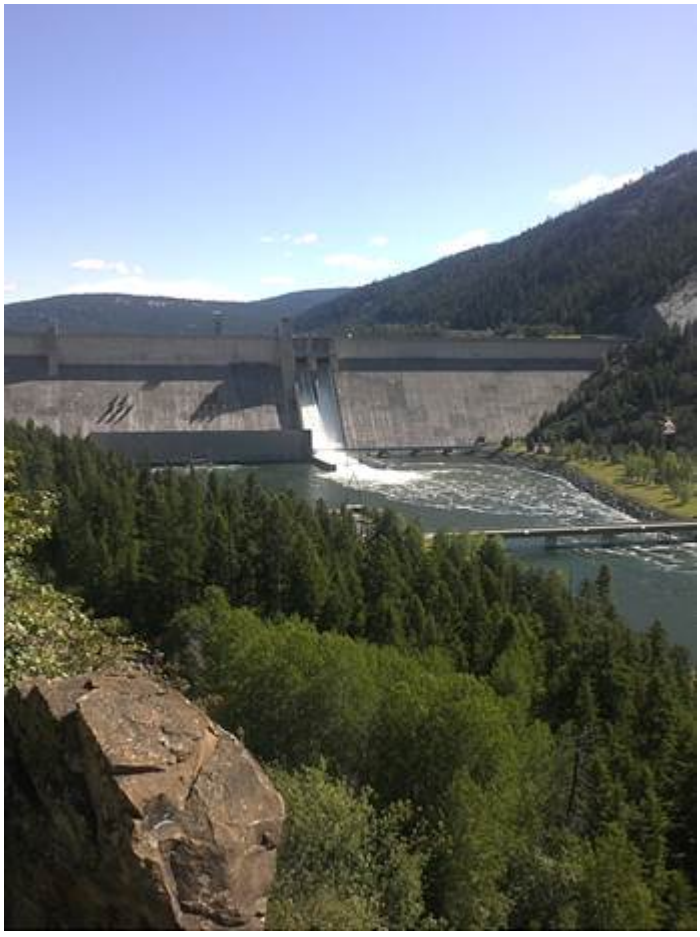
# 2017 WATER MANAGEMENT PLAN



Libby Dam
Libby, Montana

Bonneville Power Administration
U.S. Bureau of Reclamation
U.S. Army Corps of Engineers

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# 1. Introduction

The U.S. Army Corps of Engineers (Corps), Bureau of Reclamation (Reclamation), and Bonneville Power Administration (BPA), collectively referred to as the Action Agencies (AAs), have consulted with NOAA Fisheries and the U.S. Fish and Wildlife Service (USFWS) on the effects of operating the 14 Federal multi-purpose hydropower projects in the Federal Columbia River Power System (FCRPS) on fish species listed as endangered or threatened under the Endangered Species Act (ESA). These consultations resulted in biological opinions (BiOps) from NOAA Fisheries and USFWS that identify FCRPS operations that are implemented by the AAs to avoid jeopardizing the survival and recovery of ESA-listed fish species. The FCRPS BiOps and other applicable governing documents are described below in Section 2.

The 2017 Water Management Plan (WMP) describes the AAs plan for the 2017 water year (October 1, 2016, through September 30, 2017) for implementing the specific operations identified in the 2008 NOAA Fisheries FCRPS BiOp, as supplemented in 2010 and 2014 (collectively referred to as the 2008/2010/2014 NOAA Fisheries BiOp), and the 2000 USFWS FCRPS BiOp, as supplemented in 2006 for Libby Dam (collectively referred to as the 2000/2006 USFWS BiOps). The AAs are the final authorities on the content of the WMP after coordination with the sovereign inter-agency Technical Management Team (TMT) to solicit their review, comment and recommendations for consideration during preparation of the WMP. The WMP is consistent with the adaptive management provisions in the 2008/2010/2014 NOAA Fisheries BiOp and the Corps' Record of Consultation and Statement of Decision (ROCASOD) adopting the project operations contained in the applicable FCRPS BiOp and the Columbia Basin Fish Accords (Accords). The AAs will prepare seasonal updates to the 2017 WMP that will be posted on the following website for regional review through the TMT:
http://www.nwd-wc.usace.army.mil/tmt/documents/wmp/

The system operations contained herein may be adjusted according to in-season water year conditions based on coordination with the TMT.

# 2. Governing Documents

The following are the governing documents associated with the WMP—the biological assessments (BAs) produced by the AAs and submitted to NOAA Fisheries and USFWS to initiate consultation; and the resulting BiOps issued by NOAA Fisheries and USFWS:

## 2.1. Biological Assessments (BA)

- 1999 BA for the Effects of FCRPS Operations on Columbia Basin Bull Trout and Kootenai River White Sturgeon (Corps, BPA, Reclamation)

The AAs submitted a BA to USFWS in December 1999 addressing the effects of 2000-2010 FCRPS operations on bull trout and Kootenai white sturgeon. The BA addressed FCRPS project operations on the Columbia River and on the Snake River downstream of Lower Granite Dam.

The BA is incorporated by reference in the 1999 Multi-Species BA that may be found on the following website:
http://www.usbr.gov/pn/fcrps/documents/1999ba.pdf

- 2004 BA for the Effects of Libby Dam Operations on Kootenai River White Sturgeon (Corps, BPA)

Due to the critical habitat designation and new information on the Kootenai River white sturgeon, the Corps and BPA re-initiated consultation on the effects of Libby Dam operations on the Kootenai sturgeon and its critical habitat. The AAs submitted a BA to USFWS in July 2004 to supplement the 1999 FCRPS BA with this additional information. A complete administrative record of this consultation is on file at the USFWS Upper Columbia Office in Spokane, WA.

- 2007 FCRPS BA and Comprehensive Analysis of the FCRPS and Mainstem Effects of Upper Snake and Other Tributary Actions (Corps, BPA, Reclamation)

The AAs submitted a BA and a Comprehensive Analysis to NOAA Fisheries on August 21, 2007. The BA proposed a Reasonable and Prudent Alternative (RPA) of specific FCRPS operations that the AAs would implement to avoid jeopardy and adverse modification of critical habitat of listed fish species. The Comprehensive Analysis integrated the analysis of effects of the FCRPS with the analysis of effects of actions in the Upper Snake River and other tributaries. Both documents may be found on the following website:
http://www.salmonrecovery.gov/BiologicalOpinions/FCRPSBiOp/2008FCRPSBiOp/2007BAandCA.aspx

- 2007 Upper Snake BA (Reclamation)

Reclamation submitted a BA to NOAA Fisheries in August 2007 that described actions involving operations and routine maintenance at 12 Federal projects located upstream of Brownlee Reservoir and evaluated the effects of those actions on ESA-listed fish species. The BA may be found on the following website:
http://www.usbr.gov/pn/programs/esa/uppersnake/index.html

## 2.2. Biological Opinions (BiOp)

- 2000 USFWS FCRPS BiOp

The 2000 USFWS FCRPS BiOp, "Effects to Listed Species from Operation of the Federal Columbia River Power System," issued on December 20, 2000 evaluates the effects of operating the FCRPS on threatened Columbia Basin bull trout in areas downstream of Hells Canyon Dam and in the Upper Columbia Basin, and on endangered Kootenai River white sturgeon, and may be found on the following website:
http://www.fws.gov/pacific/finalbiop/BiOp.html

- 2006 USFWS Libby Dam BiOp

The 2006 USFWS Libby BiOp "The Effects of Libby Dam Operations on the Kootenai River White Sturgeon, Bull Trout, and Kootenai Sturgeon Critical Habitat," was issued on February 16, 2006 and supplemented the USFWS 2000 FCRPS BiOp. The document may be found on the following website:
http://www.salmonrecovery.gov/BiologicalOpinions/LibbySturgeonBiOp.aspx

In 2008, the USFWS issued a Clarified RPA for the 2006 Libby Dam BiOp in order to determine the success or non-success of Libby Dam sturgeon operations. Pursuant to this 2008 Clarified RPA, the Corps operates Libby Dam to provide additional flows to benefit Kootenai River white sturgeon. Operations for this year are further detailed in Section 6.4 below (Libby Dam Project Operations).

- 2008 NOAA Fisheries Upper Snake BiOp

The 2008 NOAA Fisheries Upper Snake BiOp was issued on May 5, 2008 and titled "Consultation for the Operation and Maintenance of 10 U.S. Bureau of Reclamation Projects and 2 Related Actions in the Upper Snake River above Brownlee Reservoir (Revised and Reissued Pursuant to court order, *American Rivers v. NOAA Fisheries*, CV 04-0061-RE (D. Oregon))." The document may be found on the following website:
http://www.westcoast.fisheries.noaa.gov/fish_passage/fcrps_opinion/federal_columbia_river_power_system.html

- 2008/2010/2014 NOAA Fisheries FCRPS BiOp

The 2008 NOAA Fisheries FCRPS BiOp, "Consultation on Remand for Operation of the Federal Columbia River Power System, 11 Bureau of Reclamation Projects in the Columbia Basin and ESA Section 10(a)(1)(A) Permit for Juvenile Fish Transportation Program (Revised and reissued pursuant to court order, *NWF v. NOAA Fisheries*, Civ. No. CV 01-640-RE (D. Oregon)," was issued May 5, 2008.

The 2008 FCRPS BiOp was supplemented in 2010 and 2014 with new and updated scientific reports and data, additional project definitions, analyses and amended RPA actions. The NOAA Fisheries FCRPS BiOps and related documents may be found on the following website:
http://www.salmonrecovery.gov/BiologicalOpinions/FCRPSBiOp.aspx

## 2.3. Additional Governing Documents

- Corps 2003 Columbia River Treaty Flood Control Operating Plan (FCOP)

The Columbia River Treaty between Canada and the United States of America provides that the powers and duties of the Canadian and United States Entities include the preparation of a Flood Control Operation Plan (FCOP) for Canadian storage in the Upper Columbia River Basin. The purpose of the FCOP for Canadian storage is to prescribe criteria and procedures by which the Canadian Entity will operate Mica, Duncan, and Arrow Reservoirs to achieve desired flood risk management (FRM) objectives in the United States and Canada. The purpose of including Libby

Reservoir in the FCOP is to meet the Treaty requirement to coordinate its operation for FRM protection in Canada. Because Canadian storage is an integral part of the overall Columbia River reservoir system, the FCOP for this storage must be related to the flood control plan of the Columbia River as a whole. The principles of the Columbia River system operation are therefore contained in the FCOP, which may be found on the following website: http://www.nwd-wc.usace.army.mil/cafe/forecast/FCOP/FCOP2003.pdf

# 3. WMP Implementation Process

## 3.1. Technical Management Team (TMT)

The TMT is an inter-agency technical group comprised of sovereign representatives responsible for making in-season recommendations to the AAs on dam and reservoir operations in an effort to meet the expectations of the applicable BiOps (listed above) and accommodate changing conditions, such as water supply, fish migration, water quality, new information, and maintenance issues. The TMT consists of representatives from the AAs (Corps, BPA, and Reclamation), NOAA Fisheries, USFWS, the states of Oregon, Washington, Idaho, and Montana, and Tribal sovereigns.

## 3.2. Preparation of the WMP

Each fall, the AAs prepare an annual WMP (draft by October 1 and final by January 1). The AAs prepared this WMP for the 2017 water year consistent with the 2008/2010/2014 NOAA Fisheries BiOp, and the 2000/2006 USFWS BiOps. This WMP describes the planned operations of the FCRPS dams and reservoirs for the 2017 water year (October 1, 2016, through September 30, 2017)[1]. The operations are designed to:

1. Implement water management measures consistent with actions considered in their respective BiOps.

2. Assist in meeting the biological performance standards specified in the BiOps in combination with other actions or operations identified in the 2008/2010/2014 NOAA Fisheries BiOp.

3. Meet other FCRPS project requirements and purposes such as flood risk management (FRM), hydropower, irrigation, navigation, recreation, and fish and wildlife not listed under the ESA. Additional information regarding Columbia River FRM may be found on the following website: http://www.nwd.usace.army.mil/Missions/WaterManagement/ColumbiaRiverBasin/ColumbiaRiverFloodControl.aspx

4. Take into account recommendations contained in the applicable Northwest Power and Conservation Council's Fish and Wildlife Program and amendments.

[1] In the preparation of the draft WMP, very little information is available about the upcoming year's water supply; therefore, the draft provides a general description of planned FCRPS operations for that water year.

The WMP also includes special operations planned for the year (e.g., special tests, maintenance, construction activities, etc.) known at the time the WMP is developed. Throughout the season, the AAs will utilize the TMT forum to provide the region with seasonal updates on water supply forecasts and specific project operations. These will be available on the following website: http://www.nwd-wc.usace.army.mil/tmt/documents/wmp/

## 3.3. Fish Passage Plan (FPP)

The Corps coordinates with regional agencies to prepare an annual Fish Passage Plan (FPP) that provides detailed operating criteria for project fish passage facilities, powerhouses, and spillways to facilitate the safe and efficient passage of migratory fish. The FPP contains appendices that describe special operations for fish research studies, the juvenile fish transportation program, operation of turbine units within 1% of best efficiency, spill for fish passage, total dissolved gas (TDG) monitoring, and dewatering procedures. The FPP is coordinated through the inter-agency Fish Passage Operations and Maintenance (FPOM) Coordination Team and is available on the following website:
http://www.nwd-wc.usace.army.mil/tmt/http://www.nwd-wc.usace.army.mil/tmt/documents/fpp/

## 3.4. 2008/2010/2014 NOAA Fisheries BiOp Strategies

The WMP addresses water management actions defined in the 2008/2010/2014 NOAA Fisheries BiOp RPA Hydropower Strategy 1 (Table 1) to enhance juvenile and adult fish survival, achieve performance standards, and provide benefits to resident fish through a coordinated set of hydropower project management actions. RPA Hydropower Strategies 2, 3, and 4, defined below, are more directly addressed in other documents (e.g., FPP); however some actions identified in the WMP may support those strategies as well.

1. Hydropower Strategy 1—Operate the FCRPS to provide flows and water quality to improve juvenile and adult fish survival (outlined in Table 1 and described in greater detail in Sections 4 through 10).

