Section 4 - Mainstem operations

Table of Contents

List of Tables

4. Mainstem Operations

4.1 Approach

The Technical Management Team (TMT) was designated to prepare the multi-year work plan for Mainstem Operations. A subgroup of the team, chaired by the Corps of Engineers met regularly during September, October, and November to draft the plan. It is important to highlight that the multi-year concept cannot be fully utilized for mainstem operations because of the unique nature of year-to-year variations in hydrologic conditions.

This section describes the ecological objectives of hydrosystem operation for anadromous and resident fish and wildlife affected by the operation of the Federal Columbia River Power System (FCRPS). This section also describes FCRPS operations to achieve the ecological objectives, as described in several regional plans.

Section 2 contains summaries of the various regional policies and plans. This section focuses on the mainstem operations identified by the National Marine Fisheries Service (NMFS) Biological Opinion on Reinitiation of Consultation on 1994-1998 (Biological Opinion), Operation of the Federal Columbia River Power System and Juvenile Fish Transportation Program in 1995 and Future Years, the Northwest Power Planning Council's (NPPC) Columbia River Basin Fish and Wildlife Program, and *Wy-Kan-Ush-Mi Wa-Kish-Wit*—Spirit of the Salmon: the Columbia River Anadromous Fish Restoration Plan of the Nez Perce, Umatilla, Warm Springs and Yakama Tribes. There are many commonalties among these plans as well as some distinct differences which are described in this section. No attempt is made in this section to resolve these differences.

In general, all of these plans recognize the importance of coordination forums for establishing regionally supported operational strategies that enable the achievement of fish and wildlife objectives while ensuring FCRPS stability. Central to ensuring that operations achieve the intended outcomes are development and maintenance of monitoring and evaluation programs necessary to make informed decisions and measure success. Therefore, in the context of mainstem operations, strategies include operating forums and monitoring and evaluation programs to facilitate regional participation in planning, implementation, and evaluation of mainstem operations. These strategies map out an adaptive management approach so that all FCRPS mainstem operations are carefully monitored and evaluated to determine their value in meeting fish and wildlife objectives and improving survival.

Operational strategies for the FCRPS that affect management objectives for anadromous and resident fish are listed by project and fish species in Table 4-1. Implementation of these operational strategies is facilitated primarily in forums established by the Biological Opinion. Although the TMT was established as a requirement in the Biological Opinion to assure coordinated implementation of opinion measures, it also discusses and plans for the needs of listed fish and incorporates protection and mitigation measures for all fish and wildlife species into hydropower system management. For listed salmon, the Biological Opinion requires the TMT to annually develop a Water Management Plan to address the same objectives as the earlier Coordinated Plan of Operation. In addition to listed stocks, the plan also addresses non-listed fish

and wildlife species and special requirements that have been approved through other processes such as those of the System Configuration Team (SCT), Anadromous Fish Evaluation Program (AFEP), the Dissolved Gas Team (DGT), or other research and monitoring groups. The TMT process and objectives are intended to assure representation of the state and tribal sovereigns in implementation of fishery measures consistent with both the Biological Opinion, the NPPC Fish and Wildlife Program, and the regional involvement in an adaptive management approach addressing issues. Mainstem operations decisions relating to the implementation of the Biological Opinion and NPPC measures include flow augmentation to improve juvenile and adult fish survival, spill at certain dams to reduce turbine mortality of juveniles, and specific reservoir and project operating requirements. The mainstem operations are year-round activities reflecting the adaptive management nature of hydropower system operation and management.

Wildlife requirements have not been explicitly addressed through the TMT process. However, Appendix N of the Systems Operation Review report addressed wildlife responses to system-wide changes in hydropower system operation. A common theme was that little information existed regarding the relationship between wildlife populations and reservoir level operations. Because of that, any conclusions concerning wildlife responses are qualitative.

The approach to mainstem operations and the implementation of mitigation measures must be sensitive to Native American cultural resources. Archeological material and spiritual/legal sites will be exposed as a consequence of varying degrees of mainstem operations departing from traditional inundated norms. Operational plans must anticipate both the potential discovery and subsequent protection of archeological material and incorporate this eventuality into financial allocations for the mainstem plan.

Section 3.5 describes future alternatives for mainstem configuration that will largely be addressed with capital expenditures after the end of the MOA period in 2001. As this section indicates, the direction of future system configuration activities, including mainstem operations, depends upon the resolution of major policy issues.

4.2 Ecological Objectives

A goal of mainstem hydro operations is to make the mainstem migration corridor a safer environment for anadromous fish while maintaining habitat integrity, quality, and quantity for resident fish and wildlife. A common primary ecological objective of flow, spill, and project operation strategies of the three plans for anadromous salmonids is to provide immediate improvements in survival of juveniles, whether transported or migrating in-river, and adults. All three plans recognize that, along with other actions, mainstem survival must be increased several fold in order to restore anadromous fish production in the Columbia River basin. Both the NPPC and tribes have concluded that this improvement must be made by reducing travel times of smolts in the mainstem by calling for phased-in implementation of drawdown of Snake and Columbia River dams over the next five years. In contrast, NMFS does not call for immediate drawdown of reservoirs, instead calling for studies to determine if survival improvements can be made in the current system configuration by improving in-river and transportation survival and to begin implementation of drawdown by 2000 if these strategies fail. A primary ecological objective for resident fish and wildlife is to maintain or improve habitat integrity, quality, and quantity and,

through in-season management, to account for variable hydrologic conditions to create river and reservoir conditions that achieve the biological and management objectives described in the anadromous fish, resident fish, and wildlife sections of this document. Much of this work focuses on implementing measures established to protect listed and non-listed species of migratory fish, resident fish, and wildlife. At present, these include Biological Opinion measures for Snake River salmon, Kootenai River white sturgeon, bald eagles, Snake River snails, gray wolf, grizzly bear, and peregrine falcon. They also include the NPPC Fish and Wildlife Program and management plans of the tribes and states.

For listed Snake River chinook and sockeye salmon, the Biological Opinion outlines a general goal to be addressed by FCRPS operations of reducing mortalities of listed fish (juveniles and adults) as necessary to ensure their survival and recovery. However, the Biological Opinion acknowledges a more specific objective for listed species of increasing egg-to-adult survival by 100 percent to 300 percent, depending on stock. This performance measure (egg-to-adult survival) may also be considered appropriate for non-listed salmonids. However, few similar goals were established for resident fish or wildlife; this lack creates a challenge to meet all of the conflicting ecosystem needs. So far river management has not been done in a manner satisfactory to all parties in the region. Some objectives identified specifically for Kootenai River white sturgeon include flow augmentation to provide for spawning and recruitment. Future policy guidance to the TMT will be needed to accomplish the ecological objectives as the region leads to decisions on system configuration alternatives as described in Section 3.5. Among the three current plans, there are differences in ecological objectives. The NMFS 1995 Biological Opinion outlines a general goal for mainstem passage:

> Implement all reasonable measures for operation and configuration of the Federal Columbia River Power System that will reduce mortalities of listed fish (juveniles and adults).

In Reasonable and Prudent Action (RPA) 15 of the Biological Opinion, NMFS outlines its mainstem performance objective:

> The interim performance objective for these bypass improvements is an 80 percent fish passage efficiency and a 95 percent passage survival at each dam. They intend that this be done without exceeding a 115/120 percent total dissolved gas saturation standard. The adult performance criterion is to “maintain fish facilities within criteria identified in the COE Fish Passage Plan” (RPA 7).

The provisions of the Northwest Power Act strive for balance between hydropower operation and fish and wildlife resources. The Council’s 1994 Fish and Wildlife Program outlines its mainstem Columbia and Snake River passage actions in Section 5.6A. The biological objective is stated as follows:

> To minimize delays at dams and minimize the passage of juvenile fish through turbines by providing high survival alternative passage routes.

The Council's operational objective, as stated in Section 5.6A, is:

> To achieve 80 percent fish passage efficiency at each Snake River project from April 15 to July 31 and at each Columbia River project from May 1 to August 31, while keeping dissolved gas levels within the limits of federal and state water quality standards and ensuring a high degree of adult passage success; ensure a 98 percent or greater salmon survival rate in all bypass and collection facilities; and increase smolt survival in areas below bypass system outfalls.

The Council's goal for resident fish as listed in Section 10 is to recover and preserve the health of native resident fish injured by the hydropower system. For wildlife, Section 11 says the goal of this program is to achieve and sustain levels of habitat and species productivity as a means of fully mitigating wildlife losses caused by construction and operation of the federal and non-federal hydroelectric system.

The Spirit of the Salmon plan is limited in scope to salmon and states its biological objectives in Section 5 on page 5B-2:

> Within seven years, halt the declining trends for all anadromous fish (salmon, sturgeon and lamprey); within 25 years, increase the annual escapement above Bonneville Dam from existing 0.5 million to 4 million adult salmon; within 25 years, increase lamprey and sturgeon populations to permit sustainable levels of tribal harvest; and restore anadromous fishes to historical abundance in perpetuity.

In Section 5 on pages 5B-27 to 5B-30, the Spirit of the Salmon plan states performance objectives:

> Implement passage measures which will result in a three to five-fold increase in the survival of stocks originating above eight or more dams; implement a program of controlled spill to achieve an 80 to 90 percent fish passage efficiency (PFE) over the short term (3 to 5 years), and at least a 90 percent FPE over the long term; and maximize spill efficiency through use of hydroacoustic monitoring across the entire dam, and implementation of full-flow surface bypass systems, gas abatement measures and previously evaluated spill patterns.

