

2002 Water Management Plan

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1.0 Introduction

1.1 Preparation of Plans

This Water Management Plan for 2002 has been prepared as part of the implementation planning process outlined in the 2000 Biological Opinions (BiOps). This plan describes how the Federal Columbia River Power System (FCRPS) reservoirs will be operated for the 2002 water year (October 1, 2001 through September 30, 2002) to implement the water management measures in the BiOps. This plan will also describe any special operations or water management activities planned for the 2002 water year.

Per the BiOps, the action agencies will annually prepare a 1-year water management plan that covers FCRPS hydro operations in the upcoming water year. These plans will generally be drafted in July and completed by the end of September. The plan will cover the upcoming water year, which begins on October 1 and ends on September 30 the following year. This one-year plan will be written when very little information is known about the future year's water supply. Therefore, the annual water management portion of the 1-year implementation plan will generically describe how the FCRPS will be operated during the year. It will also include any special operations (such as any special tests, implementation of VARIABLE Q (flows) Flood Control Procedure (VARQ) at a project, etc.) planned for the year.

The action agencies will also develop more detailed in season action plans to describe how the FCRPS projects will be operated under actual conditions with current water supply forecasts. The first action plan will be prepared in the fall to address the fall/winter operation of the FCRPS projects. A spring update, will be drafted in January and finalized in the March/April time period to address the spring/summer operation of the FCRPS projects.

1.2 Strategy

The overall strategy for the water management plan is to enhance juvenile and adult fish survival through a coordinated set of hydro project management actions to achieve performance standards. The plan is structured to address the following substrategies associated with this overall strategy:

1. Reservoir Operations to enhance fish survival: Actions under this substrategy are generally specific project operations that benefit fish at or near the project or its reservoir.
2. System Flow Management to enhance fish survival: This substrategy includes coordinated system operations for mainstem flow management and redd protection.
3. Spill Operations for project passage: This substrategy includes spill operations at individual projects to provide a better project passage for juvenile fish while avoiding high dissolved gas levels or adult fallback problems.
4. Juvenile fish transport actions to enhance fish survival: This substrategy includes actions to collect juvenile fish at selected projects for transport past mainstem dams.

5. Other actions to enhance water management: This substrategy includes water management related actions that are being done to improve fish survival, such as studies, water quality actions and water conservation improvements.

1.3 Changes From Last Year's Plan

This is the first water management plan developed under the 2000 BiOps.

Prior to 2001, the Technical Management Team (TMT) had developed annual Water Management Plans. These plans primarily described operations needed to comply with existing biological opinions, as well as relevant factors affecting those operations and any special research operations planned for the year. Similarly, this 2002 Water Management Plan contains most of the operational actions contained in TMT's plans. The operational actions outlined in this plan are intended to help the Action Agencies achieve the performance standards in the 2000 BiOps by improving hydro system survival of juvenile and adult salmon. The Action Agencies intend to seek input from TMT on this plan prior to its finalization.

Last year in response to the low water conditions and unprecedented power market conditions, in March 2001, six Federal agencies (U.S. Army Corps of Engineers (COE), Bureau of Reclamation (Reclamation), Bonneville Power Administration, U.S. Fish & Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), and Environmental Protection Agency) developed a set of reliability criteria and priorities for fish operations for water year 2001 operations. In April, the agencies developed an operations plan to guide water management decisions in consideration of the established criteria and prioritization of operations from the 2000 BiOps. Input from states, tribes, and other regional parties were considered in the development of this plan. Hopefully the convergence of both a low water year and an electrical shortage in 2001 were a very unique occurrence. It is anticipated that in future years the actions called for in the BiOps will be implemented consistent with any modifications made through adaptive management and reflected in annual and 5-year implementation plans.

2.0 Hydro System Operation

2.1 Priorities

The NMFS and USFWS BiOps list the following strategies for flow management:

- Limit the winter/spring drawdown of storage reservoirs to increase spring flows and the probability of reservoir refill.
- Draft from storage reservoirs in the summer to increase summer flows.
- Provide minimum flows in the fall and winter to support mainstem spawning and incubation flow below Bonneville Dam.

The Action Agencies have reviewed these strategies and other requirements in the BiOps and developed the following priorities (in order) for flow management and individual reservoir operations:

- Operate storage reservoirs (Hungry Horse, Libby, Dworshak, and Albeni Falls) to meet criteria for bull trout and sturgeon.
- Refill the storage projects by June 30 to provide summer flow augmentation.

- Operate storage projects to be at their April 10 flood control elevation to increase flows for spring flow management.
- Provide fall and winter flows for chum spawning.

The Action Agencies implement several independent FCRPS project operations to benefit fish at or near the project or its reservoir. Reservoirs are to be operated to meet project minimum outflows, to reduce outflow fluctuations to avoid stranding resident fish, to reduce cross sectional area to speed juvenile passage, and to make specific temperature releases to improve water temperatures for fish. These operations are generally the highest priority and not likely to change from the BiOp requirements.

In an operating year that begins on October 1, the flow needs are not encountered in the same order as the priorities, i.e., the first decision to be made is for chum spawning flows which ultimately have a lower priority than summer flows. So chronologically, the Action Agencies will attempt to operate during the year as follows.

The initial objective is to operate the storage reservoirs (Dworshak, Hungry Horse, Libby, Albeni Falls, and Grand Coulee) to be at flood control levels by early April. This level varies by runoff forecast. Reaching early April flood control levels will be affected by how much water was released for flood control, power generation, and fishery flows to support both chum and Hanford reach spawning. There may be years when chum and Hanford Reach flows may need to be reduced in order to be at the early April flood control levels.

The next objective is to refill the storage reservoirs by about June 30 to maximize available storage of water for the benefit of summer migrants. The June 30 refill would have priority over spring flow (April, May, June) objectives, although there would be an attempt to meet the spring flow objectives and other fish needs.

The final objective is the management of available storage to augment summer (July and August) flows to achieve flow objectives and for water temperature control. The storage reservoirs will be drafted to their specified August 31 draft limits to augment summer flows. These limits would have a higher priority over the summer flow targets in order to meet other project uses and reserve water in storage for 2003.

These objectives are intended as general guidelines in overall system operations. The BiOps also embrace the concept of adaptive management. Adaptive management is the concept that the operation of the system should account for current information on stock status, biological requirements, and hydrologic and environmental conditions as opposed to following a rigid set of rules. System managers recognize that there is often insufficient water to meet all the actions specified in the BiOps and meet other system obligations such as flood protection, power system reliability, irrigation, recreation, and navigation needs. The use of water for any one fish species or project purpose will most likely affect the amount of water available for other fish species or project purposes. Therefore, the Action Agencies, in coordination with regional parties through the TMT, endeavor to balance the multiple purposes of the system, and keep the provision of measures to benefit listed species a high priority.

2.2 Conflicts

As stated above, there usually is not enough water available in the Columbia River basin to meet every action item stated in the BiOps and provide for other project purposes. Below are some of the main conflicts that may occur.

2.2.1 Flood control draft versus project refill

One way to maximize flood control is to provide abundant storage space in the event a large flood occurs. Conversely, the BiOps require that the storage projects be as full as possible to increase the likelihood of refill and provide flows for spring flow management and summer flow augmentation. Therein lies the conflict. The BiOp requires that the FCRPS storage reservoirs be at the April 10 flood control elevation is a balance between flood control and the need to provide flow for listed species.

Flood control procedures specify the amount of storage needed to protect against flooding. In many years not all the space is needed although it was provided to reduce the risk of forecast and runoff uncertainty. In an effort to reduce forecast error and to better anticipate the runoff timing or water supply will be for a given year, the BiOps require the action agencies to study the system flood control requirements and forecast procedures to determine if they can be improved.

2.2.2 The provision of spring flows versus project refill and summer flow augmentation

Again, because water supply and runoff forecasts are not 100 percent accurate, it is hard to estimate how much water is available for spring flows and still assure refill at the storage projects by June 30. If too much water is allowed to flow through the storage reservoirs instead of being used to refill, there is an increased risk of not refilling the projects. This will reduce the water supply available for summer flow augmentation. On the other hand refilling the reservoirs too quickly in the spring results in early refill and less control of the amount and timing of the spring flows. This could also increase the risk of damage from flooding and potentially produce higher dissolved gas levels.

2.2.3 Chum flows versus refill/Spring flows

Setting the flow level for chum spawning and incubation in recognition of the spring refill priority is one of the decisions that the Action agencies in consultation with TMT have to make with the least amount of reliable information. Decisions about the flow level for chum spawning and incubation are made in the October/November time period, long before the action agencies have reliable information on the coming year's expected water supply. If the flow level selected is too high there is a risk of refill failure. Choosing to refill runs the risk of reducing the flow level and dewatering chum redds. A chum salvage plan is now being prepared to ensure some level of chum salmon production occurs in the event chum flows cannot be provided.

2.2.4 Sturgeon pulse versus summer flow augmentation

Water released from Libby Dam for the spring sturgeon pulse during May through June may reduce the water available for summer flow augmentation from Libby. If the pulsed water cannot be stored in Grand Coulee, it will increase spring flows at the expense of summer flows.

2.2.5 Fish operations versus other project purposes

In addition to flood control operation, there are operations carried out for the purpose of enhancing fish survival that may conflict with other project purposes. For example, keeping the flow steady below a project for resident and anadromous fish needs conflicts with the ability to use a project to follow electrical load changes; spilling water for juvenile fish passage reduces the amount of power that can be generated to meet demand; and augmenting flows during fish migration periods may conflict with the shape of power demand. Additionally, irrigation demands and recreation elevations at headwater reservoirs may impact the amount of water available for spring flows.

