al., 1995, 1996, 1997*) to evaluate water temperatures in the fish ladders. Two years of data have been collected and a third year is scheduled for 1998. Results at BON and TDA indicate no differences between forebay and tailwater temperatures through the ladder systems. At JDA, there is a temperature difference between forebay and tailrace through the ladder system through most of the fish passage season. The difference may be as much as 3.5 ° Celsius with warm forebay water cooling as it moves down the ladder. Cooler water is introduced by floor diffusers from auxiliary water supplies pumped from the tailrace. This cooling of the water may be beneficial to adult salmon as they move from cooler to warmer water gradually, and may have time to acclimate to the temperature change. The Corps will coordinate information available in 1998 to determine whether addition information is needed, or whether sufficient information is available to determine engineering alternative measures that could mitigate fish ladder temperature problems, if any exist.

4.6.2 The Corps began monitoring fishway temperatures at BON, TDA, and JDA in 1994. In subsequent years, the Corps expanded that monitoring to include the tailrace, multiple forebay depths, and all sources of AWS input into the fishways, as well as the John Day River and John Day Reservoir above the John Day River. In short, no temperature differences greater that 0.5 ^{o}F were found between forebay, fishway, and tailrace locations for BON and TDA dams. At JDA in 1996, temperature differences greater than 0.5 ^{o}F occurred within the south ladder 22 % of the time and 5 % of the time in the north ladder. At the south ladder, the trend was to go from a warmer forebay surface temperature and gradually cool as it proceeds down the ladder to a cool tailwater temperature. The occurrences greater than 0.5 ^{o}F from surface forebay to tailwater (greatest differences) averaged 1.4 ^{o}F with a high of 3.0 in 1996. In 1996, 1995, and 1994, respectively, fishway temperatures reached highs of 70.0, 71.2, and 72.0 ^{o}F at BON, 70.0, 71.6, and 72.0 ^{o}F at TDA, and 74.5, 74.4, and 72.0 at JDA.

4.6.3 Coincidentally, cool water releases from Dworshak Reservoir (RPA 1.g.) cooled off the Snake River possibly reducing water temperatures that would have been otherwise desired. Available information suggests that the needs citation extent of any temperature problem in fish ladders is less than originally thought and has improved as a result of recent operations of Dworshak Reservoir. The Action Agencies are concerned that unwarranted modifications could result in delays of passage through fish ladders, migration barriers, crowding, and/or thermal shock to fish; conditions which do not now appear to exist.

4.6.4 A work group on management of water temperatures in the Columbia River Basin has been organized. Participants include the US Environmental Protection Agency, Corps, NPPC, States of Idaho, Oregon, and Washington, Columbia River Inter-Tribal Fish Commission (CRITFC), US Geological Survey, NMFS, USFWS, BPA. and USBR. This work group is investigating: 1) whether annual and diurnal temperatures in the Columbia/lower Snake have changed over time; 2) how much temperature change in the Columbia/lower Snake is due to dams and reservoir operations; 3) whether there are significantly different temperatures in reservoirs and fish passage facilities; 4) what the potential effects of temperature changes are on fish and other aquatic life; and 5) whether there are potential solutions to improve main stem water temperatures; and 6) relationship of the Lower Snake and the Columbia Rivers to the total Columbia River Basin ecosystem relative to existing water temperature and ability to effect changes.

4.6.5 Pending the findings of the studies and activities of the work group described above, the Action Agencies are not proposing any changed beyond existing operations for control of water temperatures within the FCRPS.

4.7. Juvenile Fish Facility Operations

4.7.1 RPA 7 calls for operation of JFFs according to the FPP. The Corps operates the JFFs in accordance with the FPP, which is reviewed and updated annually by fishery agency, tribal, BPA, Corps, and NPPC representatives through the FPOM. Project personnel maintain JFFs according to the FPP within the constraints of personnel and funding at the projects. Collection and bypass facilities in the JFTP are operated in accordance with ESA Section 10 Permit No. 895 issued to the Corps by the NMFS. Bypass facilities at IHR are operated under ESA Section 10 Permit No. 996. Criteria established for operation of these facilities are aimed first at protection of listed Snake River salmon. Second, they provide similar protection to the now listed steelhead and to other unlisted salmonids and other migrating species. The Smolt Monitoring Program biologists have ESA Section 10 permits for handling fish at the projects. It is expected that facilities will continue to be operated to benefit listed species. A new ESA Section 10 Permit will be requested for the JFTP and operation of the juvenile fish bypass at IHR for 1998 and future years. Because the JFFs are operated and maintained to benefit chinook and sockeye, which are equally or more susceptible to injury and stress than steelhead, it is assumed that maintenance of the JFFs to standards acceptable for listed salmon will be equally acceptable for listed steelhead.

4.7.2 RPA 12 calls for improved FGE at BON First Powerhouse (BON1). In 1988, FGE was 55% for coho, 41% for yearling chinook, 11% for subyearling chinook, and 56% for steelhead. Spill volumes are limited to 75 kcfs during the day, and 120 kcfs at night to avoid surpassing the 120% TDG modified standard. The spill limits, plus low FGE at both powerhouses (41% at BON2), prevent the Corps from achieving 80% FPE. At a typical 275 kcfs spring discharge, steelhead FPE would be about 66%. In 1996, the Corps initiated investigations. ESBSs, streamlined trashracks, and new vertical barrier screens (VBSs) have been designed and will be tested in 1998. Hydroacoustics and fyke nets will be used to estimate FGE. Although fyke nets will result in some fish mortality, they will ensure species specific FGE data. If FGE does not reach 80%, relocated trashracks and other measures will be evaluated.