2. Hydropower Strategy 2—Modify Columbia and Snake River dams to maximize juvenile and adult fish survival.

3. Hydropower Strategy 3—Implement spill and juvenile transportation improvements at Columbia River and Snake River dams.

4. Hydropower Strategy 4—Operate and maintain facilities at Corps mainstem projects to maintain biological performance.

**Table 1.** RPA Actions Related to Water Management in Hydropower Strategy 1 (excerpted from 2008/2010/2014 NOAA Fisheries BiOp RPA Table of Actions, included in the WMP as Appendix 7).

| **Hydropower Strategy 1**<br>**Operate the FCRPS to provide flows and water quality to improve juvenile and adult fish survival.** | |
|---|---|
| RPA No. 4 | Storage Project Operations (Libby, Hungry Horse, Albeni Falls, Grand Coulee, Dworshak) |
| RPA No. 5 | Lower Columbia and Snake River Operations (Bonneville, The Dalles, John Day, McNary, Ice Harbor, Lower Monumental, Little Goose, Lower Granite) |
| RPA No. 6 | In-Season Water Management |
| RPA No. 7 | Forecasting and Climate Change/Variability |
| RPA No. 8 | Operational Emergencies |
| RPA No. 9 | Fish Emergencies |
| RPA No. 10 | Columbia River Treaty Storage |
| RPA No. 11 | Non-Treaty Storage (NTS) |
| RPA No. 12 | Non-Treaty Long-Term Agreement |
| RPA No. 13 | Non-Treaty Coordination with Federal Agencies, States, and Tribes |
| RPA No. 14 | Dry Water Year Operations |
| RPA No. 15 | Water Quality Plan for Total Dissolved Gas and Water Temperature in the Mainstem Columbia and Snake Rivers |
| RPA No. 16 | Tributary Projects |
| RPA No. 17 | Chum Spawning Flows |

## 3.5. Non-ESA Operations

Each year the AAs implement water management actions to achieve other project purposes in addition to those required under the ESA, including: FRM, power generation, irrigation, navigation, recreation, and fish and wildlife not listed under the ESA. Table 2 defines non-ESA listed fish and wildlife related water management actions that may be implemented and the time of year such actions typically occur, and are further described below.

**Table 2.** Location and Timing of Water Management Actions Related to non-ESA listed Fish and Wildlife Species.

| **Project** | **Water Management Actions for:** | **Time of Year** |
|---|---|---|
| Keenleyside (Arrow) | Mountain whitefish | December – January |
| Keenleyside (Arrow) | Rainbow trout | April – June |
| Duncan | Whitefish | March – May |
| Libby | Burbot (temperature) | October - February |
| Dworshak | Hatchery release (increased flow) | March-April |
| Grand Coulee | Kokanee | September – mid-November |
| Hanford Reach Fall Chinook Protection Program Agreement | | October – June |
| McNary | Waterfowl Nesting | March – May |
| McNary | Waterfowl Hunting Enhancement | October – January |
| Ice Harbor | Waterfowl Hunting Enhancement | October – January |
| Little Goose | Waterfowl Hunting Enhancement | October – January |

# 4. Hydrosystem Operation

## 4.1. Priorities

The 2008/2010/2014 NOAA Fisheries BiOp and the 2000/2006 USFWS BiOps list the following strategies for flow management:

1. Provide minimum project flows in the fall and winter to support fisheries below the storage projects (e.g., Hungry Horse, Dworshak, Albeni Falls, and Libby). Limit the winter/spring drawdown of storage reservoirs to increase spring flows and the probability of reservoir refill.

2. Draft from storage reservoirs in the summer to increase summer flows.

3. Provide minimum flows in the fall and winter to support mainstem chum spawning and incubation below Bonneville Dam.

The AAs have reviewed these strategies and other actions called for in the 2008/2010/2014 NOAA Fisheries BiOp and the 2000/2006 USFWS BiOps, and developed the following priorities (in order) for flow management and individual reservoir operations after ensuring adequate flood risk management is provided:

1. Operate storage projects to meet minimum flow and ramp rate criteria for resident fish.

2. Refill the storage projects to provide summer flow augmentation. The target refill date may vary depending on the timing and shape of the spring runoff. For example, a late snowmelt runoff may result in a later refill in order to avoid excessive spill. Target refill dates for the storage projects are listed below in Table 6, and further described in the RPA Table (Appendix 7).

3. Operate storage projects to be at their April 10 elevation objectives to provide spring flow augmentation.

4. Operate storage projects to balance the needs of chum flow augmentation and spring flow augmentation from the start of chum spawning in November through the end of chum emergence (approximately April) to maintain sufficient water depth to protect chum spawning and incubation habitat at the Ives Island complex below Bonneville Dam.

In addition to operations intended to benefit ESA-listed anadromous fish, the AAs operate the FCRPS projects to benefit ESA-listed resident fish (i.e., bull trout, Kootenai River White Sturgeon) that may be affected by FCRPS operations. Projects are also operated to meet minimum outflows; avoid involuntary spill and resulting elevated TDG; avoid fluctuations in outflow that may strand fish and degrade fish habitat; reduce the cross-sectional area of run-of-river reservoirs in order to minimize fish travel times, passage delays, and avoid increases in water temperatures; and to provide specific releases from storage projects in order to improve downstream flows and water temperatures for fish. These operations are generally the highest

priority because of the direct linkage between a particular operation and impacts on fish near the dam.

Because the water year begins on October 1, the flow objectives are not encountered in the same order as the 2008/2010/2014 NOAA Fisheries BiOp flow priorities (e.g., chum spawning flows will be determined prior to spring and summer migration flows, even though chum flows are a lower priority). However, the AAs will make every effort to follow flow priorities while implementing operations as they occur chronologically during the year. Objectives include:

1. Storage reservoir draft limits in late summer are a higher priority than the summer flow objectives in order to meet other project uses and reserve water in storage for the following year.

2. Operate the storage reservoirs to achieve the April 10 elevation objectives with a high probability. These levels will vary with the runoff forecast. The ability to meet this objective is affected by the quantity of water released for FRM, changes in runoff volume forecasts, power generation and unit availability, planned and unplanned pool restrictions, draft rate restrictions, water quality, and fishery flows to support both lower Columbia River chum and Hanford Reach fall Chinook spawning, as well as minimum flow requirements below the projects.

3. Refill the storage reservoirs by about June 30 while minimizing spill (except as needed to maintain FRM) in order to maximize available storage of water for the benefit of summer migrating fish. Through TMT and in-season management, priority for spring flow may be adjusted with a recognition that summer refill may be compromised.

4. Manage the available storage to augment summer (July and August) flows in the lower Columbia River and lower Snake River in an attempt to meet flow objectives and to minimize increases in water temperature, as described below in the project-specific sections (Section 6).

These objectives are intended as general guidelines. The 2008/2010/2014 NOAA Fisheries BiOp and the 2000/2006 USFWS BiOps rely on adaptive management to make adjustments in FCRPS operations based on best available science, and knowledge about current conditions in the system and effects due to management actions. Conditions that are continually changing include: information on fish migration, stock status, biological requirements, biological effectiveness, and hydrologic and environmental conditions.

## 4.2. Conflicts

System managers recognize that water supply conditions are variable and unpredictable and there is often insufficient water to accomplish all the objectives addressed in the 2008/2010/2014 NOAA Fisheries BiOp and the 2000/2006 USFWS BiOps for the benefit of listed fish. This may be further complicated by responsibilities to provide for other authorized purposes such as FRM, power system reliability, irrigation, recreation, and navigation needs. Management of water resources for any one fish species may conflict with the availability of water for other fish species or project purposes. The AAs, in coordination with regional parties through the TMT,

consider the multiple uses of the system, while prioritizing measures to benefit listed species. Below are some of the typical conflicts that may occur.

### 4.2.1. Flood Risk Management Draft versus Project Refill

The 2008/2010/2014 NOAA Fisheries BiOp and the 2000/2006 USFWS BiOps specify that the storage projects be as full as possible on April 10 while still being able to maintain adequate reservoir storage for flood risk management. This is designed to increase the likelihood of refill and to maximize both spring flow management and summer flow augmentation.

FRM procedures specify the amount of storage needed to provide flood damage reduction. In furtherance of the flood damage reduction objective, storage space is provided to minimize the risk due to forecast and runoff uncertainty. In an effort to reduce forecast error and to better anticipate the runoff timing or water supply, the AAs and the Northwest River Forecast Center (NWRFC) use the best available science to compute water supply forecasts. An annual forecast review will occur each fall by the Columbia River Forecast Group (CRFG) to evaluate the performance of the current forecast procedures. The CRFG will evaluate new forecasting techniques for potential implementation.

### 4.2.2. Spring Flow Management versus Project Refill and Summer Flow Augmentation

FRM elevations are determined based on water supply, runoff and hydrologic model forecasts and can change significantly from one forecast to the next. Changes in forecasts throughout the FRM season can make it difficult to achieve spring flow and project refill objectives. The summer flow objective at McNary is supported by various flow augmentation measures. There is a limited amount of water available for flow augmentation and summer flow objectives are provided as a biological guideline.

### 4.2.3. Chum Flow versus Project Refill and Spring Flow Management

Providing a Bonneville Dam tailwater elevation level conducive to chum spawning and incubation in the Ives Island complex typically requires flow augmentation from storage reservoirs before reliable flow forecast information becomes available. Refill to the April 10 elevation objective at Grand Coulee has priority over the flow augmentation required to provide the chum spawning level which is set in November - December and protection level set in December and persists through chum fry emergence, typically early April. Although water supply forecasts are available in November and December the forecast errors are very large. Water supply forecasts become incrementally more reliable as time between the forecast and the forecast period decreases. If the tailwater elevation level selected during the spawning season is too high (requiring higher flows and potentially requiring deeper reservoir drafts), there is an increased risk of missing refill to the April 10 elevation objective at Grand Coulee thereby reducing spring flow augmentation if the higher flows are maintained throughout the chum incubation period. Conversely, if the flows must be reduced during the incubation period to target refill, then there is the risk of dewatering chum redds. When this conflict arises, TMT will discuss balancing project refill and spring flows that benefit multiple ESUs that have priority over maintaining the chum tailwater elevations set in December.

### 4.2.4. Libby Dam Sturgeon Flow versus Summer Flow Augmentation

Water released from Libby Dam for spring sturgeon spawning flows (pulse) during May and into July can reduce the probability of reservoir refill, and consequently the amount of the water available for summer flow augmentation from Libby. Although an effort will be made to balance sturgeon flows and reservoir refill, water released for sturgeon spawning flows will take a higher priority than refilling by early July.

### 4.2.5. Fish Operations versus Other Project Uses

In addition to FRM operation, there are other project purposes that may conflict with operations for the benefit of fish. For example, a particular spill pattern at a project may impact the ability of commercial barges to access and enter navigation locks safely. Additionally, in some cases, spill must be curtailed temporarily to allow fish transport barges to safely moor and load fish at loading facilities in the tailrace. With regard to power generation, spilling water for juvenile fish passage reduces the amount of power that can be generated to meet demand, and timing of releases for flow augmentation during fish migration periods may conflict with the shape or timing of power demand. In addition to power generation, operations for irrigation and reservoir recreation may conflict with releases of water for flow augmentation. TMT will discuss these issues when they arise and may make recommendations to the AA with responsibility for the operational decisions.

### 4.2.6. Conflicts and Priorities Summary

The conflicts described above pose many challenges to the AAs in meeting the multiple uses of the hydrosystem. The priorities for flow management and individual reservoir operations outlined in section 4.1 will assist the AAs in operational decision-making.

Discussion of conflicts between operational requirements and alternatives for addressing such conflicts will occur in TMT. Ultimately, the AA with the authority and responsibility for the operation to meet authorized project purposes will make the decision.

## 4.3. Emergencies

The WMP, the 2008/2010/2014 NOAA Fisheries BiOp, and the current FPP acknowledge that emergencies and other unexpected events occur and may cause interruptions or adjustments of fish protection measures. Such deviations may be short in duration, such as a response to an unexpected unit outage or power line failure, or a search and rescue operation, or longer in duration, such as what was experienced in 2001 in response to the low water conditions. Emergency operations will be managed in accordance with the TMT Emergency Protocols (included in the WMP as Appendix 1), the FPP and other appropriate AA emergency procedures.

### 4.3.1. Operational Emergencies

The AAs will manage interruptions or adjustments in water management actions, which may occur due to unforeseen power system, FRM, navigation, dam safety, or other emergencies. Such emergency actions will be viewed by the AAs as a last resort and will only be used in place of operations outlined in the annual WMP, if necessary. Emergency operations will be managed

in accordance with TMT Emergency Protocols, the FPP and other appropriate AA emergency procedures and coordinated through TMT when practicable. The AAs will take all reasonable steps to limit the duration of any interruption in fish protection measures. Emergency Action Plans for generation and transmission emergencies are provided in the Attachments to the TMT Emergency Protocols.

### 4.3.2. Fish Emergencies

The AAs will manage operations for fish passage and protection at FCRPS facilities. The intended operation may be modified for brief periods of time due to unexpected equipment failures or other conditions. These events can result in short periods when projects are operating outside normal specifications due to unexpected or emergency events. Where there are significant biological effects of more than short duration emergencies impacting fish, the AAs will coordinate with the in-season management Regional Forum (see BA Appendix B.2.1) to develop and implement appropriate adaptive management actions to address the situation. The AAs will take all reasonable steps to limit the duration of any fish emergency. The AAs will operate in accordance with the TMT Emergency Protocols identified in Appendix 1 of the WMP.

### 4.3.3. Emergency Operations for Non-ESA listed Fish

The AAs agree to take reasonable actions to aid non-listed fish during brief periods of time due to unexpected equipment failures or other conditions and when significant detrimental biological effects are anticipated or likely to have occurred. When there is a conflict in such operations, operations for ESA-listed fish will take priority.