2.2.6 Conflicts and priorities

The conflicts described above pose many challenges to the Action Agencies in meeting the multiple purposes of the Federal hydro system. Given these challenges, the priorities for flow management and individual reservoir operations outlined in section 2.1 will guide the Action Agencies in their operational decision making when conflicts arise. Discussion of conflicts between operations and alternatives for addressing such conflicts will occur in TMT.

2.3 Emergencies

The 2000 BiOps acknowledge that unexpected events/emergencies can occur that may cause deviations from fish operations. Such deviations may be short in duration, such as a deviation to respond to an unexpected unit outage or power line failure, or longer in duration, such as experienced this past year in response to the low water conditions and unprecedented power market conditions. The TMT has developed Emergency Protocols to be followed to respond to short-term emergencies.

(See TMT homepage at <http://www.nwd-wc.usace.army.mil/TMT> for current version of protocols.)

As the NMFS BiOp anticipated, not all of the operations called for in the BiOp can be fully implemented under all conditions. Near-record drought conditions prevented full implementation of flow and spill operational measures in 2001. Another significant factor in 2001 was a newly deregulated power market. Electric energy prices rose to unprecedented levels, limiting options to respond to the drought. In the midst of these trying conditions, the Action Agencies began implementation of the NMFS and FWS 2000 BiOps. We expect that, in 2002, as the region considers lessons learned from 2001, those lessons will be reflected in seasonal updates of the water management plan. Adverse effects from 2001 may extend into 2002.

2.4 Research

Research studies sometimes require special operations that differ from routine operations otherwise described in the Biological Opinion's. These studies are generally developed through technical workgroups of the Regional Forum (e.g., SCT) and the COE' Anadromous Fish Evaluation Program (FFDRWG and SRWG) and further described in 1- and 5-Year Implementation Plans. In most cases, operations associated with research entail relatively minor changes from routine operations and are coordinated in technical forums (e.g., TMT, FPOM). In

some cases, the nature or magnitude of operational changes for research may require further coordination and review in policy forums (e.g., IT). Generally, research planning and coordination occurs throughout the late fall and winter, with final research plans established by late winter/early spring. In extraordinary events such as extreme low runoff conditions or power emergency, planned research may be modified prior to spring to accommodate anticipated unique circumstances and/or to reallocate resources to obtain the greatest value given the circumstances.

3.0 Decision Points and Water Supply Forecasts

The table below lists the key water management decisions and when they need to be made. Some decision points, such as setting flow objectives, are clearly articulated in the BiOps. Other decision points, such as setting flow augmentation goals, require much discussion and coordination. Some of the decision points given below are spelled out in the BiOps and some are based on past experience. These decisions are made by the action agencies in consideration of requirements in the BiOps and of input received through the Regional Implementation Forum (TMT, IT, Regional Executives).

	Early October	Winter (December – March)	Early April	Early May	June	Early July
Operations	<ul style="list-style-type: none"> • Assess potential of providing flows for Chinook populations below Bonneville Dam (<i>Non-BiOp Action</i>) • Assess potential flow levels to support chum spawning below Bonneville Dam • Preliminary discussions of flood control/ project refill strategy • Albeni Falls fall/winter draw down strategy discussion • Hanford Reach /Vernita Bar flows set (<i>Non-BiOp Action</i>) • Determine Integrate Rule Curves at Hungry Horse 	<ul style="list-style-type: none"> • Determine winter/spring chum flow levels below Bonneville Dam • Determine flood control and refill strategies, including any available flood control shifts • Minimum flows from Hungry Horse Dam and minimum Columbia Falls flows are set by April-August forecast • Begin discussing spring operations • Spring Creek Hatchery release –March (<i>Non-BiOp Action</i>) • Begin spring transport discussions • Hanford Reach Operations Discussed (<i>Non-BiOp Action</i>) • Outlook for meeting flow objectives prepared 	<ul style="list-style-type: none"> • Spring flow objectives are set by the April final volume forecasts • Determine spring flow management strategy including priority for refill • Determine start dates and levels by project for spring spill • Determine start date for MOP at Lower Snake River projects • Determine John Day forebay elevations 		<ul style="list-style-type: none"> • Summer flow objective at Lower Granite determined by June final volume forecast • Determine summer flow augmentation strategy (early June) • Complete Dworshak temperature modeling and determine release strategy • Decision on McNary juvenile fish transportation (late June) 	<ul style="list-style-type: none"> • Grand Coulee summer reservoir draft limit determined by July final volume forecast
Plans	Develop fall/winter update to the annual water management plan	Preliminary work on spring/summer update to the annual water management plan	Start operational plans for Libby and Hungry Horse Dams	Libby and Hungry Horse operational plans due		

Forecasts		<ul style="list-style-type: none">January, February, and March volume forecasts released by the RFC	April final forecast released by RFC		June final forecast released by RFC	
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Water supply forecasts

Water supply forecasts are used as a guide to how much water is available for fish and other operations.

The National Weather Service’s Northwest River Forecast Center, COE Northwest Division Hydrologic Engineering Branch, Reclamation, and others prepare water supply forecasts to manage the Columbia River. The table below lists the forecasts that are referenced by the NMFS 2000 BiOp and the USFWS 2000 BiOp.

Forecast Point	Forecast period	Forecast	What does it control	BiOp reference	RPA Action Item
Lower Granite	April – July	April Final	Spring Flow objective at Lower Granite	NMFS BiOp at Section 9.6.1.2.1 Page 9-57	NMFS Action 14
Lower Granite	April – July	June Final	Summer Flow objective at Lower Granite	NMFS BiOp at Section 9.6.1.2.1 Page 9-57	NMFS Action 14
The Dalles	April – August	April Final	Spring Flow objective at McNary Dam	NMFS BiOp at Section 9.6.1.2.1 Page 9-57	NMFS Action 14
Hungry Horse	April – August	March Final provided by Reclamation	Hungry Horse minimum flows	NMFS BiOp at Section 9.6.1.2.3 Page 9-63 USFWS BiOp at Section 3.A.1 Page 6	NMFS Action 19
Hungry Horse	April – August	March Final provided by Reclamation	Columbia Falls minimum flow	NMFS BiOp at Section 9.6.1.2.3 Page 9-63 USFWS BiOp at Section 3.A.1 Page 7	NMFS Action 19
The Dalles	April – August	July Final	Grand Coulee Summer Draft Limit	NMFS BiOp at Section 9.6.1.2.3 Page 9-64	NMFS Action 19
Libby	April – August		Volume of Water for Sturgeon Flow at Bonners Ferry and Minimum bull trout flows between sturgeon and salmon flows	USFWS BiOp at Section 8.1 Page 74 and USFWS BiOp at Section 3.A.2 Page 15	USFWS Action f-3

4.0 Sub-Strategies: Reservoir Operations and System Flow Management to Enhance Fish Survival

These substrategies include individual and system operations of the FCRPS. The two substrategies Reservoir Operations to enhance fish survival and System Flow Management to enhance fish survival are discussed in one section in the water management plan in order to conveniently group the operational actions for one project in one section.

The substrategy “Reservoir Operations to enhance fish survival” generally includes independent FCRPS projects operations which benefit fish at or near the project or its reservoir and increases system survival by improving mainstem passage conditions. Reservoirs are to be operated to meet project minimum outflows, to reduce outflow fluctuations to avoid stranding resident fish, to reduce cross sectional area to speed juvenile passage, and to make specific temperature releases to improve water temperatures for fish.

The following table summarizes the major fish-related reservoir and flow operations by project. More detailed descriptions of each of these operations follows.

Project	Flood Control & Refill	Sturgeon	Bull Trout	Spring Anadromous	Summer Anadromous	Chum	Kokanee
Libby	<p><u>Winter:</u> Operate to flood control rule curve by April 10</p> <p><u>Spring:</u> Operate to meet flow objectives and June 30 refill</p>	May-June augment flows at Bonners Ferry for sturgeon pulse	<p><u>Year Round:</u> Operate to minimum flows and project ramping rates to minimize adverse affects of flow fluctuations</p>	Operate to meet flow objectives and June 30 refill	<p><u>July/August:</u> Draft for summer flow augmentation, not to exceed reservoir draft limit of 2,439 feet</p>	Fall / winter Storage may be used to support Chum Flows	
Hungry Horse	<p><u>Winter:</u> Operate to VARQ flood control</p> <p><u>Spring:</u> Operate to meet flow objectives and June 30 refill</p>		<p><u>Year Round:</u> Operate to Columbia Falls minimum flows and project ramping rates to minimize adverse affects of flow fluctuations</p>		<p><u>July/August:</u> Draft for summer flow augmentation, not to exceed reservoir draft limit of 3,540 feet</p>	Fall / winter Storage may be used to support Chum Flows	
Albeni Falls	<p><u>Winter:</u> Operate to flood control rule curve by April 10</p> <p><u>Spring:</u> Operate to meet flow objectives and June 30 refill</p>					Fall / winter Storage may be used to support Chum Flows	<p><u>Fall/Winter:</u> Maintain elevation 2,051 feet until kokanee fry emergence (approximately end of April)</p>
Grand Coulee	<p><u>Winter:</u> Operate to flood control rule curve by April 10</p> <p><u>Spring:</u> Operate to meet flow objectives and June 30 refill</p>				<p><u>July-August:</u> Draft for summer flow augmentation, not to exceed reservoir draft limit of 1,280 feet (\geq 92 Maf fcast at The Dalles) or 1,278 feet ($<$ 92 Maf fcast at The Dalles)</p>	Fall / winter Storage may be used to support Chum Flows	