4.7.3 Results of the 1998 test are critical because the JFF is being upgraded. The downstream migrant channel is being redesigned to increase safety for fish. Design is at the 30% level and installation is scheduled for 2001. Additionally, the JFF outfall will be relocated. Concurrently, the Corps is evaluating installation of a surface collector system at BON1. If that option is selected, installation would be completed by 2006.

4.7.4 The Corps proposed a BON2 FGE improvement study for 1998, however, the SCT did not prioritize the study high enough for it to be funded. The JFF, smolt monitoring facility, and new outfall for BON 2 have all been designed. The new outfall and JFF will be ready for the 1999 outmigration and the smolt monitoring facility will be ready for the 2000 outmigration. After these improvements are made and evaluated, improving FGE will become more critical if the new JFF and outfall location significantly increase survival compared with the old juvenile fish bypass pipe (Dawley, et al., 1989).

4.7.5 ITS 6 calls for improvement on hydraulic conditions in the BON1 and BON2 JFFs by the year 2000. The Action Agencies believe that modifications addressed under RPA 12 will resolve this concern.

4.7.6 At BON2, the Corps is investigating the use of a behavioral guidance structure (BGS) to guide fish to the spillway. If a surface collector system is developed at BON2, it could be operational in 2005.

4.7.7 RPA 19 calls for installation of ESBSs at LGR, LGS, and MCN Dams. ESBSs were installed at LGR by the spring of 1996, and at LGS by the spring of 1997. A partial installation occurred at MCN Dam in 1996, with completion by the spring of 1997. Studies to install ESBSs at LMN and IHR are on hold until results of the surface bypass collector (SBC) studies are obtained.

4.7.8 RPA 20 calls for investigating installation of new juvenile fish facilities at LGR by 1997 or as soon as possible thereafter. The Corps determined that the necessary engineering, design, and construction could not be completed by 1997 and proposed a phased construction program to complete a new flume and separator in 1998 and a collection channel and orifice modifications in 1999. However, the regional forum has determined that this modification should be delayed until the 1999 SRFS decision has been made. In view of new information on the inter-specific interactions of steelhead and chinook (Kelsey, 1997), it may be wise to reconsider modification of the LGR JFF. This study shows negative effects to juvenile chinook resulting from being collected, held, and transported with steelhead. Since part of the modification to the LGR JFF was to include installation of a separator to partially segregate larger steelhead from smaller chinook, this new facility would lessen stress to chinook.

4.7.9 RPA 21 calls for installation of ESBSs at JDA. They were tested at JDA in 1996 and FGE, estimated by conventional methods (fyke nets), was 94.1 +/- 1.8% for steelhead, 84.0 +/- 1.6% for yearling chinook, and 60.2 +/- 6.3% for subyearling chinook (Brege et al., 1997*). Descaling was low (<0.5%) and orifice passage efficiency was high (> 97%). Hydroacoustic estimates of FGE were 92 +/- 1.3% for spring fish and 75 +/- 0.7% for summer fish (BioSonics, 1997a*). A set of redesigned ESBSs was tested at JDA in 1997, but cracks were found in perforated plates after 1 week of operation. These structural problems have delayed full installation until 1999. The Action Agencies propose to continue installation of a full compliment of ESBSs at JDA starting in 1999, and recommend reduction or elimination of spill to meet FPE requirements from the 1995 BiOp. The Corps is also studying surface collection at JDA with the possibility of using skeleton bays as part of the bypass system. If this option is pursued, installation could be completed by 2006.

4.7.10 RPA 22 calls for installation of juvenile fish sampling systems at JDA and BON. Juvenile fish bypass and sampling facilities are under construction at JDA with completion due by the spring of 1998. At BON, construction is to be complete by the spring of 2000. PIT tag detection systems are scheduled to be in place for the 1999 outmigration.

4.7.11 RPA 23 calls for installation of permanent juvenile fish outfalls below BON1 and BON2 by 1999. The Corps has contracted for completion of a new outfall below BON2 by 1999 and is designing a new outfall for the BON1 JFF. The Action Agencies assume that these outfalls will provide higher survival than current outfalls for salmon and steelhead.

4.7.12 RPA 24 calls for continued investigation of bypass technology at TDA and installation by 1999. Installation of a new JFF is dependent upon results of prototype tests of a SBC. The Corps is continuing the studies.

4.8 Juvenile Fish Transportation

4.8.1 Juvenile salmon and steelhead transportation has been studied in the FCRPS since the late 1960s (Ebel, 1970; Ebel, et al., 1971-74; Ebel, 1974; Park and Ebel, 1975; Park, et al., 1976-86; Park, 1980; Park and Athearn, 1985; Park, 1993; Matthews, et al., 1985-92;

Achord, et al., 1992; Harmon, et al., 1989-96; Marsh, et al., 1996b; Marsh, et al., 1997). Until 1980, the program was experimental, conducted by the NMFS while they researched the potential impacts and benefits of the program. In 1981, the program became operational under the Corps. Continuous research and development of handling methods and facilities have improved development up to 21 million fish in a single season (1990) and survival through the collection systems and in transport vehicles has been consistently 99% or greater (Spurgeon, et al., 1997*). Over 20 years of research data for yearling chinook and steelhead have, in the preponderance of years, shown that transport provided 2.5 to 3 times better survival to adult returns than in-river passage. At the present time, transportation provides the highest survival through the FCRPS of all available options. The SRFS is comparing existing FCRPS conditions, improved bypass systems (SBCs), and drawdown of the lower Snake River reservoirs for a decision in 1999 on which option gives the best potential for recovery of Snake River salmon. Until that decision is made, or until drawdown is implemented if it is the outcome of the SRFS, the Corps and BPA believe that maximization of the transportation program would be the best interim method of maximizing steelhead survival through the FCRPS.