4.3 Strategies Associated with the Objectives

The strategies to meet objectives in the operation of the FCRPS have been developed over several decades as the result of studies and experimentation. The mainstem operation strategies (as opposed to mainstem construction) include flow augmentation, spill, pool drawdowns, transportation, gas abatement, passage facility improvement, and predator control. These operations strategies are displayed in Table 4-1 in detail for each plan. Successful implementation of these strategies has been pursued for the long term as the understanding of hydropower system development and operation impacts increased. The need for implementation of these strategies has been consistently recognized since the early 1970s. They have been tested and modified over the years; however, the results have been contentious. The ISG concluded that "a clear flow-survival

relationship adequate for defining flow requirements in the system has yet to be demonstrated." (page 195)
Spill is intended to reduce turbine mortality and to decrease passage time through a project. Spill is managed within the constraints of dissolved gas standards and adult passage constraints, to achieve 80 percent fish passage efficiency by providing a non-turbine route of passage at each project.

Flow augmentation is implemented to reduce fish travel time through the hydropower system. The effects of flow level on fish travel time and survival have been and continue to be studied throughout the basin. Flow augmentation is a key component of each of the regional plans. Flow augmentation has been the most important aspect of the state, federal, and tribal fishery entity recommended strategies addressing the operation of the FCRPS to restore and enhance fisheries.

The reduction of the cross section of mainstem Columbia and Snake rivers' run-of-river-pools (drawdown) has been developed as a strategy for increasing water velocity through mainstem reservoirs. Drawdown, like flow augmentation, increases the water velocity through mainstem reservoirs. Increased velocity reduces travel time and increases survival. Drawdown is included in all of the plans. The degree and schedule of drawdown varies.

Reservoir pool elevations are manipulated to influence resident fish habitat, spawning sites and food webs. Seasonal draft depths, draft timing, and refill level and timing can all influence these parameters. Reservoir operations also affect the riverine habitat below reservoirs. Reservoirs, by design, alter the river hydrograph by shifting water between seasons. The timing, magnitude, and duration of flood events and base flow events can affect river ecology, structure, and fish habitat. The productivity of a reservoir can be influenced by the rate of flow through the reservoir. The concept of water retention times is used at some reservoirs to manage the productivity. Flow rate can also influence the number of fish entrained through the turbines.

Table 4- 1 Comparison of the three major salmon recovery plans' river operations measures (short-term actions)

Project/Species	Ecological Objectives	NMFS' 1995 Biological Opinion	Council's 1994 Fish & Wildlife Program	1995 Tribal Spirit of the Salmon Restoration Plan
Upper Snake Basin • Rainbow • Bull trout • Sturgeon • Red-band • Cutthroat • Fall chinook, Snake and Columbia River • Spring chinook, Snake and Columbia River • Steelhead, Snake and Columbia River	A A A A A B B B	Provide 427 Kaf for flows at LWG Dam	In '95, 427 Kaf for flows at LWG Dam In '96, provide add'l. 500 Kaf In '98, provide another 500 Kaf	Use 1 to 3 Maf for Snake River flows
Brownlee • Sturgeon • Rainbow • Sm bass • Crappie • Channel cat • Fall chinook, Snake and Columbia River • Spring chinook, Snake and Columbia River • Steelhead, Snake and Columbia River • Sockeye, Snake and Columbia River	A A A A A B B B B	**Jan-Apr15:** shift system FC to Coulee **May:** up to 110 Kaf (2,069'); **June:** pass inflow; **July:** up to 137 Kaf (2,067') ; **Aug:** pass inflow; **Sept:** 100 Kaf (2,059')	**Jan-Apr15:** shift system FC to Coulee **Apr16-30:** up to 110 Kaf (2,069') **May:** up to 110 Kaf (2,069'); **June:** pass inflow **July:** up to 137 Kaf (2,067') ; **Aug:** pass inflow; **Sept:** 100 Kaf (2,059')	Provide 450 Kaf for spring and summer Snake River flows

A. Maintain or improve habitat integrity, quality, and quantity.
B. Increase the egg to adult survival by 100-300%, depending on stock.

Project/Species	Ecological Objectives	NMFS' 1995 Biological Opinion	Council's 1994 Fish & Wildlife Program	1995 Tribal Spirit of the Salmon Restoration Plan
Dworshak • Bulltrout • Kokanee • Cutthroat • Rainbow • Sturgeon • Steelhead, Snake and Columbia River • Sockeye, Snake and Columbia River • Fall chinook, Snake and Columbia River • Spring chinook, Snake and Columbia River	A A A A A B B B B	**Sep-Apr15:** flood control oper, shift system FC to Coulee **Apr16-June:** up to 1.5 Maf; **July-Aug:** draft limit 1,520' (80')	**Sep-Apr15:** flood control oper, shift system FC to Coulee **Apr16-June:** up to 1.0 Maf; **July:** draft limit 1,520' (80'); **Aug:** refill; **Sept:** 200 Kaf	**Spring:** 1.5 Maf for Snake River flows **Summer:** 1.0 Maf for Snake River flows
Lower Granite • Sturgeon • Rainbow • Sm bass • Crappie • Steelhead, Snake River • Sockeye, Snake River • Fall chinook, Snake River • Spring chinook, Snake River	A A A A B B B B	**Apr16-Aug:** operate near MOP (733') **Flow Targets:** **Apr16-June:** 85-100 Kcfs; **July-Aug:** 50-55 Kcfs	**Apr16-Jun15:** operate near elev. 690' **Jun16-Aug:** operate near MOP **Flow Targets:** **Apr16-June:** 85-140 Kcfs equivalent **July:** 50 Kcfs equivalent	**All year:** operate near elev. 710' beginning in '97 **Flow Targets:** No specific targets -- release volumes identified above to augment flows.

A. Maintain or improve habitat integrity, quality, and quantity.
B. Increase the egg to adult survival by 100-300%, depending on stock.

Project/Species	Ecological Objectives	NMFS' 1995 Biological Opinion	Council's 1994 Fish & Wildlife Program	1995 Tribal Spirit of the Salmon Restoration Plan
Little Goose • Sturgeon • Rainbow • Steelhead, Snake River • Sockeye, Snake River • Fall chinook, Snake River • Spring chinook, Snake River	 A A B B B B	**Apr16-Aug:** operate near MOP (633')	**Apr16-Jun15:** In 1996-98, near MOP Starting in '99, operate near elev. 590' **Jun16-Aug:** near MOP	**Apr15-Oct31:** operate near MOP
Lower Monumental • Sturgeon • Rainbow • Sockeye, Snake River • Steelhead, Snake River • Spring chinook, Snake River • Fall chinook, Snake River	 A A B B B B	**Apr16-Aug:** operate near MOP (537')	**Apr16-Aug:** operate near MOP	**Apr15-Oct31:** operate near MOP
Ice Harbor • Sturgeon • Rainbow • Sockeye, Snake River • Steelhead, Snake River • Fall chinook, Snake River • Spring chinook, Snake River	 A A B B B B	**Apr16-Aug:** operate near MOP (437')	**Apr16-Aug:** operate near MOP	**Apr15-Oct31:** operate near MOP

A. Maintain or improve habitat integrity, quality, and quantity.
B. Increase the egg to adult survival by 100-300%, depending on stock.

Project/Species	Ecological Objectives	NMFS' 1995 Biological Opinion	Council's 1994 Fish & Wildlife Program	1995 Tribal Spirit of the Salmon Restoration Plan
Arrow • Rainbow • Fall chinook, Snake and Columbia River • Spring chinook, Snake and Columbia River • Sockeye, Snake and Columbia River • Steelhead, Snake and Columbia River	A B B B B	**Jan-Apr15:** store up to 1 Maf of "operational" volume	**Jan-Apr15:** store "operational" volume (Total of 4 Maf in US and BC projects.)	Use as necessary for flow targets at The Dalles Dam. (Also use Mica and Duncan, if nec.)
Libby • Cutthroat • Kokanee • Sturgeon • Burbot • Fall chinook, Snake and Columbia River • Spring chinook, Snake and Columbia River • Sockeye, Snake and Columbia River • Steelhead, Snake and Columbia River	A A A A B B B B	**Jan-Apr15:** flood control operation **May-July:** Provide sturgeon flows **Apr16-May:** draft limit 2,420' (39') **June-Aug:** draft limit 2,439' (20')	**Jan-Apr15:** store "operational" volume Operate to integrated rule curve (IRC) draft limits year-round. **May-July:** Provide sturgeon flows	Use as necessary for flow targets at The Dalles Dam. Make add'l. Water available in better than average runoff years.

A. Maintain or improve habitat integrity, quality, and quantity.
B. Increase the egg to adult survival by 100-300%, depending on stock.

Project/Species	Ecological Objectives	NMFS' 1995 Biological Opinion	Council's 1994 Fish & Wildlife Program	1995 Tribal Spirit of the Salmon Restoration Plan
Hungry Horse • WS cutthroat • Kokanee • Bull trout • Fall chinook, Snake and Columbia River • Spring chinook, Snake and Columbia River • Sockeye, Snake and Columbia River • Steelhead, Snake and Columbia River	A A A B B B B	**Sep-Apr15:** flood control oper, **Apr16-Aug:** draft limit 3,540' (20'), max flow 13 Kcfs.	**All Year:** Operate to integrated rule curve draft limits	Use as nec. for flow targets at The Dalles. Add'l water available in better than average runoff years.
Albeni Falls • Kokanee • Bullspout • Cutthroat • Largemouth • Yellow perch	A A A A A		In 1996, minimum elevation 2,054' In 1997, minimum elevation 2,055' In 1998, minimum elevation 2,056'	

A. Maintain or improve habitat integrity, quality, and quantity.
B. Increase the egg to adult survival by 100-300%, depending on stock.