## 4.4. Fish Research

Research studies may require special operations that differ from routine operations otherwise described in the 2008/2010/2014 NOAA Fisheries BiOp, the 2000/2006 USFWS BiOps, and the current FPP. These studies are generally developed through technical workgroups of the Regional Forum (e.g., the Corps' Anadromous Fish Evaluation Program, Fish Facilities Design Review Work Group, and Studies Review Work Group). Specific research operations are further described in the Corps' FPP (Appendix A) and the AAs' seasonal updates to the WMP. In most cases, operations associated with research entail relatively minor changes from routine operations and are coordinated in regional technical forums (e.g., TMT and/or FPOM). In some cases, the nature or magnitude of operational changes for research may require further coordination and review in policy forums [e.g., Hydro Coordination Team (HCT) or Regional Implementation and Oversight Group (RIOG)]. Generally, research planning and coordination occurs throughout the late fall and winter, with final research plans established by late winter/early spring. If extraordinary events occur, such as extreme runoff conditions (high or low) or a hydrosystem emergency, planned research may be modified prior to implementation to accommodate anticipated unique circumstances and/or to reallocate resources to obtain the greatest value given the circumstances.

## 4.5. Flood Risk Management Shifts

The AA will look for opportunities to shift system FRM requirements from Brownlee and Dworshak to Grand Coulee periodically from January through April to provide more water for flow augmentation in the lower Snake River during the spring migration. The shift will be based upon end-of-month FRM elevations as stated in the official water supply forecasts produced early each month during this time period. Consideration of these FRM shifts by the Corps will include an analysis of impacts to FRM and will not be implemented if FRM would be compromised. These shifts may be implemented after coordination with TMT to discuss tradeoffs and impacts. The reservoirs must be back to their specific upper rule curve (URC) by April 30.

# 5. Decision Points and Water Supply Forecasts

## 5.1. Water Management Decisions and Actions

Table 3 below lists the key water management decisions/actions and when they need to be made. Some decision points, such as setting flow objectives, are clearly articulated in the 2008/2010/2014 NOAA Fisheries BiOp and the 2000/2006 USFWS BiOps. Other decision points, such as setting weekly flow augmentation levels, require thorough discussion and coordination. The decision points given below are spelled out in the BiOps, or are based on best professional judgment and expertise. These decisions are made by the AAs in consideration of actions called for in the BiOps, and input received through the regional forums (TMT, RIOG, and Regional Executives).

**Table 3.** Water Management Decision Points/Actions.

| | September | Early October | November | Winter (December–March) | Early April | Early May | June | Early July |
|---|---|---|---|---|---|---|---|---|
| ***Action*** | • Albeni Falls: Lake Pend Oreille will be drafted mid to late Sep from the summer operating range.<br>• Libby: Stable flows to protect bull trout and other resident fish while targeting 10 feet from full by end of Sep.<br>• Hungry Horse: Stable flows to protect bull trout and other resident fish while targeting 10 feet from full by end of Sep.<br>• Dworshak: Draft to 1520 feet (80 feet from full) by end of Sep, unless modified per the Agreement between U.S. and Nez Perce Tribe for water use in the Dworshak Reservoir. | • Albeni Falls: draft to 2051 feet by mid-Nov unless otherwise requested.<br>• Bonneville: Assess potential tailwater elevations to support chum spawning.<br>• Preliminary discussions of FRM/ project refill strategy.<br>• Support for Hanford Reach fall Chinook protection operations *(non-BiOp action).*<br>• Consider Kootenai burbot temperature operation. | • Early season WSF using SOI.<br>• Hanford Reach fall Chinook redd protection level set *(non-BiOp action).* | • Bonneville: Determine winter/ spring chum redd protection tailwater elevation.<br>• Determine FRM and refill strategies, including any available FRM shifts.<br>• Determine final April 10 objectives based on FCEs from March WSF.<br>• Hungry Horse, Columbia Falls: Min flows set by Jan, Feb, Mar WSF for Apr-Aug.<br>• Begin discussing Hanford Reach operations *(non-BiOp action)* in January.<br>• Dworshak: Determine flexibility to operate above min flow and still reach spring refill targets.<br>• Libby: Corps Dec WSF determines end of Dec FRM elevation.<br>Grand Coulee: Use March WSF at The Dalles Apr-Sep to determine if Lake Roosevelt Inc. Storage draft is 82.5 KAF or 132.5 KAF. | • Spring flow objectives set by April WSFs.<br>• Determine spring flow management strategy including priority for refill.<br>• Lower Snake Projects: Apr 3 begin MOP.<br>• John Day: Apr 10 begin MIP, 262.5-264 feet) through Sep 30.<br>• Determine refill start date based on streamflow forecast to exceed ICF at The Dalles.<br>• Libby, Hungry Horse: If required, use April WSF to determine VARQ refill flows.<br>• Storage Projects: When not at min flows, operate to upper FRM elevation on or about April 10 (exact date determined by in-season management). | • Libby: Evaluate likely tier for sturgeon volume using May WSF. Regional technical team recommends shape, timing of sturgeon pulse.<br>• Libby: minimum outflow 6 kcfs for bull trout from May 15 until sturgeon op begins.<br>• Libby: Use May WSF to calculate tiered bull trout flow for post-sturgeon flow through Aug.<br>• Determine refill start date based on streamflow forecast to exceed ICF at The Dalles (if not in April).<br>• Libby/Hungry Horse: Use May WSF to determine VARQ refill flows.<br>• Libby/Hungry Horse: Use May WSF for The Dalles Apr-Aug to determine Sep draft limit. | • Lower Granite: Summer flow objective determined by June WSF.<br>• Libby, Hungry Horse: Use June WSF to determine VARQ refill flows.<br>• Libby: Regional technical team recommends shape and timing of sturgeon pulse.<br>• Determine summer flow augmentation strategy (early June).<br>• Begin Dworshak temperature modeling.<br>• Dworshak: Refill by about June 30. | • Grand Coulee: summer draft limit determined by July WSF for The Dalles Apr-Aug.<br>• Libby, Hungry Horse, Dworshak: Estimate stable flows that will draft for salmon.<br>• Libby: Refill probability is likely later in July (exact date determined in-season).<br>• Dworshak: Begin summer flow augmentation and temperature moderation. |

## 5.2. Water Supply Forecasts (WSF)

Water supply forecasts (WSF) serve as a guide to how much water may be available for fish and other operations. Flow projections are provided to the TMT regularly during the fish passage season (April 3 – August 31).

The NWRFC, Corps, Reclamation, and others prepare water supply forecasts to manage the Columbia and Snake rivers, and implement actions described in the BiOps (Tables 4 and 5).

The NWRFC produces a minimum of three Ensemble Streamflow Prediction (ESP) forecasts each week for various forecast points, differentiated by the number of days of deterministic weather forecasts used to initialize the forecast. The three initializations used have been the 10, 5, and 0 days of weather forecast. The AAs use the 50% exceedance value for the 5-day initialization as the Official forecast.

The AAs will continue to track the performance of the 5-day initialization forecasts against the performance of the 0- and 10-day initializations. To date, this analysis shows that the meteorological science is still not adequate to have a reliable forecast out 10 days into the future, whereas 5-day forecasts continue to show skill. In 2017, the 50% exceedance value for the 5-day initialized ESP forecast for The Dalles and Lower Granite, released closest to or prior to the 3rd working day of the month will be used as the official forecast for each month. FRM or other computations will continue to be computed at the same intervals as before. This process for integrating the ESP forecasts into the water management planning process is being implemented as described. The AAs will continue to track the process for 2017 and will evaluate after the water year is complete to determine if any additional adjustments need to be made.

**Table 4**. Forecast Designations.

| Date | Forecast Designation |
|---|---|
| 5 January 2017 | January |
| 3 February 2017 | February |
| 3 March 2017 | March |
| 5 April 2017 | April |
| 3 May 2017 | May |
| 5 June 2017 | June |
| 5 July 2017 | July |

**Table 5.** Water Supply Forecasts Used to Implement BiOp Actions. See Table 6 for project-specific operations**.**

| Forecast Point | Forecast period | Forecast | BiOp Actions to be Determined |
|---|---|---|---|
| Hungry Horse | April – August Provided by Reclamation | January, February, March | Sets min. flows at Hungry Horse and Columbia Falls |
| | May – September Provided by Reclamation | January, February, March | Sets VARQ FRM targets |
| | | April | Sets VARQ FRM targets and VARQ refill flows |
| | | May, June | Sets VARQ refill flows |
| The Dalles | April – September Provided by NWRFC | March | Sets CRWMP adjustments at Grand Coulee |
| | April – August Provided by NWRFC | April | Sets spring flow objective at McNary Dam |
| | | May | Sets end of September draft limits at Hungry Horse and Libby |
| | | July | Sets end of August draft limit at Grand Coulee |
| Lower Granite | April – July Provided by NWRFC | April | Sets spring flow objective at Lower Granite |
| | | June | Sets summer flow objective at Lower Granite |
| Libby | April – August Provided by Corps Seattle District | December | Sets end of December variable draft target |
| | | January, February, March | Sets VARQ FRM targets |
| | | April | Sets VARQ FRM targets and VARQ refill flows |
| | | May | Sets Libby min. sturgeon flow volume and min. bull trout flows for after sturgeon pulse through Sept.<br>Sets VARQ FRM targets and VARQ refill flows |
| | | June | VARQ refill flows |
| Dworshak | April – July Provided by Corps Walla Walla District | January to June | Manage for reservoir FRM and refill |

# 6. Project Operations

Table 6 summarizes the major fish-related reservoir and flow operations by project, consistent with the 2008/2010/2014 NOAA Fisheries BiOp RPA (Appendices 7 and 8). More detailed descriptions of each of these operations by project follow the table.

**Table 6.** Project Operations for ESA-listed Fish Species.

| Project | Flood Risk Management & Project Refill | Kootenai River White Sturgeon | Bull Trout | Spring Anadromous | Summer Anadromous | Chum |
|---|---|---|---|---|---|---|
| **Libby (section 6.4)** | Winter: Operate to VARQ FRM rule curve and achieve target elevation by April 10 if possible.<br>Spring: Adhere to VARQ Operating Procedures, supply tiered volume for sturgeon and minimum flow for bull trout.<br>Summer: Provide summer flow augmentation, refill. Exact date determined in-season dependent on available water supply, shape, and spring flow operations, while avoiding involuntary spill and meeting FRM objectives. | May–July: Provide USFWS sturgeon volume to augment flow at Bonners Ferry. | Year -Round: Maintain project minimum flow requirements. Operate using ramping rates to minimize adverse effects of flow fluctuations.<br>May 15–Sep 30: Operate to Bull Trout minimum flow requirements. Maintain steady outflow if possible Jul–Sep while targeting experimental draft to 10 feet from full by end of Sep (except in dry water years[4] when target elevation can be to 20 feet from full). Full is 2459 feet. | Operate to meet refill and support flow objectives if possible without jeopardizing FRM, meeting sturgeon volume goals and not exceeding TDG limits. | September: Target experimental draft to 10 feet from full by end of Sep (except in dry water years[4] when the draft target will increase to 20 feet from full). Full is 2459 feet. | Fall/winter storage may be used to support chum flows. |
| **Hungry Horse (section 6.2)** | Winter: Operate to VARQ FRM rule curves and to 75% probability of meeting April 10 elevation objective. | N/A | Year-Round: Maintain Columbia Falls and project minimum flow requirements. Operate using ramping rates to minimize adverse effects of flow fluctuations and maintain steady outflow if possible Jul–Sep.<br>Experimental draft during Jul-Sep to a target elevation of 3550 feet (10 feet from full) by Sep 30, except in dry water years[4] when the draft target is 3540 feet (20 feet from full). Full is 3560 feet. | Refill by about June 30 if possible without excessive spill and operate to help meet flow objectives without exceeding TDG limits. | September: Experimental draft during Jul-Sep to a target elevation of 3550 feet (10 feet from full) by Sep 30, except in dry water years[4] when the draft target elevation is 3540 feet (20 feet from full). | |

| Project | Flood Risk Management & Project Refill | Kootenai River White Sturgeon | Bull Trout | Spring Anadromous | Summer Anadromous | Chum |
|---|---|---|---|---|---|---|
| **Albeni Falls (section 6.3)** | Winter: Operate within standard FRM criteria.<br>Spring: Refill by June 30.<br>Spring: When not operating to meet minimum flows, or to minimize downstream flooding, operate to be at upper FRM elevation on or about April 10 (exact date determined in-season) to increase flows for spring flow augmentation for fish. | | Fall/Winter: Winter minimum control elevation will be 2051 feet by mid-Nov. Maintain 2051 feet until stable lake elevation is no longer required to support kokanee spawning as coordinated with IDFG.<br>After end of stable lake operation to support kokanee spawning, operate not to exceed FRM rule curve but not below minimum control elevation. | | | Fall/Winter: Storage may be used to support chum flows |
| **Grand Coulee (section 6.5)** | Winter: Operate for FRM and to 85% probability of meeting April 10 elevation objective to increase spring flows in the Columbia River.<br>Spring: Refill by about June 30 and operate to help meet flow objectives (exact date determined in-season). | N/A | | Operate to help support Spring flow objectives below Priest Rapids and McNary. Jan-Apr maintain 85% confidence of meeting April 10 elevation objective. | July-August: Draft to support salmon flow objectives during Jul-Aug with variable draft limit of 1278 to 1280 feet by Aug 31 based on the WSF.[2]<br>August: Reduce pumping into Banks Lake and allow Banks Lake to operate up to 5 feet from full (1565 feet) to help meet salmon flow objectives when needed. | Fall/Winter: Storage may be used to support chum flows. |
| **Dworshak (section 6.8)** | Winter: Operate to achieve April 10 elevation objective (exact date to be determined during in-season management).<br>Spring: Refill by about June 30 and operate to help meet flow objectives. | N/A | | | Draft to 1535 feet by end of Aug and to 1520 feet (80 feet from full) by end of Sep, unless modified per the Agreement between U.S. and Nez Perce Tribe for water use in the Dworshak Reservoir. | Fall/Winter: Storage may be used to support chum flows. |

[2] These draft limits will be modified by the *Lake Roosevelt Incremental Storage Release Project* (Section 6.5.6).