Project	Flood Control & Refill	Sturgeon	Bull Trout	Spring Anadromous	Summer Anadromous	Chum	Kokanee
Grand Coulee (continued)					July/August: Operate Banks Lake at elevation 5 feet less than full to provide more water for summer flow augmentation		
Dworshak	<p><u>Winter</u>: Operate to flood control rule curve by April 10</p> <p><u>Spring</u>: Operate to meet flow objectives and refill by June 30</p>				Draft for summer flow augmentation and water temperature reduction, not to exceed reservoir draft limit of 1,520 feet	Fall / winter Storage may be used to support Chum Flows	
Lower Granite				<p>Flow objective of 85-100 kcfs</p> <p>Operate within 1 foot of MOP to reduce juvenile travel time</p> <p><u>Mar 15-Nov 30</u> Operate to 1% peak efficiency</p>	<p>Flow objective of 50-55 kcfs</p> <p>Operate within 1 foot of MOP to reduce juvenile travel time</p> <p><u>Mar 15-Nov 30</u> Operate to 1% peak efficiency</p>		
Little Goose				<p>Operate within 1 foot of MOP to reduce juvenile travel time</p> <p><u>Mar 15-Nov 30</u> Operate to 1% peak efficiency</p>	<p>Operate within 1 foot of MOP to reduce juvenile travel time</p> <p><u>Mar 15-Nov 30</u> Operate to 1% peak efficiency</p>		
Lower Monumental				<p>Operate within 1 foot of MOP to reduce juvenile travel time</p> <p><u>Mar 15-Nov 30</u> Operate to 1% peak efficiency</p>	<p>Operate within 1 foot of MOP to reduce juvenile travel time</p> <p><u>Mar 15-Nov 30</u> Operate to 1% peak efficiency</p>		

Project	Flood Control & Refill	Sturgeon	Bull Trout	Spring Anadromous	Summer Anadromous	Chum	Kokanee
Ice Harbor				Operate within 1 foot of MOP to reduce juvenile travel time <u>Mar 15-Nov 30</u> Operate to 1% peak efficiency	Operate within 1 foot of MOP to reduce juvenile travel time <u>Mar 15-Nov 30</u> Operate to 1% peak efficiency		
McNary				Flow objective of 220-260 kcfs <u>Mar 15-Oct 31</u> Operate to 1% peak efficiency	Flow objective of 200 kcfs <u>Mar 15- Oct 31</u> Operate to 1% peak efficiency		
John Day				<u>Apr 10-Sep 30</u> Operate within 1.5 foot of MIP to reduce juvenile travel time <u>Mar 15-Oct 31</u> Operate to 1% peak efficiency	<u>Mar 15-Oct 31</u> Operate to 1% peak efficiency		
The Dalles				<u>Mar 15-Oct 31</u> Operate to 1% peak efficiency	<u>Mar 15-Oct 31</u> Operate to 1% peak efficiency		
Bonneville				<u>Mar 15-Oct 31</u> Operate to 1% peak efficiency	<u>Mar 15-Oct 31</u> Operate to 1% peak efficiency	If hydrologic conditions indicate system can likely maintain minimum flow below BON of 125 kcfs Nov 1-April, implement mainstem chum flows. If not, provide flows below BON to enable access to creeks for spawning.	

4.1 Flow Objectives

The purpose of the flow objectives is to aid in achieving the hydro system performance standards by providing better instream flow to aid in juvenile migration and by enhancing water quality.

4.1.1 Lower Granite

4.1.1.1 Spring anadromous fish

The spring flow objective at Lower Granite Dam is determined by the April final runoff volume forecast at Lower Granite Dam for April to July.¹ When the forecast is less than 16 Maf the flow objective will be 85 kcfs. If the forecast is between 16 Maf and 20 Maf the flow objective will be linearly interpolated between 85 kcfs and 100 kcfs. If the forecast is greater than 20 Maf the flow objective will be 100 kcfs. The planning dates for the flow objective will be from April 3 to June 20.

4.1.1.2 Summer anadromous fish

The summer flow objective at Lower Granite Dam is determined by the June final runoff volume forecast at Lower Granite Dam for April to July.¹ When the forecast is less than 16 Maf the flow objective will be 50 kcfs. If the forecast is between 16 Maf and 20 Maf the flow objective will be linearly interpolated between 50 kcfs and 55 kcfs. If the forecast is greater than 20 Maf the flow objective will be 55 kcfs. The planning dates for the flow objective will be from June 21 to August 31.

4.1.2 Priest Rapids—Spring anadromous fish

The spring flow objective at Priest Rapids dam is 135 kcfs.¹ The planning dates are from April 10 to June 30.

4.1.3 McNary

4.1.3.1 Spring anadromous fish

The spring flow objective at McNary Dam is set according to the April final runoff volume forecast at The Dalles Dam for April to August.¹ When the forecast is less than 80 Maf the flow objective will be 220 kcfs. If the forecast is between 80 Maf and 92 Maf the flow objective will be linearly interpolated between 220 kcfs and 260 kcfs. If the forecast is greater than 92 Maf the flow objective will be 260 kcfs. The planning dates for the flow objective will be from April 10 to June 30.

¹ NMFS BiOp at Section 9.6.1.2.1 Page 9-57, Action 14

4.1.3.2 Summer anadromous fish

The summer flow objective at McNary Dam is 200 kcfs.² The planning dates for the flow objective will be from July 1 to August 31.

4.2 All Storage Projects

The purpose of the following actions is to refill FCRPS storage projects as much as possible for spring flows and summer flow augmentation.

The FCRPS dams will be operated during the winter season in order to achieve a high probability of water surface elevations within 0.5 foot of the flood control rule curve by April 10 and to refill by June 30, except as specifically provided by the TMT.³

During the spring, the Action Agencies shall operate the FCRPS to meet the flow objectives and refill the storage reservoirs (Albeni Falls, Dworshak, Grand Coulee, Hungry Horse, and Libby) by approximately June 30.⁴ If both these objectives cannot be achieved, the TMT will make an in-season decision, weighing considerations unique to each particular year. Because research results indicate that increased flows have more direct survival benefits for summer than spring migrants, modest reductions in spring flows to facilitate reservoir refill would generally be preferable to refill failure.

During the summer, the Action Agencies draft mainstem storage reservoirs within the BiOp's specified draft limits, based on flow recommendations provided by TMT. TMT considers a number of factors when developing its flow recommendations, such as: the status of the migration, attainment of flow objectives, water quality, and the effects that reservoir operations will have on other listed and resident fish populations.

4.3 Libby

4.3.1 Flood Control

Libby will be operated during the winter season in order to achieve a high probability of water surface elevations within 0.5 foot of the flood control rule curve by April 10 and to refill by June 30, except as specifically provided by the TMT.³

During the spring, the Action Agencies shall operate Libby to contribute to meeting the flow objectives and refill by approximately June 30.⁴

4.3.2 Sturgeon

The purpose of the actions below is to provide water for sturgeon spawning.

Water shall be stored in Libby reservoir and supply, at a minimum, water volume during May and June based upon water availability or the "tiered" approach as defined

² NMFS BiOp at Section 9.6.1.2.1 Page 9-58, Action 14

³ NMFS BiOp at Section 9.6.1.2.1 Page 9-56, Action 14 and NMFS BiOp at Section 9.6.1.2.3 Page 9-61, Action 18

⁴ NMFS BiOp at Section 9.6.1.2.3 Page 9-61, Action 18

and summarized in the table below. This water shall be in addition to storage needs for listed bull trout, salmon, and the 4,000 cfs minimum releases from Libby Dam. Accounting on these total tiered volumes shall begin when the USFWS determines benefits to conservation of sturgeon are most likely to occur. This may include releases timed to enhance survival of eggs, yolk sac larvae, or larvae reared under the preservation stocking program and released into the Kootenai River. Releases may be timed to serve both wild fish and hatchery eggs/fish. Sturgeon flows will generally be initiated between mid-May and the end of June to augment lower basin runoff entering the Kootenai River below Libby Dam.⁵

Forecast runoff Volume (Maf) at Libby	Tier	Sturgeon Flow (Maf) at Bonners Ferry
0.00 < forecast < 4.80	1	Sturgeon flows not requested
4.80 < forecast < 6.00	2	1.42
6.00 < forecast < 6.70	3	1.77
6.70 < forecast < 8.10	4	2.56
8.10 < forecast < 8.90	5	3.89
8.90 < forecast	6	4.77

Minimum “tiered” volumes of water for sturgeon flow enhancement to be provided at Bonners Ferry according to April-August volume runoff forecasts at Libby.