Project/Species	Ecological Objectives	NMFS' 1995 Biological Opinion	Council's 1994 Fish & Wildlife Program	1995 Tribal Spirit of the Salmon Restoration Plan
Grand Coulee • Kokanee • Rainbow • Fall chinook, Snake and Columbia River • Spring chinook, Snake and Columbia River • Sockeye, Snake and Columbia River • Steelhead, Snake and Columbia River	A A B B B B	**Jan-Apr15:** flood control operation **June-Aug:** draft limit 1,280' (10')	**Jan-Apr15:** store "operational" volume Minimum draft limits: **Jan:** 1,270' ; **Feb:** 1,260' **Mar-Apr15:** 1,250'; **Apr16-30:** 1,255' **May:** 1,265'; **Jun-Aug:** 1,280' Maximum fill limits: **June-Aug:** 1,288' /1,283' alternate **Sep-Dec:** 1,288'	Use as necessary to meet flow targets at The Dalles
Priest Rapids Vernita Bar • Sturgeon • Fall chinook, Columbia River	A B	None	Comply w/ Vernita Bar min flow plan **(Dec-May:** 70 Kcfs minimum flow)	**Dec-May:** 55 Kcfs minimum flow

A. Maintain or improve habitat integrity, quality, and quantity.
B. Increase the egg to adult survival by 100-300%, depending on stock.

Project/Species	Ecological Objectives	NMFS' 1995 Biological Opinion	Council's 1994 Fish & Wildlife Program	1995 Tribal Spirit of the Salmon Restoration Plan
John Day • Sturgeon • Fall chinook, Snake and Columbia River • Spring chinook, Snake and Columbia River • Sockeye, Snake and Columbia River • Steelhead, Snake and Columbia River	A B B B B	**All year:** near MIP (elev. 263')	**All year:** near MOP (elev. 257')	**All year:** near MOP (elev. 257')
The Dalles/ McNary Flow Targets • Sturgeon • Fall chinook, Snake and Columbia River • Spring chinook, Snake and Columbia River • Sockeye, Snake and Columbia River • Steelhead, Snake and Columbia River	A B B B B	**Apr16-Apr30:** 200-230 Kcfs **May-June:** 220-260 **July:** 200; **Aug:** 200	**Apr16-Apr30:** 170 Kcfs **May-June:** 180-300 **July:** 200 ; **Aug:** 160	**Apr16-Jun15:** 220-300 Kcfs **Jun16-Jun30:** 200-250 Kcfs **July:** 200 Kcfs ; **Aug:** 160 Kcfs **Sep:** 120 Kcfs

A. Maintain or improve habitat integrity, quality, and quantity.
B. Increase the egg to adult survival by 100-300%, depending on stock.

Project/Species	Ecological Objectives	NMFS' 1995 Biological Opinion	Council's 1994 Fish & Wildlife Program	1995 Tribal Spirit of the Salmon Restoration Plan
Spill • Fall chinook, Snake and Columbia River • Spring chinook, Snake and Columbia River • Sockeye, Snake and Columbia River • Steelhead, Snake and Columbia River	B B B B	**Apr15-Aug 31:** 80% FPE; 120% gas cap	**Snake River -- Apr15-July 31:** **Columbia R -- May-Aug 31:** 80% FPE w/120% gas cap	**Apr15-Aug 31:** 80% FPE 125-130% gas cap

A. Maintain or improve habitat integrity, quality, and quantity.
B. Increase the egg to adult survival by 100-300%, depending on stock.

4.4 Summary of Current Plans

This section describes the three major regional plans to the extent that they address listed and non-listed anadromous fish and other resident fish and wildlife species in the Columbia River Basin. The NMFS Biological Opinion, the NPPC Fish and Wildlife Program, and the Spirit of the Salmon plan are all based upon the provision of improved migration flows and spill for fish passage. The measures are mostly similar, with a few clear measures that conflict between the plans. All programs recognize the necessity of providing migration flows, spill, and fish passage. All three plans call for spill for fish passage to provide 80 percent fish passage efficiency at each project, i.e., 80 percent of the fish passing the dam must pass via non-turbine routes. The greatest difference in the plans is in their treatment of summer migration flows, both in duration and in reservoir operations and juvenile fish transportation (Table 4-1). The three plans also address drawdown of mainstem reservoirs, with the Biological Opinion identifying a decision point in 1999, and the NPPC and CRITFC plans identifying earlier drawdown schedules beginning in 1996 (See Section 3). The Biological Opinion describes, as an overall objective for ensuring the survival and recovery of these listed stocks, increasing egg-to-adult survival by at least 200-300 percent. Correspondingly the Biological Opinion identifies specific measures necessary to achieve that objective. The Northwest Power Planning Council's Fish and Wildlife Program and individual management plans of tribes and states also describe FCRPS operations necessary to meet management objectives for fish and wildlife under their care.

4.4.1 Specific Descriptions of Differences

Table 4-1 is a condensed summary of the specifics contained in each of the three plans for each reservoir for the short-term. For each measure, proper references to the plan involved are also shown. A description of the measures listed, where and how they differ, and the basis for the differences, follows:

4.4.1.1 Snake River Operations

Snake River Flow Targets Both the Council's 1994 Fish and Wildlife Program and 1995 NMFS Biological Opinion identify Snake River flow targets or objectives at Lower Granite Dam. NMFS flow targets range from 85 to 100 Kcfs during the spring, and between 50 and 55 Kcfs during July and August. The Council's sliding scale flow equivalent objectives range from 85 to 140 Kcfs during the spring period, and 50 Kcfs during July, with no flow target in August. The Spirit of the Salmon plan has no specific flow targets for the Snake River, instead relying on the volumes identified below to augment flows for salmon.

Lower Snake Drawdowns One of the major differences in the three major salmon recovery plans is that both the Council's 1994 Fish and Wildlife Program and the 1995 Spirit of the Salmon plan call for a phased implementation of drawdown actions in the Snake River over the next five years, whereas the 1995 NMFS Biological Opinion calls for a minimum operating pool (MOP) operation at all four lower Snake projects from mid-April through August. NMFS calls for completion of feasibility studies related to drawdown actions, with a regional decision made in 1999 as to whether and how much to lower mainstem reservoirs. The Council's Fish and Wildlife Program specifies that, contingent on needed fish passage modifications and development of a mitigation plan, Lower Granite reservoir is to be drawn down 43 feet to near spillway crest

elevation 690 feet beginning in spring 1996, with Little Goose lowered a similar amount beginning in spring 1999. The Spirit of the Salmon plan calls for the Lower Granite project to be lowered to elevation 710 feet beginning in spring 1997. Further study of intermediate drawdown levels has been suspended by agreement and correspondence between NMFS and the Council.

Both the Fish and Wildlife Program and the Spirit of the Salmon plan call for MOP operation during the spring and summer migration periods at Lower Monumental and Ice Harbor projects, although the CRITFC plan calls for the MOP operation to extend through the end of October. The Council's program calls for drawdown of Lower Monumental and Ice Harbor to spillway crest by 2002.

Upper Snake Basin Water All three plans specify at least 427 Kaf be provided from the upper Snake Basin for salmon flow augmentation. A difference in the three major salmon recovery plans is that both the Council's 1994 fish and wildlife program and the 1995 tribal restoration plan call for more water to be provided from willing sellers in the upper Snake Basin. The Council's program takes a phased approach: in 1996, an additional 500 Kaf is to be found and provided; and in 1998, another 500 Kaf is to be provided, for a total volume of 1.427 Maf. The Spirit of the Salmon plan calls for a volume of between 1 and 3 million acre-feet from the upper Snake Basin to be used for salmon flows.

Brownlee The NMFS Biological Opinion and the Council's program have identical operations specified for Idaho Power Company's Brownlee project. Both plans call for a total draft of 347 Kaf from Brownlee, 110 Kaf in the spring, and another 237 Kaf in the summer months. The Spirit of the Salmon plan calls for Idaho Power to provide up to 450 Kaf during the spring and summer migration periods.

Dworshak Both the NMFS Biological Opinion and the 1995 Spirit of the Salmon plan call for up to 1.5 Maf to be provided from Dworshak during the spring migration, whereas the Council's program specifies a volume of up to 1.0 Maf in the spring. During the summer migration, the Spirit of the Salmon plan requires another 1.0 Maf volume to be provided from Dworshak. Although both the Council program and the NMFS Biological Opinion contain a draft limit of 1520 feet for Dworshak, the Council's program results in a greater volume contribution from the project during the summer months than the NMFS plan, for several reasons: (1) the Council's program does not draft Dworshak as deeply as the NMFS plan during the spring months, and thus is better able to refill from spring operations; and (2) the Council's program calls for refill during August, and specifies an additional 200 Kaf to be provided in September for Snake River water temperature control operations.