4.8.2 RPA 9 calls for enlargement of the exits on existing fish barges by 1997. All six of the Corps fish barges were modified on schedule (Corps, 1997b). While definitive data was not obtained supporting this modification, it was the expert opinion of the researchers studying the barging program (Schreck, et al., 1997*) that this was an improved condition. NMFS assumed that reducing the unloading time from 4 minutes to less than 1 minute reduces stress to the fish from fighting the current as the tanks drain. Any beneficial effects should extend to steelhead as well as salmon.

4.8.3 RPA 25 calls for the Corps to evaluate the number of additional fish barges required to provide direct loading at the four collector dams. The evaluation, completed in 1997, indicated that three additional 150,000 gallon barges are needed to allow direct loading at LGR and LGS. To provide direct loading at LMN requires three additional 100,000 gallon barges. To allow direct loading at MCN requires three more 100,000 gallon barges. The two 86,000 gallon barges are over 50 years old, and the hulls will not stand further modification. Therefore, as part of the plan outlined above, they would be replaced with 100,000 gallon barges (Corps 1997b). A total of three 150,000 and six 100,000 gallon barges would be added to the six barges now in use. Two 150,000 gallon barges are under construction at this time. Further construction is on hold at the request of regional fishery and tribal managers pending a 1999 decision on the LSRFS. As discussed in Section 4.8.1, transportation is recommended for two of three options under the LSRFS. If drawdown was the preferred option, it would take several years to implement, and transport would maximize survival until each collector dam was removed from operation. Therefore, the Action Agencies recommend that acquisition of all of the barges proceed as soon as possible in order to be able to maximize survival of juvenile listed salmon and steelhead if that measure is hereafter adopted by NMFS and the action agencies.

4.8.4 ITS 12 calls for the Corps to find and remedy sources of water pollution within fishways and collection systems. Such pollution sources have been determined and re-routed to non-fishway disposal areas. Routine monitoring is conducted for pollutants in gate wells and remedial action is taken as needed.

4.9 Studies of Future Potential Actions

4.9.1 Surface Bypass Collection

4.9.1.1 RPA 11 calls for the Corps to study a new method of bypassing juvenile fish at dams. Based on the success of the Wells Dam concept of having spillway bays located over turbine intakes (the Wells hydrocombine concept), the Corps began investigating methods of simulating the Wells condition at Corps dams. This began in 1994 with a brainstorming session comprised of fish passage experts from the region. In 1995, the CENWW quickly constructed and tested slot types at IHR. Based on the 1995 BiOp, the CENWW expedited construction of a test structure, the SBC, and further tested slot types with spring migrants in 1996 at LGR. The SBC was modified and re-tested in 1997 with spring and summer migrants and is being further modified for 1998 tests. A floating behavioral guidance structure (BGS) 1,100 feet long and up to 80 feet deep is being tested to see if it can guide fish to the surface bypass collector.

4.9.1.2 Thus far, the SBC technology, in combination with screens at LGR, has proven better than existing screen systems alone at guiding fish around turbines. Using the SBC, combined guiding efficiency (the SBC in combination with the powerhouse fish screen system) of approximately 92 % was obtained in 1997 (Johnson, 1997; Adams, 1997). However, significant numbers of fish went under or around the SBC to be guided by the powerhouse screens or pass through the turbines. For the 1998 tests, the SBC is being modified to more closely resemble the Wells intake shape and hydraulic conditions, and a BGS is being installed to guide fish from the south half of the powerhouse toward the SBC. It is anticipated that higher percentages of fish will be guided by the BGS and SBC in the 1998 tests If this is not possible, it still appears that 1995 BiOp FPE targets can be met by the SBC/powerhouse screen system.

4.9.1.3 SBC programs have also been developed for each powerhouse and spillway at BON, TDA, and JDA. However, progress has been hampered by shifting funding priorities in the region. A prototype SBC is scheduled for testing at BON1 in 1998. The structure will allow testing of a variety of entrance conditions including deep slots, a hybrid system with turbine intake screens, and incorporation of the sluiceway in the SBC. A corner collector, in conjunction with a BGS, was developed to the Letter Report stage in 1997 for BON2, however it was not funded for 1998.

4.9.1.4 In 1995 and 1996, turbine intake blocks were tested at TDA because previous tests had indicated that such blockages might increase sluiceway passage (BioSonics, 1997b). Further work on testing and refining turbine intake blocks has not been funded. However, work is continuing on relocating the sluiceway outfall in anticipation that its use as a bypass will continue and may increase as SBC technology develops.

4.9.1.5 In low flow years when spill volumes are small, delay of the outmigration has been documented (Sheer, et al., 1997*). Spillway weirs were developed at JDA to provide stronger surface flow to spillway gates. High flows in 1996 and 1997 precluded the need for testing of this concept. However, spillway weirs have the potential to provide benefits to outmigrating salmon and steelhead in low flow years. No funding of SBC development is available for JDA in 1998.

4.9.1.6 A Feature Design Memorandum is near completion for development of a shallow spillway in the JDA skeleton unit area. Hydraulic model studies (Sheer et al., 1997*) and other studies indicate that this option could provide high passage efficiencies at low discharge.