When VARQ at Libby is implemented water shall be stored in Libby reservoir and supply, at a minimum, water volumes during May, and June, based upon water availability or the “tiered” approach as defined and summarized in the table below. This water shall be in addition to storage needs for listed bull trout, salmon, and the 4,000 cfs minimum releases from Libby Dam. Accounting on these total tiered volumes shall begin when the USFWS determines benefits to conservation of sturgeon are most likely to occur. This may include releases timed to enhance survival of eggs, yolk sac larvae, or larvae reared under the preservation stocking program and released into the Kootenai River. Releases may be timed to serve both wild fish and hatchery eggs/fish. Sturgeon flows will generally be initiated between mid-May and the end of June to augment lower basin runoff entering the Kootenai River below Libby Dam. The following volumes are for planning purposes only. Final minimum tiered sturgeon volumes shall be based on further studies involving May, June, and July volumes and daily modeling. Final tiered sturgeon volumes shall be defined and modeled in coordination with the USFWS by October 2001.⁶

⁵ USFWS BiOp at Section 8.1.c Page 73, Action-f 3

⁶ USFWS BiOp at Section 8.1.d Page 74, Action-f 4

Forecast runoff Volume (Maf) at Libby	Tier	Sturgeon Flow (Maf) at Libby Dam
0.00 < forecast < 4.80	1	Sturgeon flows not requested
4.80 < forecast < 6.00	2	0.80
6.00 < forecast < 6.70	3	1.12
6.70 < forecast < 8.10	4	1.20
8.10 < forecast < 8.90	5	1.20
8.90 < forecast	6	1.60

Possible minimum “tiered” volumes of water to be stored for sturgeon flow enhancement based upon the April-August volume runoff forecast above Libby Dam.

The purpose of the actions below is to provide for the annual sturgeon pulse.

Libby outflow will fulfill the operational guidelines provided by the USFWS annually prior to and during the sturgeon spawning/incubation period. Specific release recommendations will be developed in consultation with action agencies and submitted annually through the TMT or similar regional process.⁷

Efforts will be coordinated to attempt to limit sturgeon-spawning flows so they do not exceed a levee elevation of 1,764 feet at Bonners Ferry. (Note: This may not always be possible during periods of unusual local runoff that may be beyond control of Libby Dam.)⁸

During sturgeon recruitment flow periods, local inflow will be allowed to supplement Libby Dam releases to the maximum extent feasible, while assuring public safety by monitoring water levels throughout relevant areas of the Kootenai River basin.⁹

The following minimum flow between the sturgeon and salmon flows will be provided based on the April – August volume runoff forecast at Libby.

Forecast runoff Volume (Maf*) at Libby	Min bull trout flows between sturgeon and salmon flows
0.00 < forecast < 4.80	6 kcfs
4.80 < forecast < 6.00	7 kcfs
6.00 < forecast < 6.70	8 kcfs
6.70 < forecast < 8.10	9 kcfs
8.10 < forecast < 8.90	9 kcfs
8.90 < forecast	9 kcfs

(USFWS BiOp at Section 3.A.2 Page 13)

⁷ USFWS BiOp at Section 8.2.c Page 80, Action-f 20

⁸ USFWS BiOp at Section 8.3.b Page 80, Action-f 23

⁹ USFWS BiOp at Section 8.3.g Page 81, Action-f 28

4.3.3 Summer anadromous fish

During the summer (July–August) the Action Agencies shall operate Libby to help meet the flow objectives. Retention of July/August water in Lake Koocanusa is possible under a Libby-Arrow water exchange. This exchange agreement also reduces the second flow peak created by July/August salmon flow through Kootenay Lake July and August. An agreement will be sought by October 2001.¹⁰ The purpose of this action is to reduce or eliminate the second peak. (Note: This type of exchange is allowed under the current Libby Coordination Agreement, which was signed February 16, 2000. Because the operation must have mutual benefit and the magnitude of the water year is not known earlier, the operation for a given water year is not finalized until June or July of that year.)

The summer reservoir draft limit is 2,439 feet.¹¹ If Libby is below 2,439 on July 1 Libby will provide the USFWS bull trout minimum flow.¹² This limit determines the maximum draft available for summer flow augmentation from Libby.

4.3.4 Bull Trout

The purpose of the following actions is to provide better conditions for resident fish by limiting the flow fluctuations and setting minimum flow levels.

Operational constraints will be implemented at Libby Dam intended to minimize adverse effects of rapid and severe river flow fluctuations on bull trout, including year-round minimum flows and ramping rates, seasonal water management, conducting studies to monitor the adequacy of the constraints, and providing for modification of the operational constraints depending on study results.¹³ Exact operational constraints are shown in paragraphs below.

The following ramp rates will be used.

Daily and Hourly Maximum Ramp Up Rates for Libby Dam (as measured by daily flows, not daily averages, restricted by hourly rates)			
Flow Range	Ramp Up Unit (Daily max)	Ramp Up (Hourly max) 1 Oct - 30 Apr	Ramp Up (Hourly max) 1 May - 30 Sep
4,000 - 6,000 cfs	Limit ramp up to one unit per day (approx. 5,000 cfs per day)	2,000 cfs/hr	1,000 cfs/hr
6,000 - 9,000 cfs	Limit ramp up to one unit per day (approx. 5,000 cfs per day)	2,000 cfs/hr	1,000 cfs/hr
> 9,000 - 17,000 cfs	Limit ramp up to one unit per day (approx. 10,000 cfs per day)	3,500 cfs/hr	2,000 cfs/hr
> 17,000 cfs	No limit	7,000 cfs/hr	3,500 cfs/hr

¹⁰ USFWS BiOp at Section 8.1.e Page 75, Action-f 5

¹¹ NMFS BiOp at Section 9.6.1.2.3 Page 9-63, Action 19

¹² USFWS BiOp at Section 11.A..1.a Page 93, Action-f 59

¹³ USFWS BiOp at Section 10.A.1 Page 87, Action-f 42

(USFWS BiOp at Section 3.A.2 Page 13)

Daily and Hourly Maximum Ramp Down Rates for Libby Dam (as measured by daily flows, not daily averages, restricted by hourly rates)			
Flow Range	Ramp Down Unit (Daily Max)	Ramp Down(Hourly max) 1 Oct – 30 Apr	Ramp Down (Hourly max) 1 May – 30 Sep
4,000 - 6,000 cfs	Limit ramp down to 500 cfs per day	500 cfs/hr	500 cfs/hr
> 6,000 - 9,000 cfs	Limit ramp down to 1,000 cfs per day	500 cfs/hr	500 cfs/hr
> 9,000 - 17,000 cfs	Limit ramp down to 2,000 cfs per day	1,000 cfs/hr	1,000 cfs/hr
> 17,000 cfs	Limit ramp down to one unit per day (approx. 5,000 cfs per day)	5,000 cfs/hr	3,500 cfs/hr

(USFWS BiOp at Section 3.A.2 Page 14)

Daily and hourly ramping rates may be exceeded during flood emergencies to protect health and public safety and in association with power or transmission emergencies.¹⁴

Variations to ramping rates during years where runoff forecasting or shortage shortfalls occur, or variations are necessary to provide augmentation water for other listed species, will be negotiated through the TMT process. This is expected in only the lowest 20th percentile water years.¹⁴

Note: The ramp rates will be followed except when they would cause a unit(s) to operate in the rough zone, a zone of chaotic flow in which all parts of a unit are subject to increased vibration and cavitation that could result in premature wear or failure of the units. In this case the project will utilize a ramp rate, which allows all units to operate outside the rough zone. The action agencies will provide additional information to the USFWS describing operations outside the “rough zone.”¹⁵

Daily load following in the outflow from Libby Dam will be limited to the extent that levees in Kootenai Valley are no longer damaged, and public outreach materials addressing this issue shall be provided.¹⁶

4.3.5 Coordination

Libby dam flows shall be regulated consistent with existing treaties, Libby Project authorization for public safety, other laws, and the 1938 International Joint Commission order, to achieve water volumes, water velocities, water depths, and water temperature at a time to maximize the probability of allowing significant sturgeon recruitment.¹⁷

¹⁴ USFWS BiOp at Section 3.A.2 Page 14

¹⁵ USFWS BiOp at Section 3.A.2 Page 13

¹⁶ USFWS BiOp at Section 8.3.f Page 81, Action-f 27

¹⁷ USFWS BiOp at Section 8.1.a Page 73, Action-f 1

4.4 Hungry Horse

4.4.1 Flood Control

Hungry Horse will operate using VARQ starting January 1, 2001.¹⁸ The purpose of this action is to provide more water for flow augmentation.

Hungry Horse will be operated during the winter season in order to achieve a high probability of water surface elevations within 0.5 foot of the flood control rule curve by April 10 and to refill by June 30, except as specifically provided by the TMT.¹⁹

4.4.2 Refill

During the spring, the Action Agencies shall operate Hungry Horse to contribute to meeting the flow objectives and refill by approximately June 30.²⁰

4.4.3 Summer anadromous fish

During the summer (July – August) the Action Agencies shall operate Hungry Horse to help meet the flow objectives. The summer reservoir draft limit is 3,540 feet.²¹ This limit determines the maximum draft available for summer flow augmentation from Hungry Horse.

4.4.4 Bull Trout

The purpose of the following actions is to provide better conditions for resident fish by limiting the flow fluctuations and setting minimum flow levels.

Operational measures will be implemented at Hungry Horse Dam to minimize adverse effects of rapid and severe river flow fluctuations on bull trout, including year-round minimum flows and ramping rates, and seasonal water management; conduct studies to monitor the adequacy of the constraints; and provide for modification of the operational constraints depending on study results.²² Exact operational measures are shown in paragraphs below.

The following ramp rates will be used.