4.4.1.2 Columbia River Operations

Lower Columbia River Flow Targets Both the Council's fish and wildlife program and the Spirit of the Salmon plan specify lower Columbia River flow objectives at The Dalles Dam, while the NMFS Biological Opinion specifies flow targets at McNary Dam. NMFS flow targets range from 200 to 260 Kcfs during the spring and 200 Kcfs during July and August. The Council's sliding scale flow equivalent objectives range from 170 to 300 Kcfs during the spring period, 200

Kcfs in July, 160 Kcfs in August, and 120 Kcfs in September. The Tribal Restoration Plan has flow targets ranging from 220 to 300 Kcfs in the spring period, with the same flow targets as the Council during the summer months and September.

Arrow and Canadian Projects These projects are operated under the terms of the Columbia River Treaty with Canada. The three plans treat access to Canadian reservoirs for flow augmentation differently. Approximately one-half of the Columbia River's storage capacity is located in Canada. The tribal program anticipates that access to Canadian reservoirs will be provided as needed to meet flow targets at The Dalles Dam. The NMFS Biological Opinion and the Council's program limit contributions from Canadian reservoirs to certain volumes. The operation of Canadian and U.S. reservoirs are interrelated and affect resident fish and anadromous fish.

Both the Council's program and the NMFS Biological Opinion call for a portion of the total operational storage volume to be stored and released from the Arrow project in British Columbia. NMFS specifies a volume of up to 1 Maf in Arrow, while the Council's program does not specify how much of the 4 Maf total volume should be stored in particular projects. The Spirit of the Salmon plan, on the other hand, calls for the use of Arrow, Mica, and Duncan projects, as necessary, to help meet flow targets at The Dalles Dam.

Libby and Hungry Horse The NMFS Biological Opinion specifies that both of these projects operate near upper rule curve to store a portion of the operational volume for salmon flows. Both the Council program and NMFS call for Libby to provide necessary sturgeon flows according to the USFWS Biological Opinion on endangered Kootenai River white sturgeon. A major difference is that the Council's program calls for both projects to be operated to integrated rule curves year-round, which is intended to provide some storage for salmon and sturgeon flows while balancing impacts to resident fish and wildlife. The NMFS Biological Opinion, on the other hand, establishes maximum summer draft limits of 20 feet at each project for salmon flows. The Spirit of the Salmon plan calls for both projects to be drafted as necessary to meet salmon flow targets at The Dalles Dam, with no draft limits or protections for resident fish specified. The Council plan does not call for an operational volume to be stored in Hungry Horse.

Albeni Falls The Council program is the only plan that calls for phased-in draft limits at Albeni Falls project on the Pend Oreille River. By 1998, the Council's plan provides a minimum elevation at the project of 2056 feet for winter draft as a resident fish protection measure (kokanee spawning).

Grand Coulee The NMFS Biological Opinion specifies that Grand Coulee should operate near its upper rule curve to store a portion of the operational volume in FDR Lake for salmon flows. The Council's program calls for Grand Coulee project to be operated to specified minimum draft limits and water retention times, which are intended to provide some storage for salmon flows while balancing impacts on resident fish and wildlife. The NMFS Biological Opinion establishes a maximum summer draft limit of 10 feet at Grand Coulee project for salmon flows. The Spirit of the Salmon plan calls for Grand Coulee to be drafted as necessary to meet salmon flow targets at The Dalles Dam, with no draft limits or protections for resident fish specified.

Priest Rapids/Vernita Bar Flows Both the Council program and the Spirit of the Salmon plan comply with Vernita Bar minimum flow requirements for fall chinook spawning, incubation, and emergence, as specified in a FERC settlement agreement. The NMFS Biological Opinion has no such flow requirement.

John Day Drawdown All three salmon restoration plans would have John Day reservoir operated year-round near its minimum operating pool level, or elevation 257 feet, beginning in 1996, contingent upon development of a mitigation plan. In the meantime, Congress has required that further drawdown efforts be put on hold pending identification of biological justification.

Spill All three salmon restoration plans call for fish spill levels to obtain an 80 percent fish passage efficiency at each mainstem project. In the NMFS Biological Opinion, however, spill at collector/transport projects is reduced or eliminated during low flow conditions, to increase the proportion of fish transported. In the NFMS plan, fish spill may also be reduced when 12-hour average TDG levels exceed 120 percent saturation at the tailrace monitor below each mainstem dam. In the Spirit of the Salmon plan, spill may be reduced when the 12-hour average TDG levels exceed 125-130 percent saturation in the tailrace. Spill periods for both the NMFS Biological Opinion and the Council program generally range from mid-April through August 31, except for the Council program in the Snake River, which curtails spill on July 31. Spill periods are not specified in the Spirit of the Salmon plan.

Juvenile Fish Transportation The Council program encourages an interim strategy that substantially reduces the number of juvenile fish transported (under a spread-the-risk approach) and calls for a rigorous evaluation of transportation survival versus inriver survival and returns as adult spawners. The NMFS Biological Opinion calls for transportation of all fish collected at the lower Snake River collector projects, subject to spill operations specified above, and unless the TMT recommends otherwise or transport operations are out of criteria. Spill at Snake River collector projects in average and above water years effectively decreases the number of juvenile fish that can be collected and transported; spring migrants at McNary Dam are returned to the river. The NMFS plan calls for maximum transportation of fall chinook, since spill is not recommended at any of the four collector projects during the summer months. Under the Spirit of the Salmon plan, transportation of juvenile salmon using barges and trucks would be halted at all mainstem Snake and Columbia River dams.

4.5 Summary of Future Activities

As the preceding summaries of the Biological Opinion, NPPC Fish and Wildlife Program, and Spirit of the Salmon plans illustrate, there are conflicting recommendations on what future river operations should be. The past two years of operations have been prescribed by the Biological Opinion and in-season management has been constrained to operations called for in the Biological Opinion. The Biological Opinion constrains a decision point in 1999 for deciding on how the river will be configured. In turn, configuration will affect operations. In the interim and subsequent to that decision point, the in-season management process needs policy guidance on what "side-boards" will be used to guide river operations. Development of post-1999 operations is needed concurrent with the selection of the river configuration alternatives. Until then, river operations

could 1) Continue with the Biological Opinion prescriptions for flow objectives, spill, and reservoir operations, 2) Switch to implementation of another plan such as the Council's or the Spirit of the Salmon plan, or 3) Switch to a hybrid approach that incorporates elements of all the current plans and the concepts of the recent ISG Return to the River report.

Currently, the TMT dispute resolution process is not structured to address these alternatives. The current charter and administration of the TMT process allows only implementation of the Biological Opinion and as such can not effectively proceed with considering alternatives two and three listed above.

Many parties believe that these issues are at the heart of continuing regional disagreements. Finding solutions to these disagreements is a monumental task. The pending ISAB report on resident fish impacts will hopefully shed some light on this debate. The region should, as soon as possible, begin crafting a process that is capable of incorporating this and other scientific information, the biological objectives of the anadromous fish, resident fish, wildlife, and research and monitoring sections of this document with the policy objectives of the region. The goal of that process would be to produce the sideboards for in-season river management with respect to flow, spill, and reservoir elevations that meet the needs of the ESA, the Northwest Power Act, treaty obligations, and the expectations of the citizens of the Northwest.

At the end of the 1999 season, the operational plan may be somewhat different from the current Biological Opinion's plan. Although some of the operations may be different, there will still be a need for an operational team to perform the day-to-day coordinated management of the Columbia River system. This team should consist of the same members, including the federal operating agencies and sovereign states and tribes. Many of the current processes will remain in place, such as pre-season planning, in-season management, and post-season review. The overriding goal will remain the same: to implement the objectives that are in place in the region.

4.6 Key Issues

Three major issues have been identified, including the need for an appropriate plan to guide in-season management, a process for in-season decision-making and conflict resolution, and a definition and procedures for emergencies. There are many aspects to these issues that are based, in part, on substantial differences in the regional plans. Some of the issues are technical in nature, others are more distinctly policy-related, and some issues lie somewhere in between, due to the lack of conclusive information and clear policy guidance. A summary of the issues is presented in Table 4-2 along with an indication of whether the issue is policy or technical, the criticality of resolution, a time frame for resolution, and a proposed forum to provide resolution. If and when the three major issues are resolved, most of the other elements will either be resolved or a process for reaching resolution will exist. It is assumed that policy guidance to resolve the various elements listed below will include program implementation guidelines, including dispute resolution.

4.6.1 Appropriate Plan or Provisions for Mainstem Operations

As noted above, several plans exist with different requirements to address how river operations should be conducted. The primary policy issue for the region is whether mainstem operations will

continue to implement Biological Opinion requirements over other objectives when the plans conflict. Currently, no authority or mechanism exists in the region to resolve the conflicts in the various plans or to find compromises. If integration is warranted, then a new operations group or team may be required. So long as the Biological Opinions remain the only prescription for mainstem operations, then the TMT will be the central group to implement them specifically for hydropower operations. If policy makers elect to broaden the TMT mandate by allowing inclusion of river operations elements from other plans, this will create the need to assure that the structure of decision-making and conflict resolution processes are adequate to address this broadened mandate.

a. Pre-Season Conflict Resolution

Before a plan can be developed to establish in-season operations, a process must be established for decision-making and conflict resolution. This will have to be established at the Executive Committee level and then the guidelines can be followed in subordinate forums such as the IT.

b. Start/End Dates of Operation

The TMT is to make best efforts to match operations, e.g., flow and spill, to the actual fish migration. Dates in the Biological Opinion are planning dates, both for flow and spill. Review of the available information in 1996 concerning an end-of-migration date for the summer migration of Snake River fall chinook concluded that a pre-season determination cannot be made. It is suggested that the ISAB peer review the 1996 process to ensure that it is applicable to future years and, if not, to provide technical criteria to refine it.

c. Striving for a Natural Hydrograph

A natural hydrograph in the Snake and Columbia river migration corridors is characterized by high spring peaks dominated by snow melt events in the headwaters. Flows then rapidly decline toward a base flow condition in August and September. During the fall and winter months, flows would generally remain low except in response to rainstorm events that would create a range of peaks. This natural shape has been altered by flood control operations and irrigation withdrawals that reduce the magnitude of the peaks and by power operations that shift water in time to match electric power demands. In addition, impoundments on the mainstem migration corridors have increased the rivers' cross sectional area and thereby reduced river velocity.