| Project | Flood Risk Management & Project Refill | Kootenai River White Sturgeon | Bull Trout | Spring Anadromous | Summer Anadromous | Chum |
|---|---|---|---|---|---|---|
| **Lower Granite (section 6.10)** | Pool can be drafted as low as 724 feet to protect levees during high flows. | N/A | | Flow objective of 85-100 kcfs<br>Operate within 1 foot of MOP to reduce juvenile travel time.<br>Operate turbines within 1% of peak efficiency. | Flow objective of 50-55 kcfs.<br>Operate within 1 foot of MOP to reduce juvenile travel time.<br>Operate turbines within 1% of peak efficiency. | |
| **Little Goose (section 6.10)** | N/A | N/A | | Operate within 1 foot of MOP to reduce juvenile travel time.<br>Operate turbines within 1% of peak efficiency. | Operate within 1 foot of MOP to reduce juvenile travel time.<br>Operate turbines within 1% of peak efficiency. | |
| **Lower Monumental (section 6.10)** | N/A | N/A | | Operate within 1 foot of MOP to reduce juvenile travel time.<br>Operate turbines within 1% of peak efficiency. | Operate within 1 foot of MOP to reduce juvenile travel time.<br>Operate turbines within 1% of peak efficiency. | |
| **Ice Harbor (section 6.10)** | N/A | N/A | | Operate within 1 foot of MOP to reduce juvenile travel time.<br>Operate turbines within 1% of peak efficiency. | Operate within 1 foot of MOP to reduce juvenile travel time.<br>Operate turbines within 1% of peak efficiency. | |
| **McNary (section 6.11)** | N/A | N/A | | Flow objective of 220-260 kcfs.<br>Operate turbines within 1% of peak efficiency. | Flow objective of 200 kcfs.<br>Operate turbines within 1% of peak efficiency. | |

| Project | Flood Risk Management & Project Refill | Kootenai River White Sturgeon | Bull Trout | Spring Anadromous | Summer Anadromous | Chum |
|---|---|---|---|---|---|---|
| **John Day (section 6.11)** | Reservoir may be operated between 257 and 268 feet for FRM objectives | N/A | | Operate within 1.5 feet of minimum level that maintains irrigation pumping to reduce juvenile travel time.<br>Operate turbines within 1% of peak efficiency. | Operate within 1.5 feet of minimum level that maintains irrigation pumping to reduce juvenile travel time.<br>Operate turbines within 1% of peak efficiency. | When storage space allows and not in conflict with FRM, operate for chum, when hydrologic conditions indicate use of John Day storage space for benefit of maintaining chum tailwater criteria. |
| **The Dalles (section 6.11)** | N/A | N/A | | Operate turbines within 1% of peak efficiency. | Operate turbines within 1% of peak efficiency. | |
| **Bonneville (section 6.11)** | N/A | N/A | | Operate turbines as described in the FPP. | Operate turbines as described in the FPP. | Operate for chum when hydrologic conditions indicate system can likely maintain minimum tailwater elevation (at Oregon shore 0.9 miles downstream of PH1, 50' upstream of Tanner Creek) during spawning and incubation. |

## 6.1. Hugh Keenleyside Dam (Arrow Canadian Project)

### 6.1.1. Mountain Whitefish Flows

Canada has been testing Arrow flow regimes for mountain whitefish spawning over the last several years. Desirable spawning flow levels are defined by Canada and may be modified annually. The historically desired operation is an Arrow outflow between 45-55 kcfs beginning the third week in December and continuing through mid-January. Egg protection flows are generally about 19 kcfs lower than the spawning flow from mid-January through the end of March. Through negotiation of annual agreements under the Treaty, more beneficial whitefish spawning flows are typically provided than would occur otherwise.

### 6.1.2. Rainbow Trout Flows

Rainbow trout spawning typically begins in April. Protection levels begin between 15 and 25 kcfs. The goal is to have stable or increasing river levels through June. Provision of flows for trout spawning downstream of Arrow is negotiated through annual agreements under the Treaty.

## 6.2. Hungry Horse Dam

Hungry Horse Dam is operated for multiple purposes including fish and wildlife, FRM, power, and recreation. Specific operations for flow management to aid anadromous and resident fish are listed in the following sections.

### 6.2.1. Winter/Spring Operations

Hungry Horse will be operated during the winter and early spring for FRM and to achieve a 75% probability of reaching the April 10 elevation objective in order to provide more water for spring flows. This is achieved by operating between the Upper Rule Curve (URC) as an upper limit and the Variable Draft Limits (VDL) as a lower operating limit for the reservoir. The URC is the maximum elevation allowed for FRM and is calculated by using the Storage Reservation Diagram (SRD) developed for VARQ FRM. A description of VDL is provided in Section 7.4. Reclamation computes Hungry Horse Dam's April 10 elevation objective by linear interpolation between the March 31 and April 15 forecasted FRM elevations based on the Reclamation March Final May - September Water Supply Forecast (WSF).

Refill at Hungry Horse usually begins approximately ten days prior to when streamflow forecasts of unregulated flow is projected to exceed the Initial Control Flow (ICF) at The Dalles, Oregon. During refill, discharges from Hungry Horse are determined using inflow volume forecasts, streamflow forecasts, weather forecasts, and the VARQ Operating Procedures. Other factors such as local FRM are also considered when determining refill operations. During the latter part of the FRM season (April) and the refill season (typically May through June), Hungry Horse discharges may be reduced for local flood protection in the Flathead Valley. In 2014 the official flood stage for the Flathead River at Columbia Falls, Montana was modified to 13 feet (approximate flow 44000 cubic feet per second (cfs)) when Flathead Lake elevation is in the top 1 foot (2892-2893 feet). The flood stage is 14 feet (approximately 51000 cfs) when Flathead

Lake's elevation is more than 1 foot below full (2892 feet or lower). These criteria were developed to minimize flooding on the Flathead River above Flathead Lake. With these criteria, Reclamation will adjust outflows from Hungry Horse Dam as necessary (down to a minimum discharge of 300 cfs) as long as there is enough space in the reservoir to manage the remaining runoff. Hungry Horse generally starts reducing discharges when the stage at Columbia Falls hits and begins to exceed 12.5 feet when the flood stage criteria is 13 feet, and 13 feet when the flood stage criteria is 14 feet. However, depending on remaining runoff volume and available reservoir space, Hungry Horse may not start reducing discharges until Columbia Falls reaches levels higher than these criteria.

Often during the spring, changes in FRM, transmission limitations and generation unit availability will require adaptive management actions for real-time operations in order to control refill and to avoid spill.

### 6.2.2. Summer Operations

Hungry Horse will operate to refill by about June 30 to provide summer flow augmentation, except as specifically provided by the TMT. However, the timing and shape of the spring runoff may result in reservoir refill before or after the June 30. For example, a late snowmelt runoff may delay refill to sometime after June 30 in order to avoid excessive spill.

During the summer, Hungry Horse is drafted within the 2008/2010/2014 NOAA Fisheries BiOp specified draft limits. The flow levels are set to meet the end of September target elevation based on the best information available and are coordinated with TMT. A number of factors are considered in setting the flows including the status of fish migration, attainment of flow objectives, water quality, and the effects that reservoir operations will have on other listed and resident fish populations. Hungry Horse discharges during the summer months should be even or gradually declining in order to minimize a double peak on the Flathead River.

The summer operation will target the experimental draft[3] reservoir elevation of 3550 feet (10 feet from full) by September 30, except in dry water years[4] when the draft will increase to target an elevation of 3540 feet (20 feet from full). However, if the project fails to refill, especially during drought years, minimum flow requirements (see Section 6.2.4) may draft the reservoir below the end of September target elevation.

Operations in September are primarily focused on benefiting listed resident bull trout and other fish species below the project. The intent is to maintain steady or gradually declining flows below the project. Hungry Horse may draft slightly above or below the end of September draft limit depending on inflows and minimum flow requirements. Hungry Horse may end the month at an elevation above the end of September draft limit if inflows are higher than were forecasted in the planned operation. Hungry Horse may end the month at an elevation below the end of

[3] "Experimental draft" of Hungry Horse and Libby dams from July through September is defined in the 2008 NOAA Fisheries BiOp RPA 4, Table 1 (included in the WMP as Appendix 7).
[4] "Dry water years" are defined in the 2008 NOAA Fisheries BiOp RPA as the lowest 20th percentile of water years in the RFC 30-year period of record (currently 1981-2010) using the May final water supply forecast for The Dalles April-August. Currently, a dry water year is less than 72.5 MAF. See Section 9 below for more information.

September draft limit due to minimum flow requirements and if inflows are lower than were forecasted in the planned operation.

### 6.2.3. Reporting

Reclamation will fulfill the 2000 USFWS BiOp Reasonable and Prudent Measure (RPM) for annual and monthly reporting by contributing to the annual WMP and presenting weekly and/or biweekly reports of Hungry Horse operations through the TMT meeting process. Reclamation will also fulfill the USFWS RPM recommendation for reporting actual operations by making available pertinent historic elevations and flows as related to Hungry Horse Dam that are available on the following website:
http://www.usbr.gov/pn/hydromet/esatea.html.

### 6.2.4. Minimum Flows and Ramp Rates

The following minimum flows and ramp rates help guide project operations to meet various purposes, including power production. Minimum flows and ramp rates were identified in the 2000 USFWS BiOp for Hungry Horse Dam to protect resident fish and their food organisms in the Flathead River.

There are two minimum flow requirements for Hungry Horse Dam. One is for the South Fork of the Flathead River below the project, the second is for Columbia Falls on the mainstem Flathead River located just downstream from the confluence of the South Fork with the mainstem. The minimum flows for both sites are determined monthly based on the Reclamation WSF for the inflows to Hungry Horse for the period April 1 through August 31. These minimum flows are determined monthly starting with the January forecast, and then set for the remainder of the year based on the March final runoff forecast. Table 7 shows how the minimum flows are calculated[5]. The minimum flow requirements generally govern Hungry Horse discharges in the fall unless the static flood risk management levels require discharges greater than the minimum flow to maintain the required space in the reservoir through the end of December.

**Table 7.** Minimum Flows at Hungry Horse and Columbia Falls.

| Hungry Horse Apr–Aug inflow forecast (KAF) | Hungry Horse min flow[a] (CFS) | Columbia Falls min flow (CFS) |
|---|---|---|
| < 1190 | 400 | 3200 |
| 1190 - 1790 | Interpolate between 400-900 | Interpolate between 3200-3500 |
| > 1790 | 900 | 3500 |

**a**. To prevent or minimize flooding on the Flathead River above Flathead Lake, Hungry Horse discharges can be reduced to a minimum flow of 300 cfs when the stage at Columbia Falls exceeds 13 feet.

The maximum ramp up and ramp down rates are detailed in Table 8. The 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. The ramp rates will be followed except when they would cause a unit(s) to operate in a zone that could result in premature wear or

[5] 2000 USFWS BiOp, Section 3.A.1, Page 6.

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 AAs will provide additional information to the USFWS describing operations outside the "rough zone."

**Table 8. Hungry Horse Dam Ramping Rates.**

| 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 Limit (daily max)** | **Ramp Up Unit Limit (hourly max)** |
| 3200 - 6000 cfs | 1800 cfs/day | 1000 cfs/hour |
| >6000 - 8000 cfs | 1800 cfs/day | 1000 cfs/hour |
| >8000 - 10000 cfs | 3600 cfs/day | 1800 cfs/hour |
| >10000 cfs | No limit | 1800 cfs/hour |

| 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 Limit (daily max)** | **Ramp Down Unit Limit (hourly max)** |
| 3200 - 6000 cfs | 600 cfs/day | 600 cfs/hour |
| >6000 - 8000 cfs | 1000 cfs/day | 600 cfs/hour |
| >8000 - 12000 cfs | 2000 cfs/day | 1000 cfs/hour |
| >12000 cfs | 5000 cfs/day | 1800 cfs/hour |

## 6.2.5. Spill Operations

Hungry Horse will be operated to avoid spill if practicable. Spill at Hungry Horse is defined as any release through the dam that does not pass through the power plant. Full capacity of the power plant is around 408 MW (~12,000 cfs) at full pool, however current transmission restrictions limit generation to 310 MW (~9,000 cfs). Large amounts of spill can cause TDG levels in the South Fork of the Flathead River to exceed the state of Montana's standard of 110%. Empirical data and estimates show that limiting spill to a maximum of 15% of total outflow will help to avoid exceeding the Montana State TDG standard of 110%.

### 6.2.5.1 Special Spill Test Operation

A plan has been prepared to conduct a spill test of the "glory hole" spillway structure at Hungry Horse Dam in the spring of 2017. The purpose of the test is to monitor TDG levels downstream of Hungry Horse Dam that may affect resident fish populations when discharges are made through the spillway. This test would be conducted when the elevation of Hungry Horse Reservoir is in the top 12 feet (elevations 3548 to 3560 feet). Currently the combinations of spill vs. turbine discharge, duration, and timing of the test are being planned but will depend on the timing and amount of runoff. If runoff conditions in 2017 are unfavorable for a test, the test will be delayed to a year where conditions are more favorable. When the plans are finalized they will be included in the seasonal updates and provided to TMT.

## 6.3. Albeni Falls Dam

### 6.3.1. Albeni Falls Dam Fall and Winter Operations

Pursuant to the 2000 USFWS BiOp and the USFWS letter of September 28, 2007, to the Corps and BPA on "Lake Pend Oreille Winter Lake Elevations," the AAs will meet annually with the USFWS, NOAA Fisheries, and IDFG, along with the Kalispel Tribe and other interested parties, to evaluate Lake Pend Oreille female kokanee spawner numbers, the winter climate (precipitation) forecast, spawning and incubation success for threatened lower Columbia River chum salmon the previous winter, and recent history of winter elevations for Lake Pend Oreille (hereafter referred to as the "interagency meeting").

The Corps received a letter from the USFWS dated October 21, 2013, regarding the 2013-2014 Minimum Control Elevation (MCE) for Lake Pend Oreille, Idaho (FWS Ref: 01EIFW00-2014-TA-0005 (COMM-110)). The letter indicated the USFWS would not be providing a System Operations Request (SOR) for the 2013-2014 MCE due to IDFG's re-evaluation of kokanee egg-to-fry survival data. Subsequent to this letter IDFG concluded survival data do not exist at this time to justify a USFWS request for a specific MCE and accordingly the USFWS deferred to the AAs for determining the MCE.