Daily and Hourly Maximum Ramp Up Rates for Hungry Horse Dam (as measured by daily flows, not daily averages, restricted by hourly rates).		
Flow Range (measured at Columbia Falls)	Ramp Up Unit (Daily Max)	Ramp Up Unit (Hourly max)
3,200 - 6,000 cfs	Limit ramp up 1,800 cfs per day	1,000 cfs/hour
> 6,000 - 8,000 cfs	Limit ramp up 1,800 cfs per day	1,000 cfs/hour

¹⁸ NMFS BiOp at Section 9.6.1.2.3 Page 9-62 Action 19

¹⁹ NMFS BiOp at Section 9.6.1.2.1 Page 9-56, Action 14 and NMFS BiOp at Section 9.6.1.2.3 Page 9-61, Action 18

²⁰ NMFS BiOp at Section 9.6.1.2.3 Page 9-61, Action 18

²¹ NMFS BiOp at Section 9.6.1.2.3 Page 9-63, Action 19

²² USFWS BiOp at Section 10.A.1 Page 87, Action-f 43

> 8,000 - 10,000 cfs	Limit ramp up 3,600 cfs per day	1,800 cfs/hour
> 10,000 cfs	No limit	1,800 cfs/hour

(USFWS BiOp at Section 3.A.1 Page 8)

Daily and Hourly Maximum Ramp Down Rates for Hungry Horse Dam (as measured by daily flows, not daily averages, restricted by hourly rates)		
Flow Range (measured at Columbia Falls)	Ramp Down Unit (Daily max)	Ramp Down Unit (Hourly max)
3,200 - 6,000 cfs	Limit ramp down to 600 cfs per day	600 cfs/hour
> 6,000 - 8,000 cfs	Limit ramp down to 1,000 cfs per day	600 cfs/hour
> 8,000 - 12,000 cfs	Limit ramp down to 2,000 cfs per day	1,000 cfs/hour
> 12,000 cfs	Limit ramp down to 5,000 cfs per day	1,800 cfs/hour

(USFWS BiOp at Section 3.A.1 Page 8)

Daily and hourly ramping rates may be exceeded during flood emergencies to protect health and public safety and in association with power or transmission emergencies.²³

Variations to ramping rates during years where runoff forecasting or storage shortfalls occur, or variations are necessary to provide augmentation water for other listed species, will be coordinated through the TMT process. This is expected in only the lowest 20th percentile water years.²³

Note: The ramp rates will be followed except when they would cause a unit(s) to operate a zone that could result in premature wear or failure of the units. In this case the project will utilize a ramp rate, which allows all units to operate outside the rough zone. The action agencies will provide additional information to the USFWS describing operations outside the “rough zone.”²⁴

The minimum outflow for Hungry Horse Dam will be determined monthly starting with the January forecast, with final flows based on the March final runoff forecast for Hungry Horse Reservoir for the period April 1 to August 31. These forecasts will be provided by Reclamation to the TMT. If the April – August forecast is greater than 1,790 kaf the minimum flow shall be 900 cfs. If the forecast is less than 1,190 kaf the minimum flow shall be 400 cfs. If the forecast is between 1,190 and 1,790 kaf the minimum flow will be linearly interpolated between 400 and 900 cfs.²⁵ The minimum flow from Hungry Horse can be lowered to 145 cfs when the river at Columbia Falls reaches flood level (13 feet).

The minimum flow at Columbia Falls will be determined monthly starting with the January forecast, with the final flows based on the March final runoff forecast for Hungry Horse

²³ USFWS BiOp at Section 3.A.1 Page 8

²⁴ USFWS BiOp at Section 3.A.1 Page 7

²⁵ NMFS BiOp at Section 9.6.1.2.3 Page 9-63, Action 19 and USFWS BiOp at Section 3.A.1 Page 6

Reservoir for the period of April 1 to August 31. If the April – August forecast is greater than 1,790 kaf the minimum flow shall be 3,500 cfs. If the forecast is less than 1,190 kaf the minimum flow shall be 3,200 cfs. If the forecast is between 1,190 and 1,790 kaf the minimum flow will be linearly interpolated between 3,200 and 3,500 cfs.²⁶

4.5 Albeni Falls

4.5.1 Flood Control

Albeni Falls will be operated during the winter season in order to achieve a high probability of water surface elevations within 0.5 foot of the flood control rule curve by April 10 and to refill by June 30, except as specifically provided by the TMT.²⁷

4.5.2 Refill

During the spring, the Action Agencies shall operate Albeni Falls to meet the flow objectives and refill by approximately June 30.²⁸

4.5.3 Resident Fish

In the fall/winter 2001 (2002 water year) Albeni Falls shall be drawn down to an elevation 2,051 feet to cleanse shoreline gravels.²⁹ The purpose of this action is to provide for the alternating lake drawdown and draw-up operation as part of the, kokanee egg-to-fry survival study at Lake Pend Oreille.

4.6 Upper Snake River Reservoir Operation for Flow Augmentation

The purpose of this action is to provide water from the upper Snake Reservoirs for flow augmentation.

The Action Agencies shall acquire water for instream use from Reclamation's Upper Snake River Projects. Reclamation, NMFS, and others are participating in settlement discussions under the Snake River Basin Adjudication. Implementation of flow augmentation in 2002 will involve a settlement, another Endangered Species Act (ESA) consultation on the Upper Snake projects, and authorizing legislation from Idaho. Reclamation will coordinate the release of water acquired for 2002 through the TMT.³⁰

4.7 Brownlee, Dworshak, and Grand Coulee Flood Control

Opportunities to shift flood control requirements from Brownlee and Dworshak to Grand Coulee shall be considered.³¹ These shifts may be implemented after coordination with TMT. The

²⁶ NMFS BiOp at Section 9.6.1.2.3 Page 9-63, Action 19 and USFWS BiOp at Section 3.A.1 Page 7

²⁷ NMFS BiOp at Section 9.6.1.2.1 Page 9-56, Action 14 and NMFS BiOp at Section 9.6.1.2.3 Page 9-61, Action 18

²⁸ NMFS BiOp at Section 9.6.1.2.3 Page 9-61, Action 18

²⁹ NMFS BiOp at Section 9.6.1.2.3 Page 9-64, Action 19; USFWS BiOp at Section 10.A.1.4 Page 89, Action-f 45; and USFWS BiOp at Section 11.A.1.4.a Page 94, Action-f 65

³⁰ NMFS BiOp at Section 9.6.1.2.6 Page 9-70, Action 32

³¹ NMFS BiOp at Section 9.6.1.2.3 Page 9-65, Action 21

purpose of this action is to provide more water for flow augmentation in the lower Snake River. This will occur when the shifts will not compromise flood control and they have been coordinated.

4.8 Dworshak

4.8.1 Flood Control

Dworshak will be operated during the winter season in order to achieve a high probability of water surface elevations within 0.5 foot of the flood control rule curve by April 10 and to refill by June 30, except as specifically provided by the TMT.³²

4.8.2 Refill

During the spring, the Action Agencies shall operate Dworshak to meet the flow objectives and refill by approximately June 30.³³

After summer fish operations flows from Dworshak shall be limited to minimum one turbine operation (approximately 1,500 cfs) unless higher flows are required for flood control.³⁴ The purpose of this action is to assist in the filling of Dworshak reservoir.

4.8.3 Summer anadromous fish

During the summer (July–August) the Action Agencies shall operate Dworshak to help meet the flow objectives. The summer reservoir draft limit is 1,520 feet.³⁴ This limit determines the maximum draft available for summer flow augmentation from Dworshak.

4.8.4 Water quality

During the summer, release shall be made from Dworshak to attempt to maintain water temperatures at the Lower Granite forebay water quality station at or below 68 F.³⁴ The purpose of this action is to improve water quality (by lowering water temperature) in the Lower Snake River.

4.9 Lower Snake Projects (Lower Granite, Little Goose, Lower Monumental, and Ice Harbor)

4.9.1 Reservoir Passage

All Lower Snake Projects will operate within 1 foot of MOP (Minimum Operating Pool) from approximately April 3 until small numbers of juvenile migrants are present.³⁵ Lower Granite Dam shall not return to normal operating pool until enough natural cooling has occurred in the

³² NMFS BiOp at Section 9.6.1.2.1 Page 9-56, Action 14 and NMFS BiOp at Section 9.6.1.2.3 Page 9-61, Action 18

³³ NMFS BiOp at Section 9.6.1.2.3 Page 9-61, Action 18

³⁴ NMFS BiOp at Section 9.6.1.2.3 Page 9-65, Action 19

³⁵ NMFS BiOp at Section 9.6.1.2.3 Page 9-65, Action 20

fall, generally after October 1. The purpose of this action is to provide a smaller reservoir cross section to reduce juvenile salmon travel time.

4.9.2 Juvenile Fish Survival

Turbines at all Lower Snake projects will be operated within 1 percent of peak efficiency during the juvenile and adult migration seasons (March 15 through November 30).³⁶

4.10 Grand Coulee

4.10.1 Flood Control

Grand Coulee will be operated during the winter season in order to achieve a high probability of water surface elevations within 0.5 foot of the flood control rule curve by April 10. It will be operated to refill by July 4 if flow augmentation to meet summer flow objectives is not needed before July 4. The TMT may provide other specific operations.³⁷

4.10.2 Refill

During the spring, the Action Agencies shall operate Grand Coulee to meet the flow objectives and refill by approximately July 4.³⁸

4.10.3 Summer anadromous fish

During the summer (July–August) the Action Agencies shall operate Grand Coulee to help meet the flow objectives. The summer reservoir draft limit is 1,280 feet in years where the April through August forecast for The Dalles is equal to or exceeds 92 Maf. If the forecast is less than 92 Maf the draft limit will be 1,278 feet.³⁹ This limit determines the maximum draft available for summer flow augmentation from Grand Coulee.

4.11 Banks Lake Summer Draft

Banks Lake will be drafted to elevation 1,565 feet by the end of August.⁴⁰ The purpose of this action is to provide more water for summer flow augmentation.