The Biological Opinion, in referencing an attempt to mimic the natural hydrograph, specifically addresses the requirement to create hydrographic conditions that match the needs of migrating salmon. Too great a reduction in flows, as occurred in the past with a natural river, is not conducive to greatest fish survivals given the existence of dams and reservoirs; water velocities were sufficient even at low flows in a natural river. The flow targets address this in part, based on scientific information, by establishing spring flows higher than summer flows. The shaping of reservoir releases from fall and winter into spring and summer, the reverse of hydropower system operations designed solely to benefit power, is also a return to a more natural hydrograph.

The survival of resident fish and wildlife is also related to a natural hydrograph. Drafting storage reservoirs to overcome the effects of impoundment on the migration corridor can also disrupt the natural hydrograph in river reaches below the storage projects. In particular, high releases in July

and August may create unnaturally high discharges in river reaches that would normally be approaching low base flow conditions. A pending ISAB report will provide technical insight on this issue. Policy guidance on how to resolve this conflict is needed to aid the TMT in making in-season management decisions. An additional aspect of natural flows has been raised by the ISAB concerning the possibility that current efforts at flow augmentation may not be taking full advantage of the migratory behavior of yearling and subyearling salmon. The ISAB suggests that shaping augmentation flows into more "normative" freshets may present better opportunities for both migration and rearing than the current approach of achieving a flat line weekly average target. The TMT will need to evaluate these suggestions in 1997 to determine whether the fish needs are best met by maintaining a natural hydrograph peak of a minimum sustained flow. Then, when possible, the TMT will need to choose the hydrograph shape that provides the most benefit to migrating fish.

d. Upstream Storage Reservoir Contributions for Salmon Flows

The flow objectives contained in the Biological Opinion cannot be met with natural flows alone. Storage reservoirs are drafted to augment flows to attempt to meet the flow targets. The contribution from storage reservoirs is restricted by interim limits on reservoir elevations. The drafts of storage reservoirs to meet flow objectives raises numerous important issues. Reducing reservoir elevations has consequences for the reservoir food web in terms of primary production, benthic production, and terrestrial insect deposition. Access to spawning tributaries is also of concern. Some agencies and tribes oppose the magnitude of the salmon flow augmentation drafts and contend that the food web impacts translate into negative impacts on the resident fish resources in the reservoirs. Other impacts at the reservoirs include degraded access and wind erosion leading to dust storms.

The timing of the drafts also creates problems for river resources and users. Summer drafts can create local river flows in excess of 250 percent and up to 500 percent of summer base flow conditions. The resulting river hydrograph conflicts with agency, tribal, and scientific recommendations to move the river towards a more natural hydrograph to assure that riverine fluvial process, limnological integrity, local fish migrations, and general aquatic stability are secure and sustainable. Other impacts include limited local flooding (especially with sturgeon/salmon flows), riparian community impacts, user access, and user safety.

How the operations of various headwater storage reservoirs are coordinated to optimize their effect on salmon passage is an issue that the TMT has not been able to fully address. How, when, and if to provide more protection at FCRPS projects is a contentious issue that divides TMT members. Sometimes the reservoir operation issues are independent of the salmon operation, such as for flood control and spill prevention. The TMT lacks technical criteria to assess the merits of any reservoir and river operations that are offered to implement or as alternatives to the Biological Opinion. Furthermore, flexibility of the Biological Opinion and the TMT to consider such alternatives creates policy-related issues.

Other recommendations have been made for additional upstream storage contribution and for development of a better in-season accounting system.

e. Integrated Rule Curve Concept

The Integrated Rule Curves (IRCs) have been proposed by Montana and the Confederated Salish and Kootenai Tribes as a tool to balance the requirements of hydropower generation and flood control with resident and anadromous fish. They are the result of over 14 years of field and laboratory research to assess the effects of hydropower operations on the aquatic resources in northwestern Montana (Marotz et al. 1996). Recently, the IRC concept was determined by the ISAB to be consistant with the Normative River Concept and a valuable tool for application on other storage projects throughout the Columbia System.

The IRCs are a family of operational rules for dam operation that incorporate incremental adjustments to allow for uncertainties in water availability. These curves are intended for use similar to power and flood control rule curves. In real time, the dam operator would receive an inflow forecast in early January and operate the dam to achieve the correct elevation as dictated by the curve corresponding with that inflow forecast. Upon receipt of an updated forecast, the operator would adjust the elevation to the new curve corresponding with the updated inflow volume and so on. This causes the actual operation to be flexible and variable over time. Actual operations will vary somewhat from the target elevations due to inflow forecasting error. The curves were designed to limit the duration and frequencies of deep drawdowns and reservoir refill failure and produce a more natural discharge hydrograph. Reduced drawdown protects aquatic food production in the reservoirs, assuring an ample springtime food supply for fish. Increased refill frequency improves biological production during the warm months. At full pool, the reservoir contains the maximum volume of optimal temperature water for fish growth and a large surface area for the deposition of terrestrial insects from the surrounding landscape. Refill timing also assures that passage into spawning and rearing habitats in tributaries is maintained for species of special concern in Montana, including westslope cutthroat trout and the bull trout. Biological production in river reaches downstream of the dams is protected by the more naturally shaped hydrograph. The naturalized spring freshet resorts and cleans river sediments and helps restore nutrient cycles and floodplain function. At Libby Reservoir, the IRCs include an experimental discharge scenario designed to aid in the recovery of the endangered Kootenai white sturgeon. The volume and shape of the spring freshet is based on water availability. Instream flows from both projects then continue downstream to aid anadromous salmon smolt migration.

The computer models and BRCs were critically examined during the period 1991-1995, in the Columbia River System Operation Review (SOR) conducted by Bonneville Power Administration (BPA), U.S. Bureau of Reclamation (BOR), and U.S. Army Corps of Engineers (ACOE). State, tribes, and agencies represented on the SOR Resident Fish Workgroup examined analytical tools available for biological assessment of reservoir operation. Our methodology was deemed appropriate for use in the SOR process. A simplified version of the Montana models was modified for use on the other storage reservoirs in the U.S. portion of the Columbia River System. Results were published in Appendix K of the Final Environmental Impact Statement (SOR EIS 1995). This “screening model” enabled researchers to evaluate compromises between resident fish species in the headwaters and salmon and steelhead in the lower Columbia. The IRCs and similar resident fish constraints at other storage projects formed the basis of SOS #4 which met the requirements of more work groups than the preferred alternative. Alternatives designed to

improve anadromous fish survival with increased instream flow had a negative effect on the reservoirs fisheries (Geist et al. 1996).

In 1995, the Montana models were again critically reviewed by the Applied Physics Laboratory, Seattle, Washington (Dr. Gordon Swartzman). This review was the most in-depth review of the model code and IRCs conducted to date. Dr. Swartzman's review focused on the biological components of the models and catalyzed additional improvements within the model. The IRCs were determined to be robust to a variety of dam operations and environmental conditions including year-to-year differences in flow. Because of our conservative modeling technique, the model may underestimate the biological effects of deep drawdown and reservoir refill failure.

Although the IRCs were adopted by the Northwest Power Planning Council in its1994 Fish and Wildlife Program ,they were not implemented in 1995 because of conflicting requirements in the NMFS 1995 Biological Opinion. In general, the IRC and Biological Opinion are similar throughout the operating year but differ substantially during the summer. Whereas the IRCs fill the reservoirs in July and maintain elevations near full pool, the Biological Opinion drafts the projects 20 feet by the end of August, resulting in a failure to refill the projects by up to 20 feet in some years. This impacts biological production in the reservoirs during the productive warm months and causes unnatural fluctuation in the dam discharge to the Kootenai and Flathead rivers.

Fundamental differences between the two plans sparked heated debate and at least one congressional hearing (Senate Subcommittee on Science, Technology, and Space, June 19, 1996). A technical analysis of Columbia River operating criteria, funded by NMFS and BPA, was initiated to find common ground and develop a compromise. The IRC concept was compared to the Biological Opinion and two other alternatives (Wright et al. 1996). This analysis did not address incremental tradeoffs between anadromous and resident fish species resulting from the alternatives. The process did, however, focus the debate by identifying similarities and differences. Results of the Wright analysis showed that the enhanced reservoir operation (IRC concept) was the least expensive of the alternatives analyzed, saving the power system an incremental average of $27 million per year as compared to the Biological Opinion. A comparison of Columbia River flows during the spring freshet, revealed that the IRCs were nearly the same as the Biological Opinion. Discrepancy between the plans fell within the range of model variance and flow measurement error. This difference can be further ameliorated using techniques described below.