4.9.1.7 Based on the research at LGR, eight combinations of SBC installations are being considered for the SRFS. Options include full powerhouse SBC installations, partial powerhouse SBCs with BGSs to guide fish to spillways or other bypass systems, improved FGE through installation of ESBSs at more dams, and combinations of the above installed at the dams as appropriate. The Action Agencies believe that SBC technology currently being developed has the potential to increase FPE above the 80% target set for yearling chinook in the 1995 BiOp at all FCRPS dams. Survival for yearling salmon and steelhead passing FCRPS dams is generally over the 95 % BiOp target with existing bypass technology and spill. Preliminary results indicate that the 95% criterion may be exceeded at all dams with SBC technology. Therefore, the Action Agencies intend to continue development of SBC technology until the LSRFS decision has been made.

4.9.2 Lower Snake River Feasibility Study

4.9.2.1 RPA 10 calls for the Corps to evaluate the feasibility of drawing down the lower Snake River reservoirs by the year 1999. A comprehensive feasibility study is underway. The alternatives are: 1) continue the operation of the existing facilities; 2) improve fish guidance through implementation of SBC technology; and, 3) draw the four lower Snake River Reservoirs down to natural river level. This study is approximately 30 % complete at this time. It is scheduled to be complete to the decision making stage by the end of 1999. Extensive inter-agency and regional involvement is taking place through various committees looking at economic impacts, biological impacts, impacts to recreation, impacts to fish and wildlife, anadromous fish impacts, and so forth. The process is relying heavily on the PATH process for evaluation of anadromous fish impacts and benefits. A recommendation will be made from the feasibility study by the end of 1999, as required by the 1995 BiOp. The Congress of the United States will make a decision, based on regional recommendations, on which of the three options listed above will be implemented. The Action Agencies will implement the selected option as approved and funded by the Congress.

4.9.3 Turbine Improvements

4.9.3.1 CR 5 recommended that the Corps and BPA establish a program to develop improved turbine designs to maximize juvenile fish survival. This process, lead by the Corps has resulted in numerous workshops, revised turbine designs, construction of turbine models both at the WES and in Austria. Design improvements have demonstrated the potential to reduce fish mortality. These designs have been incorporated to some degree into the ongoing rehabilitation of BON 1 turbines. However, more recent studies indicate that turbine survival may be considerably higher than thought in the past. Where 85% survival was the regionally accepted value in the 1970s and 80s, studies in the 1990s have shown near 95% survival in some cases.

4.9.3.2 Current evaluations to replace worn out turbines include consideration of installing more efficient turbines (IHR Rehabilitation, for example). However, the great cost of turbine replacement prohibits putting in new ones before it is necessary. Therefore, the region has placed a lower priority on more efficient turbines since they compete with other fish protective measures for limited funds.

4.9.3.3 The Action Agencies assume that, when more efficient turbines are installed, steelhead, chinook, and sockeye that pass through turbines will benefit. Currently, it appears to the Action Agencies that installation of high efficiency turbines would benefit both fish and hydropower and high priority should be placed on installing high efficiency turbines as a long range goal. The Action Agencies propose further review of the status of high efficiency turbines and suggest review of rehabilitation schedules.

4.9.4 Research and Monitoring Activities

4.9.4.1 RPA 13 calls for the BPA, Corps, and USBR to participate in a coordinated effort with the NMFS, ISP, NPPC, Hydropower Management Work Group, state fishery agencies, and tribes to develop a comprehensive monitoring, evaluation, and research program. For the most part, regional coordination is accomplished through the processes detailed in Section 4.1.1. The Corps' AFEP process, and the NPPC's Independent Scientific Review Group afford the regional fishery agencies and tribes (Columbia Basin Fish and Wildlife Authority) the opportunity to provide input. Under AFEP, there are two sub groups, the Studies Review Work Group, and the Fish Facility Design Review Work Group. With the ESA listing of steelhead, the Action Agencies anticipate that research primarily focused on chinook may be re-focused to some degree on increasing steelhead survival.

4.9.4.2 RPA 13.a calls for continuation of the SMP. This program is funded by the BPA, and is conducted at various fish traps in the tributaries above the dams and at the juvenile fish facilities at the dams. Smolt monitoring has always included steelhead, though some of the PIT tag monitoring of passage times and rates may be expected to refocus on steelhead. ITS 4 calls for BPA to provide for sampling at all dams with sampling facilities. Whether through the SMP or

JFTP sampling is being carried out at all Corps dams with sampling facilities. No change is proposed by the Federal action agencies.

4.9.4.3 RPA 13.b calls for focus on the effects of smolt density as a prey base in the lower Columbia River and estuary. Research programs have been expanded to address this RPA through ongoing investigations for dredged material disposal funded by the Corps. The Corps has funded the NMFS, to investigate PIT tag recoveries in the estuary. The Caspian tern study (Roby and Collis., 1997*) indicates that 6 to 20 million juvenile salmon and steelhead, up to 10% of the total population, are taken by one species of predator in the estuary (see 4.9.4.4. below).

4.9.4.4 RPA 13.c The BPA, USBR, and Corps were asked to investigate the relationship between when the juvenile fish reach the Columbia River estuary and ocean, and the abundance of nutrients and prey. With the limited information available, PATH is attempting to test hypotheses related to ocean survival. Additional research and information are needed.