4.12 Hanford Reach Protection Flows

Grant County PUD Limits outflow from Priest Rapids Dam to minimize juvenile fish stranding. *(Note: This is not a BiOp required operation.)*

³⁶ NMFS BiOp at Section 9.6.1.4.4 Page 9-93, Action 58

³⁷ NMFS BiOp at Section 9.6.1.2.1 Page 9-56, Action 14 and NMFS BiOp at Section 9.6.1.2.3 Page 9-61, Action 18

³⁸ NMFS BiOp at Section 9.6.1.2.3 Page 9-61, Action 18

³⁹ NMFS BiOp at Section 9.6.1.2.3 Page 9-64, Action 19

⁴⁰ NMFS BiOp at Section 9.6.1.2.4 Page 9-67, Action 23

4.13 Vernita Bar Protection Flows

Flow operations are conducted at Vernita Bar so fall Chinook salmon establish redds (spawn) at an elevation that redds will not be dewatered later. Flows are generally reduced in October and November when redds are being established. Flow reductions are limited through fish emergence in early May. (*Note: This is not a BiOp required operation but is included pursuant to the Vernita Bar Settlement Agreement.*)

4.14 Lower Columbia Projects (McNary, John Day, The Dalles, Bonneville)

To enhance juvenile passage survival, turbines at all the Lower Columbia projects will be operated within 1 percent of peak efficiency during the juvenile and adult migration seasons (March 15 through October 31).⁴¹

4.15 Bonneville Dam Chum Flows

The purpose of the following actions is to provide spawning areas and protect redds of chum salmon.

Flows will be regulated below Bonneville Dam to support spawning of chum salmon if the best hydrologic data available by early October indicate that precipitation, runoff, and reservoir storage are likely to support the operation from the start of spawning (late October or early November) until the end of emergence (generally through the start of the spring flow management season in April). The chum spawning operation cannot adversely affect implementation of NMFS' 2000 FCRPS RPA or the parties' ability to comply with the Vernita Bar agreement. If these conditions cannot be met, the Action Agencies will work with NMFS and the regional salmon managers to identify operations that would benefit salmon while maintaining these other fish protection measures. Such operations may include intentionally managing flows below what is necessary for mainstem spawning to discourage redds from being established in the area or shaping flows in a manner that would discourage redd development (reverse load factoring). The chum spawning operation requires the FCRPS projects to provide a minimum flow below Bonneville Dam of 125 kcfs (or more as coordinated) from when chum salmon are found in the area around Ives and Pierce Islands (but no later than November 1) through December 31. The flows from Bonneville dam will be maintained within 5 kcfs of the established minimum.⁴² Operating to the Bonneville tailwater gauge was found to be an effective management tool during the 2001-operating year. The tailwater gauge better reflects the effects of tides, tributary inflow and groundwater influence below Bonneville Dam.

If water supply conditions indicate that it is not possible to provide a minimum flow of 125 kcfs from Bonneville Dam, flow will be provided during the chum-spawning season

⁴¹ NMFS BiOp at Section 9.6.1.4.4 Page 9-93, Action 58

⁴² NMFS BiOp at Section 9.6.1.2.1 Page 9-58, Action 15

at times to allow access to Hamilton and Hardy Creeks. Details will be set through coordination in TMT.⁴³

From January 1 to the start of spring flows April 10, if the chum operation is possible, the flow from Bonneville dam will be the daily minimum flow or minimum water surface elevation established by coordination in the TMT.⁴²

If the minimum flow established for the fall chum operation is 125 kcfs the minimum flow shall be 125 kcfs or the equivalent tailwater gauge elevation. If the minimum flow for the fall chum operation is 135 kcfs or greater, the minimum flow for the winter chum operation will be 10 kcfs lower than the fall minimum chum flow. The minimum flow in no case will be greater than 150 kcfs.

A salvage operation for the chum population residing below Bonneville Dam is being considered for the 2001-spawning season. This operation is being considered because of the record low stream flows being experienced going into the fall of 2001. Also, chum salmon will be captured this year and used as broodstock to initiate a spawning population in the recently restored habitat of Duncan Creek. The Duncan Creek project established the logistics for a brood capture and fry rearing program. The salvage operation would expand the numbers of fish captured and reared in this newly established brood collection program to make up for the lack of tributary or mainstem spawning. The salvage program is a safety net program and is not viewed as the preferred alternative to providing access to and sustenance of rearing habitat for the chum salmon.

5.0 Sub-Strategy: Spill Operations for Project Passage

This substrategy addresses spill at certain FCRPS projects to provide improved survival and better project passage for juvenile fish while avoiding adult fallback problems and creating greater than 120 percent of total dissolved gas at the designated downstream monitoring stations.

Spring spill for juvenile fish migration shall occur from (planning dates) April 3 to June 20 in the Snake River, and April 10 to June 30 in the lower Columbia River.⁴⁴ Spill levels and times are indicated below.⁴⁵ Voluntary spill at all three Snake River collector projects shall occur when seasonal average flows are projected to meet or exceed 85 kcfs.⁴⁶

Summer spill for juvenile fish migration shall occur from (planning dates) June 21 to August 31 in the Snake River, and July 1 to August 31 in the lower Columbia River.⁴⁷ There will be no summer spill at the four collector projects (Lower Granite, Little Goose, Lower Monumental, and McNary).⁴⁸

⁴³ NMFS BiOp at Section 9.6.1.2.1 Page 9-60, Action 16

⁴⁴ NMFS BiOp at Section 9.6.1.4.3 Page 9-88, Action 54

⁴⁵ NMFS BiOp at Section 9.6.1.4.4 Page 9-88, Action 54 and NMFS BiOp at Section 9.6.1.3.4 Page 9-76, Action 41

⁴⁶ NMFS BiOp at Section 9.6.1.3.2 Page 9-76, Action 40

⁴⁷ NMFS BiOp at Section 9.6.1.4.3 Page 9-88, Action 54

⁴⁸ NMFS BiOp at Section 9.6.1.3.2 Page 9-76, Action 42

Spill requirements for the various projects are shown in the table below:

Project	Spill Dates (Planning dates)	Time	Spring Spill	Summer Spill	Amount	Minimum Generation Requirements kcfs
Lower Granite	April 3– June 20	1800-0600	Yes	No	120/115 gas cap	11.5 ^a
Little Goose	April 3– June 20	1800-0600	Yes	No	120/115 gas cap	11.5 ^a
Lower Monumental ^b	April 3– June 20	24 hours a day	Yes	No	120/115 gas cap	11.5 ^a
Ice Harbor	April 3– August 31	24 hours a day	Yes	Yes	120/115 gas cap 1800 – 0500 45 Kcfs 0500 - 1800	7.5 – 9.5 ^a
McNary	April 10– June 30	1800-0600	Yes	No	120/115 gas cap	50
John Day	April 10– August 31	1800-0600 1900 – 0900 May 15– July 31	Yes	Yes	60% of outflow Min spill 25%	50
The Dalles	April 10– August 31	24 hours a day	Yes	Yes	40% of outflow	50
Bonneville	April 10– August 31	24 hours a day	Yes	Yes	120/115 gas cap nighttime 75 kcfs daytime ^d 50 min flow	30

A – Minimum Generation Requirements at the Lower Snake River Projects may not be needed all the time.

B – Lower Monumental will not be spilling, for juvenile fish passage, for part or all of the juvenile fish passage season in 2002 due to Stilling Basin Repair. At the time this report was written construction is scheduled to begin in May 2002.

C – Collection of subyearling fall chinook for transportation at McNary Dam shall not be initiated until inriver migratory conditions are deteriorating (i.e., no longer spring-like).⁴⁹ In general, the switch from spring to summer operation will occur on or about June 20. Spring-like is defined as favorable flow and water temperature conditions; i.e., river flows are at or above the

⁴⁹ NMFS BiOp at Section 9.6.1.3.4 Page 9-77, Action 43

spring flow target (220 to 260 kcfs) at McNary Dam, and ambient water temperatures are below 62°F (17°C). Actual dates shall be set by TMT coordination.

D – Day and nighttime vary during the spill season and are set in the Fish Passage Plan.

Spill for Spring Creek Hatchery Release

Water may be spilled at Bonneville Dam for a period of up to 10 days, normally only 3 to 4 days, to aid Bonneville Dam passage of the hatchery release from Spring Creek Hatchery, (*Note: This is not a BiOp required measure.*)

6.0 Sub-Strategy: Juvenile Fish Transport Actions to Enhance Fish Survival

This substrategy addresses actions to collect juvenile fish at some FCRPS projects while providing a balance between transported and in river juvenile fish migration.

6.1 Snake River Collector Projects

All non-research juvenile salmonids collected at the Snake River collector projects will be transported (Lower Granite, Little Goose, and Lower Monumental dams).⁵⁰

6.2 McNary

Juvenile spring migrants collected at McNary Dam shall be bypassed.⁵¹

Collection of subyearling fall chinook for transportation at McNary Dam shall not be initiated until inriver migratory conditions are deteriorating (i.e., no longer spring-like).⁴⁹ In general, the switch from spring to summer operation will occur on or about June 20. Spring-like is defined as favorable flow and water temperature conditions; i.e., river flows are at or above the spring flow target (220 to 260 kcfs) at McNary Dam, and ambient water temperatures are below 62°F (17°C). Actual dates shall be set through coordination with TMT.

7.0 Sub-Strategy: Other Actions to Enhance Water Management

This substrategy includes water management related actions that are being done to improve fish survival, such as studies, water quality actions and water conservation improvements.