The technical analysis by Al Wright consultants recommended further analysis of flood control to allow reservoirs to retain more water through June. The study results revealed that many of the IRC elements have minimal effect on salmon flow enhancement. The IRCs incorporate a new strategy for system flood control which was critically examined by technical modelers of the Army Corps of Engineers (ACOE) Hydraulics Branch. ACOE modelers established that the IRCs were nearly identical to a new system flood control strategy being developed by the ACOE in average to high water years. Earlier problems identified by ACOE modelers (e.g. April releases and insufficient drawdown in the highest ten percent of water years) were reworked during 1996. Differences between VARQ and IRCs during lower water years are a result of integrating power constraints. FWP and CSKT are now satisfied that VARQ is sufficiently close to the intent of the IRCs. This variable flow strategy (VARQ) is crucial to create a naturalized spring runoff (within

flood constraints) while maintaining reservoir refill probability. A report on VARQ is scheduled for completion by ACOE spring 1997.

By implementing operating curves similar to the IRCs at other storage projects, sub-basins experiencing wet conditions can supply the bulk of salmon flow augmentation. Dry sub-basins provide less flow, protecting important reservoir and riverine stocks.

The Wright report also recommended that species trade-off controversies be resolved by assessing incremental effects of changing operations at specific reservoirs. The intent of ESA is to balance the recovery of listed species (Snake River salmon/Kootenai white sturgeon) with the needs of unlisted stocks. Furthermore, the Executive Order 12962 of June 7, 1995 directs agencies to balance ESA recovery actions with recreational fisheries. A multi-species watershed approach can be used to balance actions for white sturgeon with actions for Snake River salmon, both recovery efforts can be balanced with important non-listed species.

The Biological Opinion, as presently implemented, conflicts with the Endangered White Sturgeons Recovery Team's current plan for white sturgeon recovery (due to the August release, see below) and the Montana state and tribes preferred operation for other non-listed stocks and recreational fisheries in the Flathead and Kootenai drainages. The IRCs, on the other hand, were designed to strike this balance. The White Sturgeon Recovery Team is currently drafting a white paper to address the apparent conflict between the NMFS Biological Opinion and the needs of sturgeon.

The August releases called for by the Biological Opinion are not consistent with the IRCs. The Salmon Biological Opinion calls for maximum discharge during August as the reservoirs are drafted to 20 feet from full pool. This release produces a second flow peak following the naturally-timed spring freshet for white sturgeon. The second peak in August is a gross departure from the natural hydrograph. A rapid flow reduction between the peaks would dewater a large portion of the river margins, stranding insects, zooplankton, and potentially fish and fish eggs. This could directly impact young white sturgeon if they use backwater areas (information on habitat requirements of sturgeon during their first year of life is sparse) or flow fluctuation could impact sturgeon prey production (sturgeon food habits during their first year is fairly well documented; insects and other invertebrates and small fish). High discharge during August is inconsistent with a natural hydrograph which would decline from a June peak to basal low flows by late July. The IRCs gradually ramp down from the spring runoff peak and moderate flow fluctuations, thus avoiding this riverine impact.

The Independent Scientific Group (ISG 1996) noted that the IRCs provide seasonality of flow in downstream reaches that are consistent with the ISG's Normative River Concept. The Group also noted "that an incremental, empirical relation between flow [in the lower Columbia] and survival [of anadromous smolts] has not been demonstrated, even though it is likely that survival is higher on high runoff (wet) years," and that non-seasonal flow augmentation [summer releases] to aid summer smolt migration in the lower Columbia River may do more harm than good because the smolts may not have accumulated necessary growth and energy reserves for successful migration. Given these uncertainties, and the obvious potential for conflicting direction in salmon and white

sturgeon recovery, scientific and policy guidance is needed to resolve this apparent conflict. The Biological Opinion contains language that allows for operational changes when new information becomes available.

The effectiveness of flow augmentation using Montana storage reservoirs was recently analyzed by Dr. James Anderson using the CRiSP 1.5 main stem smolt passage model. The results using 1996 data, substantiated concerns that flow augmentation is of little benefit to improved smolt survival. Dr. Anderson concluded, "Under observed conditions, with actual transport operations, reductions in headwater flow of the Columbia River has nearly no effect on Snake River fall chinook survival. Even in-river survival shows only minor reductions when flow is reduced (less than 0.1 percent increase in survival based on the full contribution of Montana water)."

In 1996, the IRCs were modified to reflect the current understanding of the system operation including VARQ flood control and summer smolt migration. The IRCs delay the refill date during high water years to avoid forced spill and associated gas supersaturation in the Kootenai and Flathead rivers. Pass through flows from Libby Reservoir are enhanced for the endangered white sturgeon and both projects enhance spring salmon migrations. A gradual ramp down from the spring runoff normalizes the river hydrograph while simultaneously increasing flows in August. This IRC modification, similar to the "split difference" compromise offered by Montana on May 31, 1996, allows a ten-foot draft from full pool in August after the reservoirs refill. Pass through flows, augmented with conservative storage release, can be shaped to achieve the greatest benefit for sturgeon, salmon, and non-listed stocks. Research should then be focused on the benefits and impacts of summer flow augmentation so that areas of conflict can be resolved based on empirical scientific evidence.

f. Pending ISAB Report on Montana Reservoirs

The Biological Opinion prescribes interim reservoir elevations. At the federal projects located in Montana, Libby and Hungry Horse, these limits equate to 20 feet from full. The Montana agencies and tribes that share co-management authority over the aquatic resources associated with these projects have asserted that the reservoir and riverine impacts are significant and should be eliminated or reduced. The Biological Opinion notes that NMFS did not find convincing data to suggest that the operations of the Biological Opinion would clearly damage resident fish and wildlife. In addition, it reports that there was not time to analyze fully the impact of these elevations on resident fish and wildlife. Given this controversy over the effects of operations on resident fish resources, the Independent Scientific Advisory Board has been requested to examine the issue. Exactly how the issue should be framed for the ISAB is also controversial. Some have proposed asking if the resident fish are at risk of extinction and if the operations will drive the resident fish extinct. Others have asked for an assessment of the operations in terms of the potential harm to the aquatic ecosystem in the affected headwaters reservoirs in comparison to the potential gains to migrating salmon. Still others have asked that the operations be reviewed to determine whether they are consistent with the "protect, mitigate and enhance" standards of the Northwest Power Act.

Policy guidance will be needed to help the TMT incorporate the ISAB product into river operations decisions.

g. Canadian Operations (Arrow Swap, IJC)

Each summer in the July-August period there is a possibility of performing a Libby-Arrow swap. These operations involve exchanging volume and the resultant flow. For example, if the agreement is reached for 200 ksfd (like 1996) Libby outflows are reduced by 10 kcfs for 20 days. In exchange, BC Hydro increases the outflow from Arrow by 10 kcfs for 20 days to equal 200 ksfd. These agreements are developed and implemented each year near the end of the refill season. BC Hydro will participate in these agreements if there is benefit to Canada. The benefit is not only energy, but current or future non-power benefit. If BC Hydro does not find benefit in the Libby-Arrow swap in a particular year, it will not participate in the agreement.

The International Joint Council (IJC) agreement dates back to 1938. It is an international agreement signed by the United States and Canada. It sets forth the operating scenario for Kootenay Lake in Canada. The real-time operation of Kootenay Lake is affected by the operation of the BC Hydro project Duncan, and also by Libby. The rule is such that the United States agrees to operate its projects in such a manner as to not violate the order. The Corps of Engineers has operated Libby in accordance with the order since Libby has been filled. In 1996 the Kootenay Lake Board of Control agreed to a slightly different interpretation of the order. This new interpretation may affect the spring filling schedule or summer drafting schedule of Kootenay Lake. The Corps is working with BC Hydro to prepare studies to demonstrate the difference in Kootenay Lake operations under the two operating interpretations.

The NMFS would like to pursue long-term arrangements more aggressively; this is not possible, however, according to existing treaty provisions. On an annual basis, the Corps and BPA will continue to explore possibilities with Canada, and the TMT will recommend adjustments to system operations as appropriate to optimize benefits to fish and wildlife.

h. Flood Control (VAR Q)

The water conditions in 1996 resulted in a flood draft of Libby Reservoir that was less than the draft to empty dictated by historical flood control rule curves. The 1996 Libby draft was also significantly less than the drafts dictated by a variable flow (VAR Q) operation. Despite the fact that Libby was not drafted as deep as either of these flood strategies requires, significant damage did not occur below the project as a result of the operation. This illustrates that an operational shift from conventional flood control rule curves to VAR Q is physically possible in wet years such as 1996.

The Corps of Engineers is currently performing a systemwide evaluation of flood control. Part of the evaluation includes a reconnaissance-level study of the VAR Q proposal at Libby. Under the proposed VAR Q operation, Libby is not drafted as deeply in the spring for system flood control as it had been in the past. The VAR Q consideration is often put together with a Montana Fish, Wildlife and Parks proposal for Integrated Rule Curves (IRC). By December 1996, the Corps of Engineers expects to have completed the VAR Q reconnaissance study. At that time there will be a recommendation whether or not to continue with the study. If the study is continued there will be further consideration of downstream structural measures that may be required and a cost/benefit analysis will be performed before a final recommendation is made. If implementation of IRCs and VAR Q would result in higher power costs, the region would have to decide how it

would pay for it. If implementation is recommended, the plan may not be adopted until downstream structural or mitigation activities are completed.

i. Snake River Water Management (Idaho Plan, Temperature)

A trial flow augmentation regime incorporating use of earlier, warmer water from Brownlee Reservoir and later, cooler water from Dworshak Reservoir was implemented in the summer of 1996. This plan was intended to be volume-neutral (i.e., the volume of flow provided to the Snake River would be the same under the plan). Water temperatures were cooler than in 1995 during the early part of the migration but warmer for the later part until late August, when Dworshak releases cooled the lower Snake River. Timing of the subyearling migration was slightly earlier in 1996 than in 1995; survival estimates are not yet available for 1996. Some biologists had concerns that the higher water temperatures provided from Brownlee were detrimental to the survival of juvenile chinook salmon and adult chinook and steelhead. It has been recommended that an accounting process be implemented to summarize the volume of water that has been released from Brownlee and Dworshak and the upper Snake River.