4.9.4.5 RPA 13.d The BPA, Corps, and USBR are asked to cooperate in investigations of the relationship between salmon abundance and fluctuations in estuarine and ocean environments. Again, PATH is addressing this from a modeling standpoint, but additional empirical data is needed.

4.9.4.6 RPA 13.e The BPA, Corps, and USBR are asked to cooperate in investigations of environmental conditions in the estuary and near-shore ocean. Again, PATH is addressing this from a modeling standpoint, but additional empirical data is needed.

4.9.4.7 RPA 13.f The BPA was asked to fund evaluation of in river juvenile salmon. The NMFS has conducted PIT tag studies in accordance with this request. Survival rates for juvenile salmon have been calculated (Muir, et al., 1995*; Muir, et al., 1996*). Results have been summarized (Williams and Matthews, 1995*; Williams, et al., 1997*). Williams, et. al. (1997*) found that in river survival has increased significantly since the 1970s, and that operation of the hydropower system is probably not the limiting factor on the recovery of the Snake River salmon For this BA, it is assumed that improvements made for increasing the survival of juvenile salmon have similarly increased the survival of juvenile steelhead.

4.9.4.8 RPA 13.g The NMFS, in consultation with the BPA, Corps, USBR, state fishery agencies and tribes are asked to evaluate the value of pulsing flows to improve in-river survival of migrating juvenile salmon. High flows in 1996 and 1997 have precluded any opportunity for performing these studies.

4.9.4.9 RPA 13.h The BPA is asked to study the effects of competition between wild salmon and introduced species and hatchery salmon.

4.9.4.10 RPA 14 calls for the BPA to continue funding studies of predator control. The BPA has funded the Northern Squawfish Management Program since 1991. Since then, over 1.2 million northern squawfish have been removed from the FCRPS. This equates to an average annual exploitation rate of approximately 12 percent of the juvenile outmigration. Biological evaluation indicates a 42 percent reduction in predation compared with pre-program levels (Ward, in press).

4.9.4.11 RPA 15 calls for the Corps to initiate studies of fish passage improvements to obtain 80 % FPE, and 95 % survival at each dam. The Corps' Columbia River Juvenile Salmon Migration Program addresses this RPA. Juvenile fish facilities have been upgraded (LGS 1989, LMN 1992, MCN 1994, IHR 1995). Thes modifications have reduced stress and improved fish survival through the systems (Monk, 1992; Gessel, 1993; Marsh, et al., 1996a; Gessel, 1997). Plans to modify the LGR facilities by 1996 were slipped to 1998, then postponed until after 2000 at the wishes of the fishery agencies and tribes. As a result of improvements, facility mortalities at MCN have been reduced to less than 1 %, while facility mortalities at IHR, LMN, LGS, and LGR are typically less than 0.5 % (Spurgeon, et al., 1997*). The 80% FPE goal has been achieved by installing ESBSs at LGS, but some voluntary spill is required to get 80% FPE at LGR (78% FGE) and MCN (79% FGE) with ESBSs, and at LMN (61% FGE) and IHR (71% FGE) with STSs for wild yearling chinook (PATH, 1997*). Spill is also required at JDA and BON, which have STSs, but are being evaluated for installation of ESBSs. Studies are continuing at TDA to determine whether STSs or ESBSs or some other alternative (SBC) would provide the best juvenile fish bypass system.

4.9.4.12 Survival of 95 % or greater can be achieved at each dam using ESBSs, STSs, and operation of turbines at least mortality levels. However, where guidance rates for subyearling chinook remain below 80 %, voluntary spill up to the 120 % TDG levels mandated by state water quality agencies is used to raise the FPE. In such cases, dam survival rates may be greater than 95 %, but reservoir survival rates may decline due to gas bubble trauma to the fish (Cramer, 1996; Smith, 1996).

4.9.4.13 Since steelhead typically guide 10 to 15 % better than yearling chinook, fish facility improvements made for yearling chinook probably incrementally improve conditions for steelhead. In the case of spill, this may be counter productive. Steelhead have been shown to be more susceptible to gas bubble trauma than chinook (FPC, 1997*).

4.9.4.14 ITS 10 called for hydroacoustic evaluation of juvenile fish passage at IHR in 1995. This was accomplished in conjunction with preliminary tests of SBC slots at IHR. Hydroacoustic and radio tracking information was obtained in 1995 and 1996 (Swan, et al. 1995*; Swan, et al. 1996*)

4.9.4.15 RPA 18 calls for the Corps to develop a gas abatement program. The Corps has initiated a system wide program investigating methods of reducing gas super saturation levels caused by spill at Corps dams. As an initial step, at the urging of the fishery agencies, the Corps has undertaken installation of spillway deflectors at JDA and IHR. Partially completed in the winter of 1996-1997, construction at JDA will continue in the winter of 1997-1998. IHR Bays 2-8 have been completed in 1997. A decision will be made this winter whether to install deflectors in spillway bays 1 and 10 at IHR. Measures required to mitigate the impacts of surface spill (caused by the deflectors) on navigation will be installed in 1998.

4.9.4.16 Other measures being studied include raising stilling basins, side spillways, submerged tunnels or siphons under spillways, and other major construction projects. Because of funding restrictions in the Fish and Wildlife Program, the SCT has recommended no funding for biological studies and evaluations in 1998. However, the Corps and agencies continue to work toward the goal of reducing gas levels to the 110% level when involuntary spill occurs in the future. It is assumed that measures to reduce gas super saturation would benefit steelhead equally or more than for salmon.