⁵⁰ NMFS BiOp at Section 9.6.1.3.2 Page 9-76, Action 40

⁵¹ NMFS BiOp at Section 9.6.1.3.4 Page 9-76, Action 41

7.1 Libby

7.1.1 Spillway test

A Libby spillway test will be conducted in 2002 under sufficiently high turbine discharge levels during the sturgeon conservation operation to reliably estimate the maximum spillway flow dilution capability and compliance with the state water quality standard of 110 percent gas saturation, with up to six (6) turbines operating at full capacity, and/or a total release capacity of 35,000 cfs through a combination of spillways and a turbine. Possible changes in dissolved gas concentrations throughout the Kootenai River shall be evaluated. This test shall also include monitoring of effects of the spill on bull trout and other fish in the Kootenai River.⁵² The purpose of this action is to see if a higher flow amount can be released from Libby dam for the sturgeon pulse.

7.1.2 Water temperature monitoring

Water temperature profiles in the south end of Lake Koocanusa during May and June will be monitored to provide information necessary for timing of sturgeon spawning/rearing flow augmentation.⁵³ The purpose of this action is to provide better information of the timing of the sturgeon pulse.

7.1.3 Libby VARQ

The purpose of VARQ is to provide more water for spring flows without reducing flood control protection.

An Environmental Impact Statement (EIS) is being prepared and additional coordination is being conducting before VARQ at Libby can be implemented. EIS activities scheduled for 2002 include public scoping meetings, hydrologic study, and initial drafting of the Draft EIS. Consequently, Libby VARQ will not be implemented in 2002.⁵⁴

In addition, modeling work related to VARQ at Libby will be ongoing in the 2002 water year with an expected completion date next year.

7.1.4 Libby Storage Diagram and Forecast Procedure

The purpose of the Libby storage diagram study and investigating a new forecast procedure is to see if more water can be made available for spring flows with out reducing flood control protection.

⁵² USFWS BiOp at Section 8.2.a.1 Page 78, Action-f 10

⁵³ USFWS BiOp at Section 8.3.h Page 82, Action-f 29

⁵⁴ NMFS BiOp Section 9.6.1.2.3 Page 63, Action 19; NMFS BiOp Section 9.6.1.2.3 Page 9-66, Action 22; and USFWS BiOp Section 8.1 page 73, Action-f2

In water year 2002 the investigation of a new forecast procedure should be completed. Work on a new Libby Storage diagram will begin this water year.⁵⁵

7.1.5 Coordination

An annual operational schedule to be supplemented on a monthly basis will be provided to the USFWS annually, on or about May 1 but not later than May 10. The annual schedule shall include month-end estimates of water surface elevation at Kootenai Reservoir and estimates of monthly discharge from Libby Dam. The monthly supplement shall include a report of actual operations over the previous month and shall include daily water surface elevation at Kootenai Reservoir and hourly spill and releases at Libby Dam.⁵⁶ The purpose of this action is to provide for better coordination.

7.1.6 Increased Flow Capacity at Libby

The purpose of the following actions is to provide for a higher flow level during the sturgeon pulse.

Pending funding approval, the COE will begin an evaluation (with completion in 2003) of flood control levels and public safety concerns along the banks of the Kootenai River below Libby Dam, and the feasibility of increasing releases above any identified channel capacity constraints through structural or non-structural means.⁵⁷

No work is scheduled in 2002 on the following BiOp actions:

USFWS BiOp at Section 8.2.a.3 Page 78, Action-f 12

USFWS BiOp at Section 8.2.a.4 Page 78, Action-f 13

USFWS BiOp at Section 8.2.a.5 Page 79, Action-f 14

USFWS BiOp at Section 8.2.a.6 Page 79, Action-f 15

USFWS BiOp at Section 8.2.a.7 Page 79, Action-f 16

7.1.7 Kootenai River Investigation

The purpose of the following actions is to provide for a higher flow level during the sturgeon pulse.

A report has already been prepared on the effects of load following on levee integrity throughout the Kootenai Valley over the last 26 years.⁵⁸

No work is scheduled in 2002 on the following BiOp actions:

USFWS BiOp at Section 8.2.a.2 Page 78, Action-f 11

⁵⁵ NMFS BiOp Section 9.6.1.2.6 Page 33, Action 36; USFWS BiOp at Section 8.1.h Page 76, Action-f 8; and USFWS BiOp at Section 8.1.i Page 76, Action-f 9

⁵⁶ USFWS BiOp at Section 11.A.1.1.c Page 93, Action-f 60

⁵⁷ USFWS BiOp at Section 8.3.a Page 80, Action f-22

⁵⁸ USFWS BiOp at Section 8.3.e Page 81, Action-f 26

7.2 Hungry Horse Coordination

An annual operational schedule to be supplemented on a monthly basis will be provided by Reclamation to the USFWS annually, on or about May 1 but not later than May 10. The annual schedule shall include month-end estimates of water surface elevation at Hungry Horse Reservoir and estimates of monthly discharge from Hungry Horse Dam. The monthly supplement shall include a report of actual operations over the previous month and shall include daily water surface elevation at Hungry Horse Reservoir and hourly spill and releases at Hungry Horse Dam. The purpose of this action is to provide for better coordination.⁵⁹

Reclamation will fulfill the USFWS recommendation for annual and monthly reporting by contributing to the annual water management plan and presenting weekly and biweekly reports of Hungry Horse operations through the TMT process. Reclamation will also fulfill the USFWS recommendation for reporting actual operations by making available pertinent historic elevations and flows as related to Hungry Horse Dam through its current website at <http://mac1.pn.usbr.gov/pn6200/esatea.html>. These actions are described in accordance with the US Bureau of Reclamation, Pacific Northwest Region Findings and Commitments Implementing December 2000 Biological Opinions for the Federal Columbia River Power System and Other Related Actions, Section III, B, 2, paragraph 23.

7.3 Water Quality Actions

7.3.1 Water Quality Plans

One- and five-year water quality plans are to improve fish passage and survival through water quality improvement measures. The intent of the water quality plans are to recommend FCRPS facility and operational improvements related to water quality, total dissolved gas (TDG) and water temperature monitoring, and related studies. All water quality Reasonable and Prudent alternatives (RPA) listed in Appendix B, Table B-2 of the BiOp are not organized in separate Water Quality one-year or five-year plan, as defined in RPA 5.⁶⁰

All of the water quality RPAs listed in Table B-2 are divided into two categories. Operationally oriented water quality RPAs are addressed in the one-year and the five-year Water Management Plans. The other capital investment water quality RPAs related to facility improvements are addressed in the one-year and the five-year Research, Monitoring, and Evaluation Plans.

7.3.2 Total Dissolved Gas Monitoring

High levels of TDG can be lethal to fish. Environmental monitoring at the dams is necessary to insure that gas levels do not exceed TDG thresholds established in the BiOp and variance levels established by the state water quality agencies. According to the BiOp, the monitoring program is to include; QA/QC components; including redundant and backup monitors at as many locations as the Water Quality Team determines necessary; calibration of monitoring equipment

⁵⁹ USFWS BiOp at Section 11.A.2.A

⁶⁰ NMFS BiOp Section 9.4.2.4 Page 9-29, Action 5

at least every two weeks; adequate funds for spot-checking monitoring equipment, error checking, correcting, and recording function for CROHMS data, and daily reporting. The QA/QC components are to be reviewed by the Action Agencies annually in coordination with the Water Quality Team.

RPA 131 will be addressed in the manner described in the paragraph above, except for the redundant monitoring. The Action Agencies will establish data Quality Objectives, in coordination with the Water Quality Team, to replace the redundancy identified in the BiOp. As part of the QA/QC component of the program, achievements of the Data Quality Objectives are to be evaluated by the Action Agencies annually, in coordination with the Water Quality Team.⁶¹

In 2002 we plan to establish data quality objectives, at existing stations, instead of establishing redundant stations. We will be monitoring similarly to what to what occurred in 2000 and 2001.

7.3.3 Total Dissolved Gas Monitoring Review

TDG measurements in the forebays and tailwaters of the dams have been monitored as part of the NMFS spill program. In-season management to improve juvenile fish survival relies on the TDG monitoring program. Based on review of possible biases in the TDG data, NMFS believes that some forebay locations, such as the Camas site, have to be changed to provide a more representative measure of TDG in the water passing through the dams. It is possible that spill could be increased if current forebay locations over-represent the level of gas saturation in the water of the forebays.

RPA 132 addresses the development of a plan to systematically review and evaluate TDG fixed monitoring site forebays at all the mainstem Columbia and Snake dams, especially the Camas site. The plan is to be developed before February 2001, and included as part of the first annual water quality improvement plan. The Action Agencies are to change the location of the fixed monitoring sites, as warranted, based on an evaluation of the review results.⁶²

Field studies to address the representatives issues related to Camas were conducted during the 2001 summer. A report will be prepared by December 31, 2001.

All forebay data collected during near-field studies of DGAS were evaluated in 2001. Based on the review of each forebay site, a program to evaluate identified problem stations will be developed in 2002.

In 2002 we plan to begin evaluation of existing data of sites above Bonneville dam and of sites with no previous cross-sectional data. Also we plan to complete the evaluation of the Camas/Washougal site.

7.3.4 Total Dissolved Gas Model

TDG caused by large volumes of water spilled over dams can result in injury and mortality of juvenile salmonids. Development and continued refinement of a systemwide TDG model would assist with in-season management of voluntary and involuntary spill.