For 1997, the Corps has indicated that Dworshak Dam repairs will require a draft to 1530 by August 15 and to 1500 by September 15. Thus, Dworshak may be drafted during the summer of 1997 on a schedule that precludes implementation of a plan similar to the Idaho Plan of 1996.

j. Water Temperature

Discussions have been initiated by EPA concerning water temperature as it affects fish in the Columbia River Basin. State water quality standards generally call for temperatures of 68 degrees F or less. During the summer, water temperatures are commonly observed above 68 degrees. While direct effects on salmonid populations are not always readily apparent, concerns exist that there may be adverse effects occurring. In previous years, cold water has been released from Dworshak Reservoir to provide some cooling in the lower Snake River reservoirs. This did not occur without associated impacts on other aquatic resources, including undesirably colder water supplied to Dworshak National Fish Hatchery and impaired juvenile fall chinook rearing conditions in the lower Clearwater River. There is no established process, such as the Dissolved Gas Team (DGT), to deal specifically with water temperature. The DGT has declined to take on water temperature. EPA believes that both lethal and sublethal temperatures must be addressed and that a systemwide temperature management plan is needed to address operational changes with emphasis on an ecosystems approach. They should continue to coordinate regional efforts to address this.

To the extent that there may be specific operational recommendations to alter water temperatures in some part of the system, TMT will become involved, and issues will likely arise if decisions involve tradeoffs between different operations. A solution has been proposed regarding cold water in the hatchery water supply system, but the issue of tradeoff of benefits to the lower Snake River subyearlings versus slowed rearing of Clearwater River subyearlings still must be addressed by the fishery agencies and tribes.

The TMT will use its technical expertise to deal with in-season integration of operational requirements for these items using established decision criteria. An effective dispute resolution process or forum to deal specifically with water temperature is needed to assist the TMT in making in-season operational decisions, as these topics are frequently contentious.

k. Lower Clearwater River Operations

The operation of Dworshak Dam to provide summer and early autumn flow augmentation for the migration of endangered salmon, pursuant to the 1995 Biological Opinion, results in flow and temperature conditions that may negatively affect rearing conditions for endangered salmon in the lower Clearwater River, Idaho. Flow operations for the lower Clearwater River that are compatible with all critical life stages of endangered salmon are essential. Continued Dworshak Dam operations that are adverse to rearing habitat conditions in the lower Clearwater River may pose a risk to the persistence of endangered salmon in this portion of critical habitat. An ISAB review of the impacts of Dworshak Dam drafting on the Clearwater River stocks, relative to the potential gains to all ESA stocks, may be required to aid the TMT in future decisions regarding Dworshak operations.

l. Biological Monitoring Protocol (TDG effects)

The FPC has served a major role in collection and distribution of biological monitoring data and information throughout the region. During the 1996 migration season, there was confusion among some parties concerning monitoring protocols and how and why the monitoring efforts were modified between migration seasons. It has also been suggested that monitoring should be expanded to encompass the effects of spill on resident fish species and aquatic ecosystems when spill is shifted outside the migration corridor. Better coordination and a more consistent approach may be appropriate if TMT is to be effective in assisting in the management of spill. This issue should be coordinated by the Dissolved Gas Team.

m. Maintenance Scheduling

There are many project maintenance requirements that require special operations. In those cases where the operations could be in conflict with implementation of fish passage measures, efforts are made to reschedule for a non-passage period. When there is a time constraint, or a forced outage, adjustments may have to be made to regularly scheduled fish passage operations. Examples include periodic turbine unit maintenance, which requires outages that may affect powerhouse hydraulic capacity and result in forced spill. Spill might be acceptable if it did not result in production of TDG levels in excess of water quality standards. In other cases, the particular unit requiring maintenance may be on a priority list for fish passage designated in the Fish Passage Plan. Most scheduled outages can be accommodated without issue if there is sufficient advance coordination. Unscheduled outages or untimely requests may lead to contentious issues.

Another issue concerns tradeoffs between fish facility inspections and operational constraints. These are primarily associated with inspections of STSs and VBSs that require unit outages and should be coordinated as far in advance as possible.

Still another issue regarding maintenance scheduling is the limited time during the year when such maintenance can be scheduled to occur. Because of the possibility of high flows during the spring and summer, routine maintenance is not planned so that generators are available to reduce spill amounts. Similarly, because of the potential for high peak electrical loads during the winter, maintenance is not scheduled. The fall season is the only time during the year to accomplish this work. However, occasionally even this time of year can conflict with peak power needs, and the system reaches the limits of its generating capability.

The TMT will use its technical expertise to deal with in-season integration of operational requirements for these items using established decision criteria described in the previous section. Having an effective dispute resolution process will be important, as these topics are frequently contentious. Preseason planning and coordination with TMT and the O & M Coordination Team for expected special operations will occur and should alleviate most of the past in-season surprises and last-minute requests. The O & M Coordination Team is working with the Corps to develop long-range maintenance schedules.

n. Unit Operation Flexibility (1 percent)

The Biological Opinion specifies that turbines shall be operated within 1 percent of peak efficiency during the juvenile and adult migration seasons. There are occasions when additional unit flexibility is desired to provide increased powerhouse hydraulic capacity to avoid excessive spills and resultant TDG levels that could exceed existing state water quality standard waivers. Additional flexibility may be needed during transport barge loading or as a result of high river flows, turbine unit outages, or special operational requests. During the spring, NMFS stated that 1 percent would not be exceeded unless TDG levels exceeded 130 percent. Other options included filling Snake River pools above MOP. During summer periods when juvenile fish collection and transport is being maximized, involuntary spill (particularly at McNary) may be reduced by operating outside of the 1 percent range. Agreement is seldom reached on excursions from the 1 percent requirement and criteria should be developed for unforeseen conditions. The TMT will use its technical expertise to deal with in-season integration of operational requirements using established decision criteria. Having an effective dispute resolution process will be important, as this topic is frequently contentious.

One such unforeseen condition is the design of the extended-length bar/vertical barrier screens (VBS) at McNary. Since installation of VBS in units 1-6 in 1996, these units have been unable to run outside the one percent range because of hydraulic conditions in the gatewells and potential damage to the VBS. This reduced capacity resulted in spill during the first two weeks of December, costing over $1 million in lost revenue. With installation in units 7-14 scheduled for 1997, this could be an even costlier restriction.

o. Special Operational Requirements for Research

The Biological Opinion calls for a variety of studies, some of which may have special project-specific operational requirements that differ from the system operations specified in the Biological Opinion. For example, a part of the surface bypass program included evaluation of 30 percent versus 64 percent spill levels at The Dalles. Because the BO specifies 64 percent spill for 24 hours a day, the 30 percent spill tests could not occur without agreement for a special operation. Some special operations requests were not made with adequate advance notice to satisfy review requirements for all of the entities. Generally, Corps-funded studies are designed to occur under whatever conditions exist in the river; however, on those occasions when special requirements must be met, there could be issues raised. Preseason planning and coordination with the O & M Coordination Team, TMT, and SCT for expected special operations will occur and should alleviate most of the past in-season surprises and last-minute requests. Any conflicts with fish passage requirements that arise should be resolved prior to the fish passage season, leaving TMT to use its technical expertise to deal with in-season integration of operational requirements using established decision criteria. Having an effective dispute resolution process will be important, as these topics are frequently contentious.

p. Use of PIT Tag Forecaster or Other Methodology

The TMT has a need for model-based tools to provide timely information on fish run status. Among the tools available are the cumulative passage index produced by the Fish Passage Center, CRiSP model, and PIT Forecaster. There has been concern expressed and an unwillingness by some parties to accept certain modeling tools and/or to use modeling results to make real-time management decisions. Resolution is needed concerning the criticisms of the PIT Forecaster and its use in future years.

q. Information Services

The TMT is a public process that requires an administrative record documenting deliberations and actions. Under regional prioritization approved by the Northwest Public Power Council, there is no funding provided for recording and transcription of FY97 TMT proceedings. An agreement needs to be reached on how the administrative record will be provided. The TMT process requires the timely exchange of technical and administrative information across the basin. During 1995 and 1996, the University of Washington and Battelle Pacific Northwest Laboratory prototyped services that provide hydrographic, water quality, operations, fishery, and administrative information via the Internet to the TMT and the public. During 1996, the Fish Passage Center, the Corps, and other TMT participants expanded regional participation in such services. Under regional prioritization approved by the Northwest Power Planning Council, there is no FY97 funding provided to continue these services. There is currently a review being conducted by the StreamNet project (with participation of the States and Tribes) to evaluate what, if any, services may be absorbed into the StreamNet mission. At this time, the issue remains unresolved pending resolution by the Council and implementation by regional data managers. The TMT needs to evaluate the utility of the prototyped services with recommendations to StreamNet or other prioritizing bodies.

r. Juvenile Fish Transportation

The Biological Opinion specifies that the Corps shall transport all fish collected at the lower Snake River collector projects unless the TMT recommends otherwise or transportation facilities are out of criteria. Spring migrants collected at McNary are to be returned to the river after PIT tag detection until subyearling chinook predominate the daily total chinook collection for three consecutive days. High flows, resulting in high spills and excessive TDG production, prompted recommendations from some entities for development of decision criteria for when transportation might be initiated at McNary for spring migrants.