For the winter of 2017 Albeni Falls planned target is an MCE of 2051 feet. The lake will stay within a half-foot of the MCE during kokanee spawning; then after spawning is declared over or December 31, whichever occurs first, the flexibility to begin implementation of the Flexible Winter Power Operation (FWPO) if requested by BPA. There will be an erosion control project upstream of Albeni Falls Dam that will limit the use of the pool for FWPO. From late January through February the Lake will need to stay below 2052 feet in order to accommodate this work. Outside of the construction window Lake Pend Oreille may be fluctuated up to 2056 feet for FWPO.

### 6.3.2. Coordination

The Action Agencies will continue to coordinate with the Region on Albeni Falls operations.

### 6.3.3. Flood Risk Management Draft

Albeni Falls Dam will be operated during the winter season using standard FRM criteria.

### 6.3.4. Refill Operations

During the spring Albeni Falls Dam will be operated to fill Lake Pend Oreille in accordance with standard FRM criteria.

### 6.3.5. Summer Operations

During the summer, Albeni Falls Dam will be operated to maintain Lake Pend Oreille elevation at Hope, Idaho, between elevation 2062.0 and 2062.5 feet. The Lake will be held above elevation 2062.0 feet through the third Sunday in September, or September 18, whichever date is later. The Corps will try to be above 2061.0 feet through the fourth Sunday in September, or

September 25 whichever is later. The latter elevations may change in the event of a power emergency or fishery need. Starting on October 1, the Lake will begin the draft to elevation 2051.0 feet by Mid-November.

## 6.4. Libby Dam

Libby Dam flows will be regulated consistent with existing treaties, Libby Project authorization for public safety, and other laws to achieve water volumes, water velocities, water depths, and water temperature at a time to maximize the probability of allowing significant sturgeon recruitment and to provide a year-round thermograph that approximates normative conditions, while also meeting flood damage reduction objectives. The year-round project minimum outflow is 4.0 kcfs.

### 6.4.1. Coordination

The AAs will continue to coordinate Libby Dam BiOp operations at TMT.

### 6.4.2. Burbot

Providing low temperatures, if possible, from Libby Dam to aid upstream migration of burbot to spawning areas in the Kootenai River in Idaho will occur each winter. These low temperatures may be called for over an extended period from October through February. Specific details of this operation for the current year will be developed and will be included in the fall/winter update. An interagency Memorandum of Agreement for this species was completed in June 2005. Use of VARQ FRM procedure and implementation of the variable end-of-December FRM target elevation may aid this operation in years with below average runoff forecasts.

### 6.4.3. Ramp Rates and Daily Shaping

The purpose of the following actions is to provide better conditions for resident fish by limiting the flow fluctuations and setting minimum flow levels. In addition, ramping rates protect varial zone productivity by emulating a normative hydrograph. These ramp rates for Libby Dam were proposed in the BA supplement to minimize impacts to bull trout and are included in the 2006 USFWS BiOp. The following ramp rates (Table 9) will guide project operations to meet various purposes, including power production.

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. Variances to these ramping rates during years when water supply forecasting errors overestimate actual runoff, or variances are necessary to provide augmentation water for other listed species or other purposes, will be coordinated through the TMT process. This is expected only in dry water years[4]. At the project, 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.

**Table 9.** Prescribed Libby Dam maximum ramp rates to protect resident fish and prey organisms in the Kootenai River in addition to minimizing levee erosion along the river. Rate of change may be less than stated limits.

| | | Summer (05/01 - 09/31) | |
|---|---|---|---|
| | | Hourly | Daily |
| Ramp Up | 4-6 kcfs | 2500 cfs | 1 unit |
| | 6-9 kcfs | 2500 cfs | 1 unit |
| | 9-16 kcfs | 2500 cfs | 2 units |
| | 16-QPHC | 5000 cfs | 2 units |
| Ramp Down | 4-6 kcfs | 500 cfs | 500 cfs |
| | 6-9 kcfs | 500 cfs | 1000 cfs |
| | 9-16 kcfs | 1000 cfs | 2000 cfs |
| | 16-QPHC | 3500 cfs | 1 unit |
| | | Winter (10/01 - 04/30) | |
| | | Hourly | Daily |
| Ramp Up | 4-6 kcfs | 2000 cfs | 1 unit |
| | 6-9 kcfs | 2000 cfs | 1 unit |
| | 9-16 kcfs | 3500 cfs | 2 units |
| | 16-QPHC | 7000 cfs | 2 units |
| Ramp Down | 4-6 kcfs | 500 cfs | 1000 cfs |
| | 6-9 kcfs | 500 cfs | 2500 cfs |
| | 9-16 kcfs | 1000 cfs | 1 unit |
| | 16-QPHC | 3500 cfs | 1 unit |

(2006 USFWS BiOp at Description of the proposed action, page 7, Table 1.)

### 6.4.4. Flood Risk Management

The Corps will continue to use its forecast procedure in December to determine the December 31 FRM elevation. In water years where the December forecast for the period April through August is less than 5900 KAF based on the Corps' forecast procedures, the end-of-December draft elevation will be higher than 2411 feet. If the December forecast for April-August is 5500 KAF or less, the end-of-December target elevation would be 2426.7 feet. The end-of-December elevation is a sliding scale between elevation 2426.7 feet and 2411 feet when the forecast is between 5500 and 5900 KAF.

Libby Dam will be operated during January through March (into April if the start of refill has not been declared) to the VARQ flood risk management storage reservation diagram (SRD). During the refill period from about April through June, Libby Dam will release flow in accordance with VARQ FRM Operating Procedures at Libby Dam. Refill at Libby Dam will begin 10 days prior to when the forecasted unregulated flow at The Dalles is expected to exceed the ICF. Once refill begins, Libby Dam outflow will be no lower than the computed VARQ flow (or inflow, if that is lower than the VARQ flow), unless otherwise allowed by the VARQ Operating Procedures. For

example, changes to reduce the VARQ flow can occur to protect human life and safety, during the final stages of refill, or through a deviation request.

The VARQ flow will be recalculated with each new Corps water supply forecast and outflows will be adjusted accordingly. If the VARQ operating procedures require discharges above powerhouse capacity, spill from Libby Dam may occur. The intent is to adjust Libby Dam discharge to maximize reservoir refill probability and minimize the potential for spill.

### 6.4.5. Spring Operations

The purpose of the following actions is to refill Libby Dam in order to provide the flow for Kootenai River white sturgeon, bull trout ramping rates, and anadromous fish flow augmentation water. Libby Dam will provide flows for sturgeon, bull trout, and salmon during spring; for salmon and bull trout during summer and for bull trout and resident fish in September while attempting to minimize a double peak or large flow fluctuations in the June–September period. The AAs will operate Libby Dam to provide for summer flow augmentation, exact refill date to be determined in-season by available water supply and shape and spring flow operations, while also avoiding involuntary spill and meeting flood risk management objectives. During the spring, the AAs will operate Libby Dam to meet its flow and refill objectives. If both these objectives cannot be achieved, VARQ and sturgeon flow operations are a higher priority over summer refill.

When not operating to minimum flows, the project will be operated to achieve a 75% chance of the upper FRM rule curve on or about April 10 (the exact date to be determined during in-season management) to increase flows for spring flow management.

### 6.4.6. Bull Trout Flows

From May 15 to June 30 and during the month of September, a minimum flow of 6000 cfs will be discharged and minimum flows of 4000 cfs will be provided for the rest of the year. Volume to sustain the basal flow of 6000 cfs from May 15 through May 31 will be accounted for with sturgeon volumes, and in the fall should be drawn from the autumn flood risk management draft. Table 10 shows how the bull trout minimum flow is determined during this period.

**Table 10.** Minimum bull trout releases from Libby Dam July 1–August 31, based on May final Libby water supply forecast for April-August period (May 15–June 30 and all of September minimum is 6 kcfs).

| Libby Forecast Runoff Volume (MAF*) | Minimum bull trout flows between sturgeon and salmon flows (kcfs) |
|---|---|
| 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 |

**MAF = million acre-feet*

### 6.4.7. Sturgeon Operation

The purpose of the actions below is to provide water for sturgeon spawning and egg incubation. Libby Dam will provide the tiered volume for sturgeon flows as described in the 2006 USFWS BiOp, the Clarified RPA from USFWS and as summarized in Figure 1. The outflow during sturgeon augmentation period will be equal to or greater than the VARQ flow. The release operation will be developed prior to commencement of the sturgeon tiered flow release. Water temperature profiles will be monitored near the dam starting in April and continue through July to provide information necessary for timing of sturgeon spawning/rearing flow augmentation. Also, water temperature profiles in the forebay are used to determine when warmer temperatures may be provided to assist sturgeon spawning. Reservoir temperature data collection is occurring and is intended to allow better planning for temperature management of water releases.

This sturgeon water will be in addition to needs for listed bull trout and salmon, and will be measured above the 4000 cfs minimum releases from Libby Dam. Accounting for these total tiered volumes will begin when the USFWS determines benefits to conservation of sturgeon are most likely to occur or when additional flow is needed to sustain basal flow of 6000 cfs from May 15 through May 31. 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, consistent with the current version of the Kootenai River Ecosystem Function Restoration Flow Plan Implementation Protocol and 2006 USFWS BiOp and applicable clarifications.

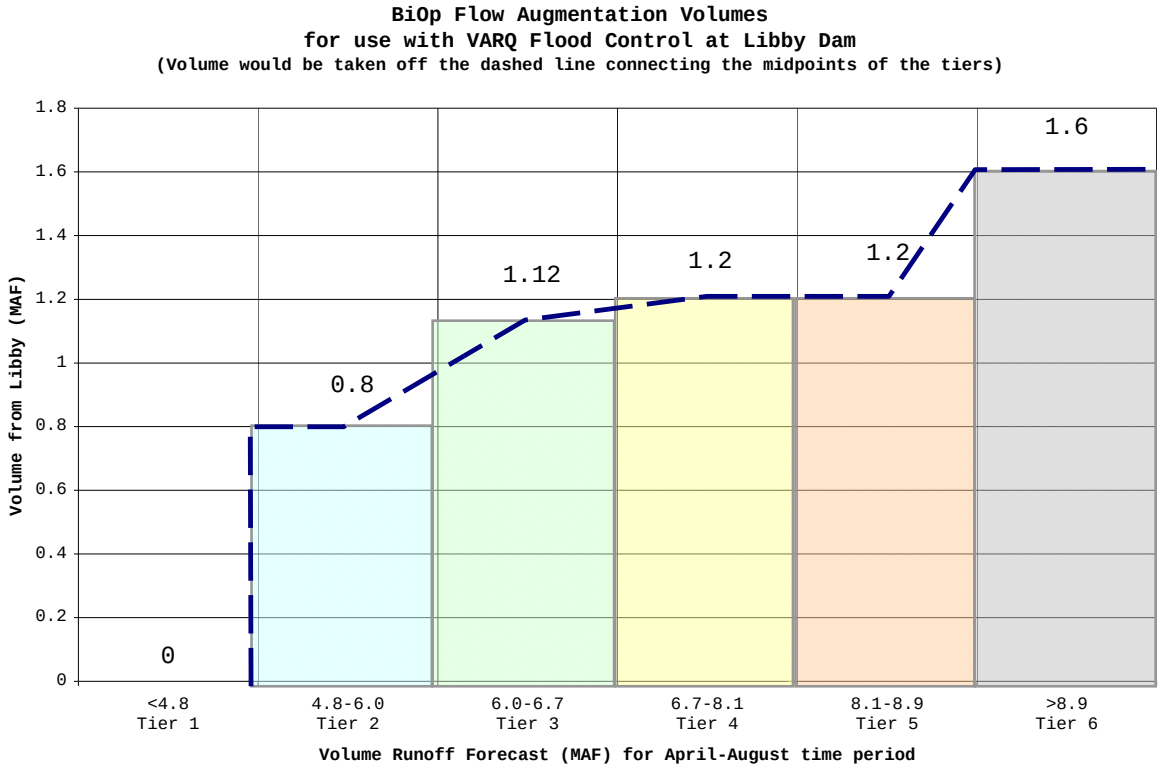


**Figure 1.** "Tiered" volumes of water for sturgeon flow enhancement to be released from Libby Dam according to the Libby May final forecast of April–August volume. Actual flow releases

would be shaped according to seasonal requests from the USFWS and in-season management of water actually available.

### 6.4.8. Post-Sturgeon Operation

After the sturgeon operation, flows will be planned to be stable or slowly declining over the summer and to achieve refill, if possible, in July or early August, while trying to minimize a double peak in outflows. Summer operations will be coordinated through TMT in-season management. Libby Dam releases will follow ramp rates listed in the 2006 USFWS BiOp and shown on Table 9.

### 6.4.9. Summer Operations

During the summer, the AAs draft Libby Dam within the 2008/2010/2014 NOAA Fisheries BiOp and USFWS BiOp's specified draft limits based on flow recommendations coordinated at TMT. The AAs consider a number of factors when developing flow recommendations for TMT to review, such as: the impact of flow fluctuations on bull trout and other resident fish below the project, the status of juvenile salmon outmigration in the lower Columbia, attainment of flow objectives, water quality, and the effects that reservoir operations will have on other listed and resident fish populations.

During the months of July through September, the AAs will operate Libby Dam to augment flows for juvenile salmon out-migration in the Columbia River and to help meet local resident fish needs. In the summer, the AAs will operate to target the experimental draft[3] reservoir elevation of 2449 feet (10 feet from full) by the end of September, except in dry water years[4] when the draft will increase to target an elevation of 2439 feet (20 feet from full). However, if the project fails to refill to above these target elevations, then the project will be operated during the summer months to release inflows or to meet minimum flow requirements and minimum bull trout flows.

Arrangements for retention of July-September water in Lake Koocanusa are possible through a Libby-Canadian storage water exchange under the current Libby Coordination Agreement, which was signed February 16, 2000. However, this operation cannot be guaranteed in any given year because it must be mutually beneficial to the Canadian Entity and the U.S. Entity. Information needed for such a determination such as the volume of the water year, is not available until well into the migration season. This operation, if any, for a given water year is generally not finalized until June or July of that year. The exchange agreement reduces the draft of Lake Koocanusa and provides an equivalent amount of water from Canada.

The Corps will use the best available forecast at the end each month for July and August to set an outflow that will gradually draft Libby to the target elevation by the end of September as defined in the FCRPS BiOp RPA (Appendix 7). The objective of this operation is to maintain a stable or gradually declining outflow for the period from July through September. If this calculated flow is greater than the bull trout minimum, then the discharge will be maintained until updated at the end of each month.