4.9.4.17 CR 1 recommends continued evaluation of adult fish spill patterns. This is accomplished in part by the adult fish radio tracking program (Bjornn, 1997*). However, with installation of spillway deflectors at IHR and JDA, and, with delays encountered in 1996-97 due to high flows, information from this study has become more critical for setting interim spill patterns. Adjustment of spill patterns for adult fish can be expected to continue in the future as facilities change, flows vary, and operational changes to the system are recommended by the fishery agencies and tribes.

4.9.4.18 CR 2 calls for the Corps, BPA, and USBR to further investigate adult fish passage with emphasis on the lower Columbia River projects for: (1) "baseline" survival rates for adult salmonids migrating upriver through free-flowing reaches of the Columbia and Snake rivers; (2) mortality and interdam losses; (3) entrance to fishways during periods of medium and high spill levels; (4) investigation and improvement of adult fishway hydraulics; (5) evaluation of the magnitude of adult passage through navigation locks; and (6) evaluation of the effectiveness of adult passage orifices. With the exception of item (4), these are being addressed in part by the adult fish radio tracking program (Bjornn, 1997). The hydraulic studies are being carried out or have been completed by Corps hydraulic engineers. Results have been or will be provided to NMFS when received.

4.9.4.19 CR 3 calls for further study of adult fish passage problems at JDA and further implementation of a project improvements program. This is being carried out by the Corps. In particular, auxiliary water supplies and steelhead jumping problems are being addressed. Results will be provided when the become available.

4.9.4.20 CR 4 calls for continued monitoring of fall chinook spawning in the Snake River below LGR Dam. This study has been carried on since 1995 by the Natural Resource Conservation Service (NRCS) and Battelle Laboratory researchers. Results have been instrumental in the location of the new LGS outfall, for example. While it is assumed that these studies will continue, no effect is expected on steelhead as a result of these studies.

4.9.4.21 CR 6 calls for the Corps and BPA to develop a regional research facility for study of fish passage concepts at the dams. The Corps has evaluated this concept and developed proposals for a regional facility. However, the Action Agencies have given this conservation measure low priority.

4.9.4.22 ITS 7 calls for evaluation of modifications to fish bypass and collection systems. The Corps routinely has NMFS researchers evaluate new facilities, first for removal of physical obstructions or protrusions, and secondly for levels of stress caused by the new system to fish. This practice would continue with all new major construction.

4.9.4.23 ITS 8 calls for the Corps to evaluate short-haul barging for release of juvenile fish from bypasses at the dams. This concept has been evaluated and placing outfalls in locations where predators should not concentrate has been the preferred option in most facility designs. Such designs are coordinated with the fishery agencies and tribes through the FFDRWG and alternatives have been selected through this process.

4.9.4.24 ITS 9 calls for the Corps to conduct studies of Caspian tern predation on juvenile salmonids below Bonneville Dam. The Corps and BPA have jointly funded at study by the Oregon Cooperative Wildlife Research Unit and CRITFC. Roby and Collis (1997) have identified tern predation as a significant source of mortality to juvenile salmonids below Bonneville Dam. The Caspian Tern population of Rice Island is comprised of over 8,000 nesting pairs which consumed 6 to 20 million smolts in 1997 (Roby and Collis, 1997), comparable to the 15.2 million estimated consumed by northern squawfish in 1996 (Beamsderfer, et al. 1996). The Caspian tern population has increased over 600% in the last 12 years, nesting on newly deposited dredged material (Rice Island). In the November 1997 PTAGIS Newsletter, Collis reported that "Steelhead and hatchery-reared fish appear to be most vulnerable to tern predation as compared to other salmonid species and rearing types."

4.9.4.25 ITS 11 calls for BPA to evaluate the affect of power peaking on juvenile and adult salmon passage and on river ecology below Bonneville Dam and in the Hanford Reach. Results from ongoing adult passage evaluations (CR 2) will provide the basis for potential future assessments of the effects of power peaking on adult passage from 1999 - 2000. Reductions in project and system-wide operating flexibility that resulted from measures of the 1995 BiOp have reduced opportunities for further reductions in power peaking.

4.9.4.26 ITS 14 calls for the Corps, BPA, and NMFS to complete development of adult fish PIT tag detection systems at mainstem dams. Both 134 and 400 kHz conventional round (wrapped flume) adult detectors will be installed and evaluated at the Bonneville Fisheries and Engineering Research Laboratory in 1998. Research on 134 kHz flat plate adult detectors will continue, with potential installation at PRD and IHR in 1999 for the 2000 outmigration.)

Section 5.0 1998 And Future Operation Of The Federal Columbia River Power System

5.1 Regional Coordination

5.1.1 In order not to jeopardize the listed salmon and steelhead stocks and to allow other stake holders in the region to have input into the process, the action agencies plan to continue using the regional coordination mechanisms that have been set up for the implementation of the 1995 BiOp. These organizations include the SCT, IT, and EC. Further, the TMT will continue the day-to-day coordination FCRPS operation of FCRPS during the fish passage season. The Corps' fish research will continue under the AFEP program, and BPA funded research should continue under the purview of NPPC's ISAB. Fish facilities should continue under review of the FFDRWG, and operation/maintenance of fish facilities under the FPOM. Review of data for incorporation into models for decision making should continue under the PATH process. The FCRPS managers strongly urge that these guiding bodies make use of the scientific data and information that has been and is being developed in relation to the recovery of Snake River salmon and steelhead, and upper Columbia River steelhead.