Another transport issue involved the proportion of juvenile fish that should be transported from Snake River projects, given the high river flows of 100 Kcfs and greater, and the presumed improved in-river migrating conditions. Various entities are strongly divided on the benefits of juvenile fish transport in general, and this influences recommendations for system operations during the downstream migration season. Some parties have also suggested that more subyearlings should be allowed to migrate inriver (present criteria call for no spill at collector projects in the summer).

s. Dissolved Gas Management

The above-average river flows in 1996 resulted in high levels of forced spill at times that produced elevated TDG levels, above the levels allowed even with the state water quality standard waivers. One major issue involved whether or not to spread the spill/TDG by releasing more water early, prior to the peak downstream migration period, so that TDG could be maintained at acceptable levels when the majority of the juvenile migrants would be present. Similar situations could occur in future years. A regional policy needs to be developed by the state and federal water quality entities to address this issue, including development of decision criteria for implementation, if necessary.

t. Reservoir Operation at MOP

The reservoir operating range of the four Snake River pools is limited to one foot for the entire juvenile and adult fish passage season (March 1 through December 31) and a portion of that time in the lowest foot of the operating range (March 1 until late August). The operation at lowest pool is commonly referred to as MOP (minimum operating pool). Three perceived benefits of these restrictions are decreased particle travel time, more constant flows through the project reaches, and, for a portion of the period, deeper adult ladder weir depths. The justification for these restricted operating ranges changes throughout the season relative to requirements for juvenile and adult fish. In the spring, the Snake River projects are required to operate within the lowest foot of operation in each pool to reduce cross-sectional area. This increases particle travel velocity and theoretically decreases juvenile fish travel time to the estuary. This operation also forces a conflict with the requirements of having the adult fish ladders at or above the eight foot weir criteria outlined in the the Corps' Fish Passage Plan.

Sometime in August there is a transition into priority for adult fish passage and the interest is in having the lower three Snake pools filled to once again comply with the ladder criteria. This filling of the pools tends to be a contentious operation because of a possible slowing down of late-season juvenile migrants. There is also some doubt as to the benefits of having an eight-foot weir depth instead of the six-foot depth to which the ladders were designed to operate.

The overriding result of this operation for the entire season is that it hampers the hydropower system's ability to store and release water to meet peaks in load. The time of year when this restriction conflicts most with system operations and creates conflicting biological effects is in the late summer and fall period when the flows drop off and the system places more emphasis on peaking at Grand Coulee and Chief Joseph Dams. In some years, this restriction will be a contributing factor to having redds created on Vernita Bar above protection levels that can be maintained with available water.

Filling Snake River pools above MOP and subsequent drafting may allow river operators and fish managers to experiment with pulsed flows, as called for in the Biological Opinion and as discussed in the ISG Return to the River report. With pulsed flows it may be possible to create wave effects that result in wave pulses that travel by a factor of 1.3 to 4 times faster than the actual water mass (page 533).

u. FERC Projects

Numerous dams are scheduled for issuance of a new FERC license. Some projects are at the initial stages of the FERC review, while others are near the final stage. The review work is voluminous, the implications for fish and wildlife potentially huge, the effects on listed or near-listed species imminent, and the cumulative impacts elusive or unexamined.

Even though the license schedules often extend beyond the five-year period, the scoping and study schedules are mostly within this period. Therefore, a five-year plan should identify the problems and opportunities for fish and wildlife management in the Columbia River Basin through the FERC license review. Should FERC do a cumulative impact analysis under the ESA? Should FERC do a comprehensive EIS for all the projects?

The NMFS is currently involved in several re-license work groups that need policy direction from a regional forum. For example, the Hells Canyon Complex (HCC) work groups have submitted proposals for data collection and analysis. The studies hopefully will answer many questions regarding anadromous fish habitat and migration. A similar process is underway for development of a Habitat Conservation Plan for the mid-Columbia River projects. Efforts are also underway at upper Snake River FERC projects.

Should FERC stipulate the reintroduction of salmon and steelhead above HCC? Should passage facilities, if needed, take advantage of new technology proposed at FERC licensed projects on the Deschutes? Should the five-year plan include a different operation of Brownlee Dam to aid the migration of listed salmon below the HCC? If so, should FERC modify the current license to include this operation?

v. Considerations for Steelhead (Proposed for ESA Listing) During 1997 Operations.
NMFS is considering listing steelhead for protection under the ESA. Conferencing activities will occur during the 1997 season to assure that the proposed stocks are not jeopardized by proposed operations. Protection requirements for steelhead may differ from current activities to protect listed Snake River salmon, which are mainly transport from the Snake River projects, transport from McNary Dam, and spill operations that affect the number of fish collected for transportation. Policy guidance is needed if there is to be a shift in emphasis for operations to include considerations for steelhead. If a policy-level decision is made to provide some additional protection measures for steelhead, guidance will be needed for in-season decisions. This includes a need for criteria to allow prioritization of activities.

4.6.2 In-Season Decision-Making and Conflict Resolution

The key elements for successful in-season decision-making and program implementation will be an agreed-upon operational approach, identification of criteria to guide in-season decisions, and establishment of a dispute resolution process, as discussed in the previous section. Then, the TMT can use its technical expertise to develop in-season operations that optimize conditions for fish and wildlife. When the TMT cannot reach agreement on an operation, the issue will be elevated to the IT for resolution. Currently, the dissenting party(ies) are to provide a written summary of the issue and the rationale for their position; however, it is necessary to be sure the issue is clearly presented and is appropriate for elevation to the IT. In the past the IT returned a number of issues to the TMT for further clarification or supporting documentation, or because they were issues that had previously been resolved but the resolution was not acceptable to one party. There is also a need for contingency planning to accommodate changes in projected conditions that may need to occur after TMT meetings.

4.6.3 Definition of and Procedures for Emergencies

On August 12, 1996, BPA declared a power emergency. Spill for fish protection was severely reduced at The Dalles Dam. Reduced spill continued for four days at 20, 0, 2, and 33 percent of

daily average flow compared to the 64 percent that was being provided for juvenile fish passage under the Biological Opinion. The incident brought to light the need for:

- The definition of an emergency, i.e., under what circumstances will implementation of the Biological Opinion be interrupted
- Development of specific criteria and procedures for declaring emergency situations
- Development of a clear procedure to be followed in emergency situations

Replacement spill for spill not provided August 12-15, 1996, was proposed by the fishery managers for early September after termination of prescribed fish spill. Spill was proposed to be provided on a percent spill replacement basis, i.e., the difference in the percent daily average spill between 64 and the level that occurred during the emergency was to be provided at a later date. However, this approach did not address the fact that the number of fish at The Dalles was not the same (fewer) during the replacement spill as during the emergency. Some parties proposed fish-equivalent mitigation. This incident brought to light the need for:

- Determination of the applicability of a "mitigation" concept
- A determination of the need for and, if necessary, the method of mitigation for emergencies that reduce fish protection below that required in the Biological Opinion
- Establishment of criteria to be used in determining the need for mitigation and the type of mitigation required
- Selection of potential alternative sites for mitigation

4.7 Costs

4.7.1 Technical Management Team

This forum was initiated in 1995. Its membership and rules of procedure are being reviewed and formalized as required in the recently signed Memorandum of Agreement. Participation in this forum is paid for by each participating member, and there is no funding requirement associated with its work.

4.7.2 Reservoir Control Center

4.7.2.1 Technical Management Team Home Page

The Corps will continue to fund the operational costs associated with maintenance and necessary enhancement of the home page, including timely data posting and updating, linkage with other pertinent web pages, normal overhead, and keeping up with the Internet state-of-the-art technique in presenting data for public use on the information highways. Projected annual cost: $30,000.

4.7.2.2 Dissolved Gas (and Water Temperature) Monitoring Program

The Corps will continue to collect dissolved gas and water temperature data on a real-time basis, and make them available to decision-makers and other water users. This program requires annual deployment and removal of data collection and transmission equipment, regular O&M schedules, and additional special transect and other monitoring studies. Additions of new monitoring sites and year-round operation at selected locations will be carried out as recommended by the region.

Projected annual cost for a network of 33 stations (including 6 year-round): $750,000. Special one-time monitoring cost is not included.

4.7.2.3 Communication and Conference

In order to cut travel cost for TMT participants, “meet-me” conference call lines need to be secured for year-round use by all participants in the TMT process. In some instances, video conferencing may also be required. The projected cost is about $28,000 for conferencing equipment at each site. Use of teleconferencing costs about $500 per hour, or $72,000 annually for two sites. Each additional site would cost about $36,000 annually for use.

4.7.2.4 Costs Incurred by other TMT-related Activities

Participation in the TMT process requires frequent travel and entails additional administrative costs to federal, state and tribal agencies. The list of such agencies includes but is not limited to: Corps, NMFS, USFW, Bureau of Reclamation, Weather Service’s River Forecast Center, and others. Cost for notetaking and minutes for the TMT meetings is $13,000 per year.