### 6.4.10. Kootenai River Habitat Restoration Program (KRHRP)

From August through October in 2014-2017, the AAs will be operating Libby Dam in coordination with the Kootenai Tribe of Idaho in order to provide conditions for construction of a suite of KRHRP projects. The restoration strategies for the KRHRP projects include: substrate placement; construction of large wood bank structures along the toe of the banks; re-grading of the bank slope and roughness treatments to trap sediment and promote floodplain development; excavation of a deep pools; construction of islands and spur structures to redirect flow toward the center of the channel which will reduce bank erosion, maintain deep scour pools, and promote hydraulic complexity; creation of alcoves that will provide low velocity areas and promote floodplain development; creation of a native riparian buffer; riparian plantings and buffer fencing; and placement of spawning substrate in existing spawning areas.

Releasing flows between 6 to 8 kcfs during September depending on the end of August elevation (minimum flows are 6 and 4 kcfs respectively in September and October) will facilitate the construction work. Flows in September will depend on hydrologic conditions, current forecast, as well as what habitat work is currently planned by the Kootenai Tribe and also the Corps downstream of Libby Dam. In order to accommodate this operation, the AAs will coordinate with TMT on the actual operation to reach the target September 30 elevation of 2449 feet (or 2439 feet if a dry water year[4]). In the event of high rainfall events in the summer, the TMT will discuss shifting the target elevation from September 30 to August 31 to increase the probability of reaching the target elevation and support the KRHRP.

### 6.4.11. Spillway Re-commissioning

In February 2017, Libby Dam will be performing required maintenance by replacing the spillway gate control system which is nearly 40 years old. After the control system is replaced the spillway gates will have to be re-commissioned, which requires the testing to be done with the gates out of the water such that the forebay of Libby Dam will be lowered to elevation 2404 feet (1 foot below spillway crest) by the end of January. Depending on the water supply forecast, drafting to 2404 feet at the end of January and holding this elevation for the 5 weeks required for testing may impact the ability of Libby Dam to meet the April 10 target elevation, lower VarQ flows in May, and slight impacts to peak reservoir elevations and summer releases from Libby Dam. A January 1 forecast of 6.5 MAF (109% of average) would require a 2404 feet FRM requirement at the end of the month.

## 6.5. Grand Coulee Dam

Grand Coulee Dam is operated for multiple purposes including fish and wildlife, flood risk management, irrigation, power, and recreation. Specific operations for flow management to aid anadromous and resident fish are listed in the following sections.

### 6.5.1. Winter/Spring Operations

Grand Coulee will be operated for flood risk management from January through April using the NWRFC's forecast for unregulated runoff at The Dalles (adjusted for available storage capacity upstream of The Dalles other than at Grand Coulee Dam) and Grand Coulee's Flood risk

management SRD. Grand Coulee is also operated during this period to support chum operations (described in detail in Section 7.3) and to maintain an 85% probability of reaching the April 10 elevation objective in order to provide more water for spring flows.

Maintaining an 85% probability of reaching the April 10 elevation objective is achieved by operating between the URC as an upper elevation limit and the VDL as a lower elevation limit for the reservoir from January through March. A description of VDL is provided in Section 7.4.

Reclamation computes Grand Coulee Dam's April 10 elevation objective by linear interpolation between the March 31 and April 15 forecasted flood risk management elevations based on the NWRFC March Final April-August WSF at The Dalles. The March forecast is chosen for the calculation of the April 10 elevation objective in order to allow enough time to react and to plan Grand Coulee operations accordingly. The April final forecast is typically released on the 6$^{th}$ working day of the month, after which the Corps calculates flood risk management elevations. This usually means that final April 15 and April 30 flood risk management elevations are released around the 5$^{th}$ working day of April at the earliest. It is notable that even modest changes in The Dalles water supply forecast can produce significant changes in the forecasted flood risk management elevations for Grand Coulee. In order to achieve final April flood risk management targets, actual Grand Coulee elevations on April 10 may be below or above the April 10 objective depending on draft rates and water supply conditions.

The most likely situation that would require Grand Coulee to draft below the April 10 elevation objective is an increase in the WSF between March and April. Large increases in the WSF forecast can require large reservoir drafts in order to achieve the April 30 flood risk management elevation. In this situation, drafting below the April 10 elevation objective may be desirable in order to avoid exceeding draft rates and to avoid spilling through the outlet tubes. Even minimal spill though the outlet tubes can create elevated TDG levels below Grand Coulee Dam. This situation most recently occurred in 2012, when Grand Coulee began pre-drafting in late March as a result of an increasing WSF and anticipated excessive draft rates during April. The operation was discussed and coordinated at TMT and resulted in an adaptive management operation that still resulted in a large draft and high discharges from Grand Coulee during April but minimized spill and avoided potential high TDG production by pre-drafting.

An additional factor that needs to be considered during spring operations is the on-going Third Power Plant (TPP) overhaul at Grand Coulee. The TPP overhaul will result in one TPP unit being out of service at any given time during the overhaul period. This is in addition to other units being out of service for routine scheduled maintenance. A TPP unit has a hydraulic capacity of 20 kcfs – 30 kcfs depending on unit and head. Every effort is made to schedule annual and other routine maintenance outside of the "normal" spring flood risk management/refill period when possible but heavy runoff years, early or delayed runoff timing, and/or unscheduled maintenance in conjunction with the TPP overhaul will increase the probability of spill and excessive TDG production. Adaptive management operations at Grand Coulee may need to be considered during the TPP overhaul period in order to minimize spill and TDG production. The TPP overhaul is currently scheduled to be completed in 2024. Grand Coulee operations will be discussed and coordinated at TMT.

Opportunities to shift system flood risk management requirements from Brownlee and Dworshak to Grand Coulee will also be considered. The deepest reservoir draft typically occurs around April 30. Refill at Grand Coulee normally begins approximately one day prior to when streamflow forecasts of unregulated flow is projected to exceed the ICF at The Dalles Dam.

During the spring, the AAs will operate the FCRPS to help meet the flow objectives, to meet system flood risk management requirements and to refill the projects. If all of these objectives cannot be achieved, the TMT will make an in-season recommendation, weighing considerations unique to each particular year and project. System flood risk management requirements during refill, especially during above average years, may result in significant spill below Grand Coulee Dam in order to control refill, meet downstream flood risk management flow objectives, and to limit downstream flooding. High levels of spill below Grand Coulee result in high TDG levels. A more detailed discussion of spill operations is discussed in Section 6.5.9.

### 6.5.2. Summer Operations

Grand Coulee will operate to refill by about June 30 to provide summer flow augmentation, except as specifically provided by the TMT. Grand Coulee will be operated during the summer (July and August) to help meet the flow objectives for juvenile salmon out-migration. Grand Coulee will draft to support salmon flow objectives during July-August with variable draft limit of 1278 to 1280 feet by August 31 based on the water supply forecast. If the July Final April through August forecast for The Dalles is equal to or greater than 92 MAF then Lake Roosevelt's draft limit will be 1280 feet. If the forecast is less than 92 MAF, the draft limit will be 1278 feet. These draft limits will be modified to implement the Lake Roosevelt Incremental Storage Release Project (see Section 6.5.6).

### 6.5.3. Banks Lake Summer Operation

Banks Lake will be allowed to draft to elevation 1565 feet by the end of August to provide more water for summer flow augmentation. Pumping to Banks Lake will be reduced and irrigation for the Columbia Basin Project will be met by drafting the reservoir up to 5 feet from full (elevation 1570 feet) by the end of August.

### 6.5.4. Project Maintenance

Drum gate maintenance is planned to occur during April and May annually. The reservoir must be at or below elevation 1255 feet to accomplish this work. Typically the flood risk management elevations during this time of year provide the required elevations and sufficient time to accomplish this work. However, during dry years flood risk management operations will not draft Lake Roosevelt low enough for a long enough period of time to perform necessary maintenance on the drum gates. Drum gate maintenance may be deferred in some dry water years[4]; however drum gate maintenance must occur at a minimum one time in a 3-year period, two times in a 5-year period, and three times in a 7-year period. The drum gates are extremely important dam safety features and must be maintained at a satisfactory level. Drum gate maintenance was completed in the spring of 2015 and 2016. Drum gate maintenance will be performed in 2017 if conditions allow.

### 6.5.5. Kokanee

Lake Roosevelt targets refill to about 1283 feet by September 30 (coordination with tribes will determine actual date and range) and maintain an elevation above 1283 feet through the middle of November to aide in kokanee brood stock collection, improve spawning access to tributaries, and to increase retention time during a critical period for zooplankton production.

### 6.5.6. Lake Roosevelt Incremental Storage Release Project

The Lake Roosevelt Incremental Storage Release Project is a component of the Columbia River Water Management Program (CRWMP) and is intended to improve municipal and industrial water supply, provide water to replace some ground water use in the Odessa Subarea, enhance stream flows in the Columbia River to benefit fish, and to provide water to interruptible water right holders in drought years. A Memorandum of Understanding (MOU) regarding the Lake Roosevelt Incremental Storage Release Project was signed by the State of Washington, Reclamation, and the Columbia Basin Irrigation Districts in December 2004. In December 2007, Water Resource Management Agreements in support of the incremental storage releases from Lake Roosevelt were signed by the State of Washington, the Confederated Tribes of the Colville Reservation, and the Spokane Tribe of Indians.

The Lake Roosevelt Incremental Storage Release Project will not reduce flows during the salmon flow objective period (April - August). This project provides that Lake Roosevelt will be drafted by an additional 1.0 foot in non-drought years and by about 1.8 feet in drought years by the end of August. A third of this water will go to in-stream flows. A more detailed description of this item is provided in Section 7.5 and in the FCRPS BA (Appendix B.2.1, pages 5-9).

### 6.5.7. Chum Flows

Grand Coulee may be used to help meet tailwater elevations below Bonneville Dam to support chum spawning and incubation. The chum operation is described in more detail in Section 7.3.

### 6.5.8. Priest Rapids Flow Objective

Grand Coulee will be operated to help meet the flow objective at Priest Rapids Dam as coordinated with TMT.

### 6.5.9. Spill Operations

Forced spill at Grand Coulee, as the result of system flood risk management requirements, may result in high levels of TDG below Grand Coulee Dam. In order to control refill, meet downstream flood risk management flow objectives, and to limit downstream flooding, Grand Coulee has to spill any required discharge that is in excess of power plant capacity. If Lake Roosevelt is above elevation 1265.5 feet, Grand Coulee can spill water over the drum gates. However, if Lake Roosevelt is below elevation 1265.5 feet, then all spill must be through the outlet tubes which can result in high levels of TDG below the project. Another factor that can cause elevated TDG levels downstream of the dam include elevated TDG levels in the forebay resulting from high TDG levels coming into Lake Roosevelt from Canada. High TDG levels resulting from outlet tube spill and/or from high forebay TDG generally affects the river reach

between Grand Coulee and Chief Joseph dams and beyond. The spillway flow deflectors at Chief Joseph Dam are very efficient at stripping TDG and reducing TDG traveling further downstream when operating. During forced spill events, Grand Coulee will be operated to minimize TDG production to the extent practicable. Involuntary spill at Grand Coulee Dam will be managed in coordination with Chief Joseph Dam operations.

## 6.6. Chief Joseph Dam

Chief Joseph will spill according to the spill priority list and TDG production estimates to assist in systemwide TDG management.

## 6.7. Priest Rapids Dam

### 6.7.1. Spring Operations

The spring flow objective at Priest Rapids Dam is 135 kcfs from April 10 to June 30.

### 6.7.2. Hanford Reach Protection Flows

Grant County PUD manages the discharge from Priest Rapids Dam at the following intervals during the year to provide protection for the spawning, incubation and rearing of fall Chinook salmon.

- October-November, reverse loading (low flows during daylight hours, spill excess at night) to reduce the formation of redds at high river elevations on Vernita Bar
- November-May, maintain "Critical Elevation" in the Hanford Reach (minimum flow restriction to prevent dewatering of redds)
- March-June, reduce daily flow fluctuations to decrease mortality to juvenile fall Chinook from stranding and entrapment

## 6.8. Dworshak Dam

### 6.8.1. Spring Operations

The spring flow operation is to maintain a 95% probability of refilling Dworshak while also maximizing the releases of stored water from Dworshak reservoir in order to maximize the chance of meeting the lower Snake spring flow objective and aid out-migrating salmon and steelhead. During the spring, the AAs will operate Dworshak Dam to improve the probability of meeting the flow and refill objectives, refilling by about June 30. The reservoir is deemed to be at “full” at elevations of 1599 feet or above. If both these objectives cannot be achieved, the TMT will make an in-season recommendation, weighing considerations unique to each particular year.

The 5 kcfs turbine at Dworshak is scheduled for rehabilitation this year. This will reduce the total outflow to about 8 kcfs while maintaining total dissolved gas (TDG) within the state of Idaho standard of 110%. Discharge of 14 kcfs is typical from this project during the spring

months to provide flow augmentation during the juvenile migration. However, the volume of water that will be provided in spring 2017 will be limited due to the turbine outage. The specifics of how much deeper than normal flood control the project may be drafted this winter to meet both flood control and avoid exceeding 110% TDG will be coordinated through TMT.

Dworshak will not shift flood control space to Grand Coulee for spring flow augmentation due to the limited discharge capacity while Unit 3 is overhauled. During the overhaul the powerhouse capacity is reduced by 55%, therefore releases for fish flow augmentation will be limited to approximately 8 kcfs (while meeting 110% TDG).

### 6.8.2. Flow Increase for Dworshak National Fish Hatchery Release

The Corps will release 4-6 kcfs from Dworshak, if necessary, in order to move juvenile fish into the mainstem Clearwater River during the spring hatchery releases. This operation is not related to the FCRPS BiOps.

### 6.8.3. Summer Operations

Summer flow augmentation is provided from Dworshak to increase listed fish survival by moderating river temperatures (improved water quality), and increasing water velocities in the lower Snake River.