5.2 Flow Augmentation Measures

5.2.1 It is the intent of the Action Agencies that storage volume and flow augmentation strategies identified in the 1995 BiOp continue to be provided by the FCRPS. Flows would be adaptively managed in coordination with the TMT for the best benefits to listed steelhead, salmon, sturgeon and other species. The FCRPS managers agree to continue to work with the fishery managers under the TMT process to provide flow augmentation.

5.3 Reservoir Drawdown

5.3.1 It is the intent of the Corps to continue the operation of the lower Snake River reservoirs near MOP, and John Day Reservoir to a lower level that provides for both fish irrigation, as described in the 1995 BiOp, except for short durations in the event a decision is made hereafter to maximize transportation. Such operations would be limited to when flows are such that remaining at MOP would force short duration spill to occur due to lack of market.

5.3.2 It is intended that the SRFS will continue to completion in 1999 so that a decision can be made to either: 1) continue operation of the lower Snake River dams with minor improvements to fish facilities and bypass systems; 2) continue operation of the lower Snake River dams with major modifications to develop surface bypass systems at the dams; or 3) remove the earth fill embankments or otherwise excavate channels around the four lower Snake River dams and return the river to its natural channel. It is intended that a scoping level study be completed on the drawdown of John Day Reservoir to spillway crest or to natural river channel by early 1998. The FCRPS Action Agencies are confident that these studies will reveal the best alternative for the preservation of the listed species.

5.4 Temperature Control in Reservoirs

5.4.1 It is intended that activities described in section 4.3.2 would continue for modification of water temperatures in the Snake River reservoirs. Use of storage from Dworshak and Brownlee. Reservoir, has moderated temperatures in the lower Snake River in the summer and early fall. It is intended that evaluation continue to assure that storage is being used to the best advantage of the listed Snake River salmon and steelhead.

5.5 Turbine Operations for Fish

5.5.1 The Corps and BPA intend to continue operating turbines within 1% of peak efficiency until an alternative is developed that better protects listed species. The best available scientific information indicates that operation of turbines as specified above maximizes survival of juvenile salmon and steelhead passing through turbines (Normandeau, 1997; Williams, et al., 1997). Furthermore, the Corps is involved in research both in Austria and at WES in Mississippi investigating turbine designs to further minimize juvenile salmonid mortality. Should such technology be developed, it is the intent of the FCRPS managers that improved turbine technology would be incorporated at Corps dams as turbines wear out and are replaced.

5.6 Adult Fish Facility Operations

5.6.1 The AFF operations have been fine tuned to protect listed Snake River salmon. However, because steelhead migrate into the Columbia River system through the summer and fall, operation of AFFs is often more critical to steelhead near the end of one season and at the beginning of the next season. Steelhead often over-winter in the reservoirs or in the fish ladders and, consequently maintaining ladder operations to FPP criteria is important for their survival. When fish ladders are dewatered in the winter for maintenance, dewatering periods are limited to the extent possible to minimize impacts to steelhead. When ladders are dewatered, precautions are taken to drain the ladders in a manner that allows steelhead to exit the ladders, and measures are taken to salvage any steelhead trapped in the ladders as they are dewatered. At projects with more than one fish ladder, one is generally kept in operation at full criteria while the other is down for maintenance. At BON, fish ladders at one powerhouse are generally operated at full criteria while fish ladders at the other powerhouse are dewatered. The Corps has adopted procedures that are described in the FPP for such protection of steelhead, particularly for salvage operations during facility unwatering. As soon as winter maintenance is completed, the ladders are out back in operation so steelhead can continue their migration to the spawning grounds or hatcheries. Winter maintenance periods are minimized by the Corps for this purpose.

5.6.2 In addition to current operations, the Corps is investigating provision of reliable auxiliary water supplies for adult fish facilities. The study has been completed at MCN Dam, and the Corps is proceeding with rehabilitation of the almost fifty year old fish pumps. Further studies are underway to evaluate the Snake River adult fish facility water supplies. If rehabilitation of adult fish facilities is required, actions will be prioritized.

5.6.3 It is the intent of the FCRPS managers that operation of the adult fish facilities continue under the purview of the FPOM, and that modifications of operations be incorporated in the Corps' FPP.

5.7 Juvenile Fish Passage Operations

5.7.1 Research by NMFS and others has consistently shown that steelhead are guided better than chinook by turbine intake screens, they typically survive handling and transportation with less stress and mortality and they consistently return at higher rates in studies comparing in-river passage with truck and barge transportation. However, recent studies indicate they are more susceptible to gas bubble trauma than spring/summer chinook. Recent studies have also shown that collecting and transporting steelhead with chinook causes stress to chinook (Kelsey, 1997). Therefore, a number of changes in operations for juvenile fish passage may be necessary to benefit both steelhead and chinook. Any such change will be made based upon recommendations by NMFS resulting from this consultation or through the AMP.

5.7.2 In 1997, juvenile fish were collected and transported from LGR, LGS, and LMN. Fish were bypassed at MCN Dam until the spring chinook migration was past, then fish were also transported from MCN Dam. With consistent evidence that juvenile steelhead benefit more from transport than yearling chinook, a predominance of evidence that yearling chinook benefit from transport, it is recommended that transportation of steelhead and chinook be maximized from the three Snake River dams and MCN Dam during both the spring and summer migrations, and that consideration should be given to such maximization by NMFS during this consultation or through the AMP. This is especially important to upper Columbia River steelhead which have been forced to migrate in river without benefit of transportation since implementation of the 1995 BiOp.