⁶¹ NMFS BiOp Section 9.6.1.7.2 Page 9-122, Action 131

⁶² NMFS BiOp Section 9.6.1.7.2 Page 9-123, Action 132

The COE developed TDG models to be used as a river operations management tool. The COE is to develop the tool(s) by the spring 2001. The COE is to coordinate the systemwide management applications of the gas abatement model(s) with the annual planning process, the Transboundary Gas Group, the Mid-Columbia Public Utilities, and other interested parties.⁶³

Use of two DGAS models (SYSTDG and MASS1) were initiated in 2001. Regional training to action agencies and salmon manager stakeholders on the use of SYSTDG was provided on March 27 and 28, 2001 and on April 6 and 7, 2001. Because of the drought year, SYSTDG was not used to provide operational guidance since the SYSTDG dataset did not include an extreme low flow year. Because of the drought year, MASS1 was used to provide guidance concerning the range of water temperatures that could be expected in the lower Snake and lower Columbia rivers during 2001. The model results were presented to TMT and the Water Quality Team during the summer 2001.

In 2002 we plan to update TDG production equations relationships at relevant projects. We also plan to update the SYSTDG users manual and documentation and do a technical review of the model. We are also planning on doing a statistical summary of historic gas data.

7.3.5 Temperature Model and Temperature Monitoring Needs

Water temperature caused by impoundment of pools behind dams can result in a change in the water temperature regime of the river, potentially causing injury and mortality of juvenile salmonids. Development and continued refinement of a system wide water temperature model would assist with in-season management of voluntary and involuntary spill. The model is to be used as a pre-season planning tool to provide predicted operations in real time to assist in the in-season water management decisions.

The geographic scope of the model is unclear in BiOp RPA 143 (page 9-127). One paragraph indicates that the purpose of the model will be to model the water temperature effects of alternative Snake River operations. The next paragraph states that the geographic scope will be from Hells Canyon Dam on the Snake River, Dworshak Dam on the North Fork Clearwater River to Bonneville Dam on the Columbia River.⁶⁴

The anticipated action will be to develop a model to address operations of only the Snake River projects.

Tasks include: identification of team members, additional data collection, database creation (see RPA 198), model development, definition of simulations, execution of simulations, analysis and reporting, coordination, and project management.

In 2002 we plan to review and select models and review meteorological and hydrological data needs.

7.3.6 Water Quality Database

As part of Cumulative Risk Initiative evaluations, NMFS has focused on the need for a single comprehensive data management system to ensure integration of monitoring and evaluation information with information from other sources. The application of performance standards and

⁶³ NMFS BIOP Section 9.6.1.7.2 Page 9-124, Action 133

⁶⁴ NMFS BiOp Section 9.6.1.7.2 Page 9-127, Action 143. USFWS BiOp Section 10.7 Page 86, Action-f 40.

measures will require additional data collection and analysis. Validation of the approach, and of specific actions taken, will require continual confirmation that the measures are sufficient to avoid jeopardy and facilitate recovery of listed salmonids.⁶⁵

The Action Agencies, in coordination with NMFS, USFWS, and other Federal agencies, NWPPC, states, and Tribes, have been designated to develop a common data management system for fish populations, water quality, and habitat data.

The Action Agencies evaluated database approaches in 2001 and are moving to develop a North Pacific regional water quality distributed data warehouse. A distributed data warehouse will provide the data architecture for Federal, State, Tribal, and other entities to share water quality and fisheries data in support of ESA and Clean Water Act compliance. A user group coordination team will establish and maintain common data policies, definitions, and dimension tables. Each entity utilizes the dimension tables to create data tables that are shared with the region. A web-based interface for querying and reporting the data is proposed as the interface for sharing information.

In 2002 we plan to begin to develop and coordinate an internal COE Water Quality database. We also will be doing regional coordination of a distributed data warehouse.

7.4 Canadian Storage for Flow Augmentation

The purpose of the actions below is to see if more water from Canadian storage projects can be obtained for flow augmentation.

One (1) Maf of Treaty storage shall be requested and negotiated with BC Hydro to be provided and released during the migration season.⁶⁶

The use of non-Treaty storage shall be requested and negotiated with BC Hydro to be used to store water to for flow enhancement provided operation forecasts indicate that the water stored in the spring can be released in July and August.⁶⁷

The shaping and release of water behind Canadian Treaty storage projects in July and August shall be evaluated requested and negotiated with BC Hydro.⁶⁸

7.5 Albeni Falls Coordination

The action agencies, the USFWS, and Idaho Department of Fish & Game shall meet annually to evaluate Lake Pend Oreille kokanee monitoring results and make necessary adjustments through subsequent in-season management.⁶⁹ The purpose of this action is to provide for better coordination.

⁶⁵ NMFS BiOp Section 9.6.5.4 Page 9-127, Action 198

⁶⁶ NMFS BiOp at Section 9.6.1.2.5 Page 9-67, Action 24

⁶⁷ NMFS BiOp at Section 9.6.1.2.5 Page 9-67, Action 25

⁶⁸ NMFS BiOp at Section 9.6.1.2.5 Page 9-67, Action 26

⁶⁹ USFWS BiOp at Section 11.A..1.4.d Page 94, Action-f 68

7.6 Public Coordination

The purpose of the following actions is to provide for better regional coordination.

Actions in the Water Management Plan will be coordinated with NMFS, USFWS, and the states and tribes in pre-season planning and in-season management of flow and spill operations. This coordination shall occur in the Technical Management Team process.⁷⁰

At all appropriate decision points the action agencies shall routinely seek timely input and concurrence from the USFWS on all matters affecting listed fish through the Columbia River Treaty, International Joint Commission Orders, and all other decisionmaking processes involving transboundary waters in the Columbia River basin. This shall include notification of all meetings and decision points and provision of opportunity to advise the action agencies during meetings and in writing as appropriate.⁷¹

7.7 System Flood Control Study

The purpose of the various flow control studies is to see if more water can be available for spring flow management without reducing flood control protection.

COE will conduct a system wide flood control study. No work is scheduled in 2002 pending appropriation of funds.⁷²

7.8 Banks Lake Flow Augmentation

Reclamation will assess effects of drafting Banks Lake to elevation 1,560 feet by the end of August. Reclamation is preparing an EIS for National Environmental Policy Act compliance to implement this action in August 2002.⁷³

The purpose of the proposed operation at Banks Lake is to enhance and attempt to meet target flows in the Columbia River during the juvenile out migration of ESA listed salmonid stocks by altering the August drawdown of Banks Lake from elevation 1,565 feet down to 1,560 feet.

7.9 Dworshak Draft to 1,500' Adult Evaluation

The purpose of the Dworshak draft to 1,500 feet study is to see if more water can be provided for summer flow augmentation.

The ongoing temperature monitoring and field evaluations will continue in 2002. The Computational Fluid Dynamic model of the Lower Snake and Clearwater is scheduled to be completed this year.⁷⁴

⁷⁰ NMFS BiOp at Section 9.4.2.2 Page 9-27, Action 3 and NMFS BiOp at Section 9.4.2.2 Page 9-60, Action 17

⁷¹ USFWS BiOp at Section 8.1.g Page 76, Action-f 7

⁷² NMFS BiOp Section 9.6.1.2.6 Page 72, Action 35

⁷³ NMFS BiOp at Section 9.6.1.2.6 Page 9-70, Action 31

⁷⁴ NMFS BiOp at Section 9.6.1.2.6 Page 9-71, Action 34

7.10 Other Reclamation Water Management Actions

The following actions from the NMFS BiOp are intended to provide additional benefits to listed fish.

Reclamation will consult with NMFS before committing any of its uncontracted storage space or entering into new contracts. No contracts are scheduled for review in 2002.⁷⁵

Reclamation shall pursue water conservation improvements at its projects. Reclamation annually receives numerous proposals for conservation projects from its irrigation districts and others. FY 2002 Project selection criteria have been developed a new ESA emphasis and will be applied to proposals considered for Reclamation projects.⁷⁶

Reclamation will provide NMFS with a report on unauthorized use of Reclamation Project water. Although unauthorized use is not a federal action, Reclamation will work with its districts and their water users to prepare a report by December 2002.⁷⁷

Reclamation shall complete ESA consultations on its tributary projects below Chief Joseph Dam. Consultations are in progress and scheduled to be completed in 2002 for the Crooked River, Deschutes, Arnold, Umatilla, Yakima, and Tualatin Projects.⁷⁸

The Action Agencies shall acquire water for instream use from Reclamation's Upper Snake River Projects. Reclamation, NMFS, and others are participating in settlement discussions under the Snake River Basin Adjudication Implementation of flow augmentation in 2002 will involve a settlement, another ESA consultation on the Upper Snake projects, and authorizing legislation from Idaho.⁷⁹

On the Columbia Basin Project, Reclamation will identify and evaluate salmon attraction problems in the wasteways and drains, initiate water quality monitoring and evaluation of return flows, and complete the construction of screens at the Burbank No. 2 and 3 pumps in 2002.⁸⁰

8.0 Conclusion

This 2002 Water Management Plan will be coordinated with the Technical Management Team. Seasonal action plans will be developed as described in the introduction to this plan. Additionally, operations may be adjusted in-season based on recommendations from the TMT.

⁷⁵ NMFS BiOp Section 9.6.1.2.6 Page 68, Action 27

⁷⁶ NMFS BiOp Section 9.6.1.2.6 Page 68, Action 28

⁷⁷ NMFS BiOp Section 9.6.1.2.6 Page 69, Action 29

⁷⁸ NMFS BiOp Section 9.6.1.2.6 Page 69, Action 30

⁷⁹ NMFS BiOp at Section 9.6.1.2.6 Page 9-70, Action 32

⁸⁰ NMFS BiOp Section 9.6.1.2.7, Page 74-75, Actions 37, 38, 39