The summer temperature moderation and flow augmentation releases from Dworshak will be shaped with the intent to maintain water temperatures at the Lower Granite tailrace fixed monitoring site at or below 68ºF. The Corps maintains and operates a water quality analysis model (CE-QUAL-W2), which is used in-season to forecast downstream water temperatures and inform Dworshak release decisions. The model extends from Dworshak (Clearwater River) and Hells Canyon (Snake River) dams downstream through Ice Harbor Dam. Dworshak releases generally are sufficient to provide effective water temperature management in the Lower Granite tailrace but these efforts can be overwhelmed by extremely hot weather or high discharges of warm water from Hells Canyon Dam.

During the summer (July and August) the AAs will operate Dworshak to help meet flow/temperature objectives in coordination with TMT. The AAs plan to draft to elevation 1535 feet by the end of August and elevation 1520 feet (80 feet from full) by the end of September unless modified per the Agreement between the U.S. and the Nez Perce Tribe (Dworshak Board Operational Plan) for water use in the Dworshak Reservoir. The extension of the draft limit into September assures that water will be released consistent with the NPT Agreement. Releases under the NPT Agreement will be determined in the annual plan prepared by the COE, NOAA Fisheries, Nez Perce, Idaho, and BPA and presented to TMT for implementation.

### 6.8.4. Fall/Winter Operations

After summer fish operations are completed (including the NPT Agreement operations in September), flows from Dworshak will be limited to minimum discharge (one small turbine operating above the cavitation zone and within 110% TDG, approximately 1600 cfs) unless higher flows are required for flood risk management, emergencies, or other project uses. The purpose of these actions is to manage the filling of Dworshak reservoir while operating the

project for multiple uses. Flows from Dworshak also may be maintained above minimum flow if Corps analysis determines there is flexibility to release a volume of water above minimum flow and still maintain a high reliability of meeting spring refill objectives. Opportunities to shift system flood risk management requirements from Brownlee and Dworshak to Grand Coulee will be considered periodically from January through April.

### 6.8.5. Project Maintenance

Dworshak Dam Unit 3 generator will be overhauled during the 2017 water year. The unit was removed from service on September 1st, 2016. The overhaul is scheduled to be completed by May 1st, 2017 followed by some testing in May and June 2017. During the overhaul the powerhouse discharge capacity is reduced by 55% from approximately 10 kcfs to 4.8 kcfs. The Corps will provide status reports to TMT on the overhaul progress.

Adaptive management operations at Dworshak Dam may need to be considered during the overhaul period in order to minimize spill and TDG production, and will be coordinated with the TMT before and during the season.

## 6.9. Brownlee Dam

Opportunities to shift system flood risk management requirements from Brownlee to Grand Coulee will be considered. See section 4.5 on Flood risk management Shifts for more details. The shifts could occur from January through April. The reservoirs need to be back to their specific URC by April 30. The purpose of this shift is to allow Brownlee to be at higher elevations to increase the probability for increased spring flows in the Snake River. These shifts may be implemented after coordination with TMT.

## 6.10. Lower Snake River Dams (Lower Granite, Little Goose, Lower Monumental, Ice Harbor)

### 6.10.1. Reservoir Operations

The four Lower Snake River FCRPS projects (Lower Granite, Little Goose, Lower Monumental, and Ice Harbor) are operated for multiple purposes including fish and wildlife, irrigation, navigation, power, recreation, and limited flood risk management. The AAs will operate the Lower Snake River projects to minimize water travel time to aid juvenile fish passage by operating in the minimum operating pool (MOP) 1-foot range from April 3 until small numbers of juvenile migrants are present (approximately September 1), unless adjusted to meet authorized project purposes, primarily navigation. The Lower Snake River MOP operation reduces the reservoir cross-section and surface area, which is another tool to assist in moderating temperatures. The AAs will coordinate changes in MOP operations with the TMT.

#### 6.10.1.1 Waterfowl Hunting Enhancement

Little Goose and Ice Harbor dams will be operated to hold the reservoirs constant several times a week from October through January to enhance waterfowl hunting.

### 6.10.2. Turbine Operations

To enhance fish passage survival, turbines at the Lower Snake River projects will be operated within ±1% of peak efficiency during the juvenile and adult migration seasons, April 1 through October 31 (see the 2017 FPP, Chapters 2-8 and Appendix C).

### 6.10.3. Spill Operations

Spring and summer spill operations for juvenile fish passage will be implemented pursuant to the 2017 Fish Operations Plan (FOP), included in the 2017 FPP as Appendix E.

### 6.10.4. Juvenile Fish Transport

Juvenile fish transport operations are described in the 2017 FPP, Appendices B and E.

### 6.10.5. Lower Granite Dam Flow Objectives

#### 6.10.5.1 Spring Flow Objectives

The April final runoff volume forecast at Lower Granite Dam for April to July determines the spring flow objective at Lower Granite Dam. When the forecast is less than 16 million acre-feet (MAF), the flow objective will be 85 kcfs. If the forecast is between 16 and 20 MAF, the flow objective will be linearly interpolated between 85 and 100 kcfs. If the forecast is greater than 20 MAF, the flow objective will be 100 kcfs. The flow objective is measured as the season average of the discharge at Lower Granite between the planning dates of April 3 to June 20. These flow objectives are provided as a biological guideline and will likely not be met throughout the entire migration season in all years because the flow in the Snake River primarily depends on the volume and shape of the natural runoff, while the augmentation volumes available are small in comparison to the overall objective. Flow in the Snake River during this period is supported by drafting Dworshak Dam and flow augmentation water from the Upper Snake River. Dworshak storage is released from the April 10 elevation to the April 30 flood risk management elevation at a rate that does not exceed the State's TDG water quality standards (110% TDG) at the project.

#### 6.10.5.2 Summer Flow Objectives

The June final runoff volume forecast at Lower Granite Dam for April to July determines the summer flow objective at Lower Granite Dam. When the forecast is less than 16 MAF, the flow objective will be 50 kcfs. If the forecast is between 16 and 28 MAF, the flow objective will be linearly interpolated between 50 and 55 kcfs. If the forecast is greater than 28 MAF, the flow objective will be 55 kcfs. The summer flow objective is measured as the season average of the discharge at Lower Granite between the planning dates of June 21 to August 31. The summer flow in the Snake River is augmented by the release of stored water upstream of Lower Granite Dam. The Summer flow objectives are provided as a biological guideline and will likely not be met throughout the entire migration season in all years because there is a limited amount of stored water available for flow augmentation and the natural shape of the runoff generally produces decreasing streamflows from July to the end of August.

# 6.11. Lower Columbia River Dams (McNary, John Day, The Dalles, Bonneville)

## 6.11.1. Reservoir Operations

The four Lower Columbia River FCRPS projects (McNary, John Day, The Dalles, and Bonneville) are operated for multiple purposes including fish and wildlife, irrigation, navigation, power, recreation, and limited flood risk management. The AAs will operate the Lower Columbia River reservoirs within their normal operating ranges.

### 6.11.1.1 Tribal Treaty Fishing

To accommodate tribal treaty fishing in the Lower Columbia River, the AAs will operate John Day, The Dalles, and Bonneville dams within a 1.5-foot range during tribal fishing seasons.

### 6.11.1.2 McNary Waterfowl Nesting and Hunting Enhancement

From March through May, McNary Dam will be operated in the top 1 foot of the pool range for several hours every 4 days to improve waterfowl nesting conditions in the McNary pool (Lake Wallula). From October through January, McNary Dam will be operated to hold a constant pool several times a week to enhance waterfowl hunting.

### 6.11.1.3 John Day Dam Minimum Irrigation Pool (MIP)

From April 10 through September 30, John Day Dam will be operated to minimize water travel time for downstream-migrating juvenile salmon by operating the forebay within the minimum irrigation pool (MIP) range of 262.5 to 264.0 feet, which is the lowest pool elevation that allows irrigation withdrawals.

## 6.11.2. Turbine Operations

To enhance fish passage survival, turbines at the four Lower Columbia River FCRPS projects will be operated within ±1% of peak efficiency during the juvenile and adult migration season, April 1 through October 31 (see the 2017 FPP, Chapters 2-8 and Appendix C).

## 6.11.3. Spill Operations

Spring and summer spill operations for juvenile fish passage will be implemented pursuant to the 2017 Fish Operations Plan (FOP), included in the 2017 FPP as Appendix E.

## 6.11.4. McNary Dam Flow Objectives

### 6.11.4.1 Spring Flow Objectives

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. 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 spring flow objective is measured as the season average discharge at McNary Dam between the planning dates of April 10 to June 30. The flow objective is provided as a biological guideline and will not be met throughout the migration season in all years due to variability in volume and shape of the natural runoff.

#### 6.11.4.2 Summer Flow Objectives

The summer flow objective at McNary Dam is 200 kcfs. The summer flow objective is measured as the season average of the discharge at McNary Dam between the planning dates of July 1 to August 31. The flow in the summer at McNary is augmented by the release of stored water upstream of McNary Dam. The summer flow objective cannot be met in all years as there is a limited amount of stored water available for flow augmentation and the natural shape of the runoff generally produces decreasing streamflows from July to the end of August.

#### 6.11.4.3 Weekend Flows

Weekend flows are often lower than weekday flows due to less electrical load demand in the region. During the spring and summer migration period (April through August), the AAs will strive to maintain McNary flows during the weekend at a level which is at least 80% of the previous weekday average.

### 6.11.5. Chum Operation

See section 7.3 for a detailed discussion on the chum operation.

# 7. Specific Operations

## 7.1. Canadian Storage for Flow Augmentation

### 7.1.1. Columbia River Treaty (Treaty) Storage

The U.S. Section of the Columbia River Treaty Operating Committee will seek a Non-Power Uses Agreement with Canada that will allow storage of 1 MAF of water in Canadian Treaty space for release during the migration season for the benefit of US Fish. These supplemental operating agreements must be mutually agreed and provide benefits for both entities.

Annual agreements between the U.S. and Canadian entities to provide flow augmentation storage in Canada for U.S. fisheries will include provisions that allow flexibility for the release of any stored water to provide U.S. fisheries benefits to the extent possible by:

- Providing the greatest flexibility possible for releasing water to benefit U.S. fisheries April through July;

- Giving preference to meeting April 10 elevation objectives or achieving refill at Grand Coulee Dam over flow augmentation storage in Canada in lower water supply conditions; and

- Releasing flow augmentation storage to avoid causing damaging flow or excessive TDG in the U.S. or Canada.

BPA and the Corps will continue to coordinate with Federal agencies, States and Tribes on Treaty operations and operating plans.

### 7.1.2. Non-Treaty Storage (NTS) Long Term Agreement

BPA and BC Hydro executed a Long Term Non-Treaty Storage (NTS) agreement effective 10 April 2012 through 15 September 2024. The U.S. and Canadian Entities are satisfied that mutual benefits can be achieved without adversely affecting the operation of Treaty storage in Canadian projects in accordance with the Columbia River Treaty or delivery of the Canadian Entitlement. This new agreement will provide 5 MAF of NTS for both power and non-power benefits for BC Hydro, BPA, and Canadian and U.S. interests, including the opportunity to provide benefits for ESA-listed fish.

### 7.1.3. Non-Treaty Coordination with Federal Agencies, States and Tribes

BPA will continue to coordinate with Federal agencies, States, and Tribes on non-Treaty seasonal agreements and operations during the fish passage season.

## 7.2. Upper Snake River Reservoir Operation for Flow Augmentation

Reclamation will attempt to provide 487 KAF annually of flow augmentation from the Reclamation projects in the Upper Snake River basin consistent with its Proposed Action as described in the November 2007 Biological Assessment for O&M of its projects in the Snake River basin above Brownlee Reservoir. Reclamation's flow augmentation program is dependent on willing sellers and must be consistent with Idaho State law.

## 7.3. Bonneville Chum Operations

The Columbia River chum Evolutionarily Significant Unit (ESU) includes all naturally spawning populations and four hatchery programs of chum salmon in the Columbia River and its tributaries in Washington and Oregon. The hatchery programs include Grays River and Washougal/Duncan, Washougal/Lewis in Washington and Big Creek in Oregon. There are two major population groups (MPG) on the Columbia River (with several smaller groups throughout the basin): Cascade and Gorge. The Ives/Pierce Islands spawning area is part of the Gorge MPG and is the focus of the Bonneville chum operations described below.

The AAs plan to operate the FCRPS to provide flows to support chum salmon spawning, incubation and egress from the Ives/Pierce Islands spawning areas. The Ives/Pierce Island complex represents a small but important spawning location for the segment of the population that spawns in the mainstem Columbia River above I-205. Listed Lower Columbia River Tule fall Chinook salmon and non-listed up-river bright fall Chinook salmon are also known to spawn in the Ives/Pierce Islands area. The 2008/2010/2014 NOAA Fisheries BiOp recognizes that access to spawning habitat in the Ives/Pierce area is primarily a function of the Bonneville Dam tailwater. When the Bonneville Dam tailwater elevation is greater than 11.3 feet above mean sea

level (msl) salmon begin to have access to the Ives/Pierce Islands spawning area. Managing the water surface elevation with the operations of Bonneville Dam has been the management measure used to maintain this spawning area. Chum access to spawn in Hamilton, Hardy and Duncan creeks is also a function of sufficient tailwater elevation but must be coupled with sufficient fall rain events to recharge the aquifer and water up the spawning areas within the creeks.

Chum access and use of the available spawning area in the Ives/Pierce Island complex is driven by Bonneville Dam tailwater elevations as measured at the Tanner Creek gage. Tailwater elevations below Bonneville Dam are directly correlated with the amount of chum spawning habitat available in the Ives/Pierce Island complex. Bonneville Dam discharges have the most direct effect on tailwater elevations. However, the daily and hourly variability of tides, wind and tributary flow downstream of Bonneville dam directly affect the amount of water required to meet a particular tailwater elevation on a daily and hourly basis.

Adult chum salmon have access to two zones of spawning habitat, a lower elevation zone and a higher elevation zone. As the tailwater elevations ranges from 11.3 to 13.0 feet the lower elevation zone becomes the first available habitat for chum spawning. The habitat in the upper portion of the lower elevation zone between tailwater elevations 12.0 and 13.0 feet has been observed to be less optimal for spawning. Operating within this range (12.0 -13.0 feet) is not considered to provide additional spawning opportunities for chum at the Ives/Pierce Island complex. As the Bonneville tailwater increases beyond 13.0 feet new habitat is wetted and the higher elevation zone becomes available for chum spawning. Both zones of habitat are available at water surface elevations exceeding 13.0 feet. However, as tailwater elevations increase above 13.5 feet some of the habitat in the lower tailwater elevation zone of 11.3 to 12.0 feet becomes unsuitable for chum due to higher water velocities. These zones are spatially distinct but there is some significant overlap. In years of high escapement and adequate water supply, it is possible to maximize the available habitat by first managing the tailwater for the lower elevation zone, and then as condition allow, increase the tailwater elevation to allow spawning in the higher elevation zone.