5.7.3 As part of the study to evaluate transport, as directed by the 1995 BiOp, in river conditions were "optimized" in 1996 and 1997. On the belief of the fishery agencies that spill is beneficial for in river survival, spill was provided up to 120% TDG (the TDG level granted by the state water quality agencies above their normal 110% TDG standards) on the belief that in river survival would be maximized voluntary. In addition to spill for fish, high flows (above powerhouse capacity) caused extended periods of forced spill and TDG levels exceeded 135% during these two years. Nonetheless, preliminary results indicate transported chinook marked in 1995 returned at 2 to 1 for hatchery fish and 2.4 to 1 times the in river rate for wild fish (Marsh., 1997*(draft report)). Steelhead were not marked for these studies but, if they had been and returns were consistent with previous transport results, significant benefits to steelhead would have accrued to steelhead as well. However, Smolt Monitoring Program reports show that steelhead are more susceptible to gas bubble trauma (Fish Passage Center, 1997*). In part, this may contribute to higher transport returns for steelhead, particularly in years when there was spill. Based on this information, it is recommended that spill should be limited to involuntary spill in the future, especially at collector dams. We believe that by maximizing transport, and minimizing spill, the survival of both in river migrants and transported migrants will be maximized. Such an operation should be considered by NMFS in this consultation or through the AMP.

5.7.4 The Corps intends to continue the dissolved gas monitoring program to facilitate optimization of spill. It is intended that the 110 % state TDG standards be adhered to whenever physically possible and that the TMT use dissolved gas data generated by the TDG monitoring program to regulate spill and generation among the FCRPS projects to minimize TDG problems throughout the system whenever possible. It is further intended that installation of spillway deflectors at JDA, including possible installation of deflectors in the end bays at both JDA and IHR, be completed. It is further intended that deflectors be added in the end bays of LGS, LMN, MCN, and BON dams if that is the recommendation of the TDG Abatement Team in 1999. It is intended that studies continue on mortality caused by spill at TDA, and that if remedial actions are identified, that they be implemented.

5.7.5. For the 1998, and possibly the 1999 outmigration seasons, special operations will be needed at LWG for the SBC evaluation studies. In 1998, a modified SBC will be tested with a BGS moved in and out of position according to the expertimental design. It would make a much better test if there was no voluntary spill for fish passage at LWG during the period of the tests. This is essentially from mid-April through mid-July. However, with the BGS in position, assuming that the SBC is as effective as it was in 1997, up to 80 percent of the fish could be diverted past the dam with the BGS in, and over 50 percent of the outmigrants should bypassed via the SBC when the BGS is out, therefore, spill for the "spread the risk" program may not be necessary at LWG. Because more fish will be bypassed at LWG with the SBC in operation, more fish could be collected at LGS in 1998 and possibly in 1999. In keeping with aneffort to maximize collection and transportation of Snake River steelhead, if adopted involuntary spill could also be minimized at LGS.

Section 6.0 Conclusions

6.1 The FCRPS Action Agencies determined that operation of the FCRPS may effect the continued existence of the threatened Snake River steelhead and the endangered Upper Columbia River steelhead. They conclude that implementation of the 1995 BiOp as described in this BA to protect Snake River spring, summer, and fall chinook and sockeye salmon, plus continued coordinated operation of the FCRPS through the AMP process will not jeopardize the listed steelhead. The Corps and BPA recommendthat additional actions be considered in this consultation or through the AMP for the transport collector dams, including termination of voluntary spill, and maximizing the number of juvenile steelhead collected and transported, in order to maximize the survival of listed steelhead until a decision in 1999 on the long-term measures for the recovery of listed salmon and steelhead.

6.2 In Section 4.1, Regional Coordination of 1998 and Future Operations, there is a description of the various mechanisms and processes established for implementation of the 1995 BiOp to coordinate, among other things, the operation of the FCRPS. Since 1995, these processes have used adaptive management t modify operations of the FCRPS. The action agencies expect the the AMP will continue to provide recommendations on operation of the FCRPS, weighing the interests of the threatened and endangered steelhead with the best interest of the Snake River chinook and sockeye and Kootenai River sturgeon (Sec 4.1.4). Operation of the FCRPS for 1998 will be described in the TMT Annual Water Mnagement Plan, and in the Corps Fish Passage Plan (FPP) after completion of this consultation in accordance with NMFS's recommendations and adopted in the action agencies ROD's. These plans will be coordinated with regional interest by the TMT and FPOM, respectively (Section 4.1.5). Given the regional coordination process, the continued scientific review on juvenile transportation, and the anticipated review of the Northwest Power Planning Council's Independent Scientific Advisory Board (based, in part, on the Corps and other regional entities information on transport), the action agencies recommend that FCRPS operations in 1998 continue to be managed in accordance with the 1995 RODs and through the recommendations of this BA.

6.3 The Action Agencies, regional fishery agencies, and other stakeholders are working toward a decision in 1999 on the future system configuration of the FCRPS that would provide the greatest probability for recovery of the listed salmon and steelhead over the long term (24 to 100 years according to the PATH process). The Action Agencies believe this study and subsequent implementation of further corrective measures recommended by this study will further contribute to the recovery of listed salmon and steelhead.

6.4 The conclusion of no-jeopardy is based upon our opinion that the proposals in this BA, consistent with the 1995 BiOp, will provide equal or greater benefits to listed steelhead. We also believe that additional transportation and curtailment of spillcould further increase the survival of listed steelhead and benefit salmon. At this time, a jeopardy standard for steelhead has not been published by the NMFS. When a standard has been established, modeling can be performed to assess whether actions described in this BA contribute to the protection of steelhead.

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