Tributary flow from Hamilton Creek can affect the access to the Ives Island habitat below 12.0 feet but has reduced impact when managing at the higher tailwater elevation zone above 12.0 feet. Chum have had restricted access to Hamilton creek at tailwater elevations less than 11.5 feet and cannot access Duncan Creek due to the height of the sill on the fish ladder at Duncan Creek dam. Since the year 2000, when the tailwater regulation for chum began, protection levels have not been set at elevations higher than 14 feet even when tailwater elevations during the spawning phase have exceeded 14 feet for an extended period of time. The additional amount of flow augmentation required to support such a high tailwater elevation and potential number of redds affected is typically weighed against the likely consequence to the ability to refill Grand Coulee to its April 10 elevation objective.

These impacts were addressed in the 2008/2010/2014 NOAA Fisheries BiOp which outlined, chum salmon spawning operations as having lower priority than achieving spring flow objectives or summer refill. If all of the BiOp objectives cannot be met, the AAs will work with NOAA

Fisheries and the regional salmon managers to identify operations that would best benefit salmon while maintaining other fish protection measures.

There are two phases of the Ives/Pierce area chum operations: spawning (typically from early November through late December) and incubation and egress (typically from late December through early April).

### 7.3.1. Chum Spawning Phase

In the first week of November or when fish arrive (as coordinated with TMT), Bonneville Dam will start operating to provide a tailwater elevation (TWE) range of 11.5-13.0 feet until spawning ends or December 31. The official project TWE gauge is located 0.9 mile downstream of Bonneville Dam's powerhouse 1 on the Oregon shore, 50 feet upstream of Tanner Creek at river mile 144.5. Generally, the range of outflow from Bonneville Dam required to maintain this TWE can vary from less than the project minimum discharge (80 kcfs) up to 135 kcfs. This range demonstrates the profound effect of natural conditions downstream of Bonneville Dam on the water elevation. Tides, wind, wave and unregulated inflows to the Columbia River all have an influence on the ability to regulate the TWE below Bonneville Dam with the outflow from Bonneville Dam.

In addition to the uncertainty and variability of downstream conditions that affect TWE at Bonneville Dam, there are many upstream variables as well. Generally, the flow at Bonneville Dam is augmented by storage releases from Grand Coulee Dam which takes approximately 24 hours to arrive at Bonneville Dam and must pass through several non-federal dams that can alter the shape and timing of the flow. Further, the volume of unregulated flow into the Columbia River upstream of Bonneville Dam is difficult to predict but is critical in meeting the spawning elevations. The ability to operate Bonneville Dam to a particular TWE constraint is contingent on the ability of the hydrosystem to forecast and manage all of these variables and conditions. Reservoir operations upstream of Bonneville may provide additional water to help support the chum operation.

The hydrosystem is often unable to maintain the TWE within the range of 11.5-13.0 feet during daylight hours throughout the entire spawning period. Significant seasonal rain events commonly require that the operation must be modified in order to manage the additional water. Research to assess the impacts of higher flows (day and night) on chum redd development indicated that increased flows nightly up to 175 kcfs delayed spawning by temporarily displacing fish until flows decreased to base levels, but did not force fish to abandon their redds and search for new locations (Tiffan et al. 2009).

### 7.3.2. Chum Spawning Operational Steps

The spawning operation should utilize the considerations below to minimize the establishment of high elevation redds. Managing the spawning operation to minimize the required protection level increases the probability that the protection level can be maintained through egress in the early spring.

- Early season forecasts can be used by TMT to determine a level of caution when choosing the spawning elevations to provide below Bonneville. A general apprehension to provide tailwater elevations which will achieve a protection level above 11.5 feet is prudent in most years. Fall precipitation can lead to chum spawning at higher elevations than intended. It may be difficult to commit to providing those elevations without a solid water supply forecast.

- If the water supply forecast indicates it is unlikely that the high elevation redds could be maintained through emergence consider managing mainstem flows to discourage redds from being established in the Ives Island area. Shaping flows in a manner that would discourage redd development above a particular elevation is a potential tool to keep redds below high risk elevations. Reverse load factoring with nighttime discharges more than 75 kcfs over the daytime discharge level has been used as a measure to avoid the placement of high elevation redds.

Steps 1-7 below describe an example of a transition from a controlled operation to an uncontrolled operation when conditions are such that the daytime TWE range cannot be maintained. The steps are reversed if it is possible to return to a controlled operation and high elevation redds have not been established. There may be changes made to these steps based on TMT discussion. The following tailwater operation was coordinated with TMT during the October 29, 2014 meeting.

1) Bonneville Dam tailwater will be operated within a 1-foot range of 11.5–12.5 feet during all hours.

2) If necessary to pass additional flow, Bonneville Dam tailwater will be operated as necessary up to 13.0 feet during all hours, and return to the range of 11.5–12.5 feet whenever possible.

3) If necessary to pass additional flow, Bonneville Dam tailwater will be operated up to 16.5 feet during nighttime hours (1700-0600). Highest tailwater elevations will be concentrated around midnight.

4) If necessary to pass additional flow, Bonneville Dam tailwater will be operated up to 18.5 feet during nighttime hours (1700-0600). Highest tailwater elevations will be concentrated around midnight.

5) If necessary to pass additional flow, Bonneville Dam tailwater operating range will become 13.0–16.5 feet during daytime hours (0600-1700) with no upper limit during nighttime hours. Highest tailwater elevations will be concentrated around midnight. The Action Agencies will notify TMT of this occurrence and coordinate further operations if necessary.

There are several conditions that typically preclude the chum spawning operation for multiple days. These events are usually forecasted well in advance, and an appropriate course of action is coordinated through the TMT. Below are some examples of the conditions where the chum operation cannot be managed within the above constraints:

6) Conditions downstream of Bonneville (e.g., high tides, high inflows) result in high TWE regardless of project discharge. Even at minimum discharge, these conditions could raise the TWE above the target range.

7) Heavy precipitation events increase inflow to the Columbia River both upstream and downstream of Bonneville Dam. The combination of low required flow at Bonneville, unregulated inflows to the Columbia River upstream of Bonneville, and the lack of storage capacity in the lower Columbia River, result in little to no control over the resulting TWE below Bonneville Dam.

### 7.3.3. Chum Incubation and Egress

Washington Department of Fish and Wildlife (WDFW) will inform TMT when they establish chum spawning is complete at the Ives/Pierce Island area; this usually occurs in late December but will not extend past December 31. Following the completion of spawning, the operation is shifted to provide a tailwater elevation (to be determined by TMT) equal to or greater than the elevation of the highest redds that will be protected. This elevation is typically around 11.3 feet - 11.7 feet msl during normal water years. Redds established due to conditions beyond the control of the action agency may not be protected. The end of the chum protection operation is coordinated at TMT after it is determined that completion of emergence and egress has occurred.

The protection operation typically ends between mid-March and April 10. If the emergence period extends beyond April 10 and a decision is made to maintain the tailwater, TMT will need to discuss the impacts of TDG associated with spill and/or operation of the corner collector for fish passage at Bonneville Dam and its potential for negatively affecting fry in the gravel. However, typically spring flow augmentation volumes generally provide sufficient flows to sufficiently maintain the protection elevations. Bonneville starts its spring spill around April 10, but a delay in the start of spill may be needed. The chum protection level decision will be revisited at least monthly through the TMT process to assure it is consistent with the need to provide spring flows for listed Columbia and Snake River stocks.

### 7.3.4. Considerations for Dewatering Chum Redds

While a conservative approach to managing tailwater elevations during spawning reduces the risk of dewatering redds, it does not eliminate dewatering as a possibility. The conditions in each year vary too dramatically to allow for the development of set criteria for whether or not to dewater redds, therefore the basis for a dewatering decision depends greatly on in-season conditions so are best made in TMT. Factors that should be considered in making a dewatering decision include:

- Number of redds that would be affected and the percentage they represent of:
    - the overall Ives/Pierce Islands complex;
    - the total population spawning above the I-205 Bridge;
    - the entire ESU.

- Emergence timing based on temperature units;

- Status of the FCRPS reservoir elevations;
- Expected benefit to reservoir levels and river operations which would be provided by the dewatering decision;
- Precipitation and runoff forecasts;
- Expected river operations due to power market environment;
- Status of the upriver spring Chinook, steelhead and sockeye listed stocks;
- Existence and status of a brood contingency plan.

### 7.3.5. Chum Redd Dewatering and Alternative Maintenance Options

If water supply conditions indicate that it is not possible to maintain the minimum tailwater elevation established in December for Bonneville Dam, flows will be reduced to the next occupied habitat band that can be maintained. If chum redds are dewatered as a result of diminished water supply conditions a "rewetting operation" once a day for ~1 hour has been utilized as an interim measure to provide some level of protection in the event that water supply conditions improve sufficiently to restore the full protection level.

If protection for all redds has been suspended TMT should consider implementing a water release strategy that would allow chum to migrate from habitat in Hamilton, Hardy and Duncan creeks if they are isolated from the mainstem Columbia. Impacts to refill will be looked at and the exact details of a release to establish connectivity will be set through coordination in TMT.

## 7.4. Description of Variable Draft Limits

Variable Draft Limits (VDLs) are period-by-period draft limits at Grand Coulee and Hungry Horse from January-March 31. These are planned limits to Firm Energy Load Carrying Capability (FELCC) generation to protect the ability to refill Grand Coulee and Hungry Horse to their April 10 elevation objectives with an 85% and 75% confidence respectively.

The VDLs are based on: (1) The April 10 elevation objective which is calculated from the forecasted March 31 and April 15 flood risk management elevations (2) statistical inflow volumes (85% exceedance for Grand Coulee and 75% exceedance for Hungry Horse), and (3) actual downstream flow objectives.

VDLs are calculated monthly from January through March after updated volume forecasts and flood risk management elevations have been issued. The VDL at the end of a period (e.g., January 31) is computed to determine the lowest elevation where the outflow requirements and the April 10 elevation objective can be achieved using a 75%/85% probable inflow volume. For example, Hungry Horse's January VDL is computed as:

- The expected April 10 Flood risk management elevation based on January forecast.
- Minus February 1 to April 10 inflow volume of 165.7 ksfd (75% statistical inflow

volume).

- Plus February 1 to April 10 minimum discharge requirement for Columbia Falls.

The VDL is not a mandatory draft elevation and operation above the VDL is acceptable as long as it is not a higher elevation than flood risk management curve, FELCC is already being met, and at-site and downstream flow objectives are also being served. Also, VDLs at Grand Coulee are further limited by VDL lower limits of 1260 feet in January, 1250 feet in February and 1240 feet in March.

The statistical inflow volumes for Hungry Horse and Grand Coulee are derived as follows:

- Hungry Horse – The inflow volumes used are the 75% probable inflow into Hungry Horse reservoir plus the 75% probable incremental at Columbia Falls. The data used to computed these inflow volumes for Hungry Horse are from the 2010 80 WY Modified Streamflows.
- Grand Coulee – The inflow volumes used are the 85% probable regulated inflow volume into Grand Coulee and the 75% probable regulated incremental to Priest Rapids Dam. The data used to compute these inflow volumes will be taken from the results of an in-season ESP hydroregulation study that reflects the most current operational assumptions streamflow forecast.

## 7.5. Lake Roosevelt Incremental Storage Release Project of the Washington State Department of Ecology, Columbia River Water Management Program

### 7.5.1. Lake Roosevelt Incremental Storage Releases

The Lake Roosevelt Incremental Storage Releases portion of Washington State's Columbia River Water Management Program (CRWMP) result in additional water withdrawals from Lake Roosevelt for both out-of-stream use and instream flows. The Incremental draft results in a release of 82500 acre-feet in most years, or about 1.0 foot of draft at Lake Roosevelt. For every two acre-feet of water put to out-of-stream use, one acre-foot of water will go to instream flows ("*no net loss plus one-third"*). In years when the March 1 final forecast of April through September runoff at The Dalles is less than 60 million acre-feet, an additional draft of 50000 acre-feet for interruptible water users and instream flow will occur, for a total draft of 132500 acre-feet or about 1.8 feet of draft.

### 7.5.2. Release Framework and Accounting for Lake Roosevelt Incremental Draft

The only way to demonstrate that the water came from Lake Roosevelt and not stream flows during the juvenile fish migration period is to draft Lake Roosevelt. Based on RPA 4 in the 2008 FCRPS BiOp, there are two elevation objectives during the juvenile fish migration period: (1) end of June (early July) refill, and (2) August 31 draft, the latter of which is forecast based. When water is released in the April-through-June spring period from the Lake Roosevelt incremental draft water account, then Lake Roosevelt would need to miss refill by that amount.

Lake Roosevelt would draft below the end of August draft limit by the amount released in both the spring and July-August summer flow augmentation periods.

### 7.5.3. 2017 Operations

The amount and timing of water to be released in 2017 will not be determined until the March final WSF for April – September at The Dalles is completed. Estimates of 2017 incremental storage releases will be included in the 2017 seasonal update.

## 7.6. Public Coordination

Actions in the WMP will be coordinated with NOAA Fisheries, USFWS, and the states and tribes in preseason planning and in-season management of flow and spill operations. This coordination will occur in the TMT process and will utilize the best available science. At all appropriate decision points, the AAs will routinely seek timely input and concurrence from the USFWS on all matters affecting USFWS listed fish through the Columbia River Treaty, IJC, and all other decision making processes involving trans-boundary waters in the Columbia River basin. This will include notification of all meetings and decision points and provision of opportunities to advise the AAs during meetings and in writing, as appropriate.

# 8. Water Quality

## 8.1. Water Quality Plans

The Corps has completed a comprehensive 2014 Water Quality Plan (WQP) outlining the physical and operational changes that could be used to improve the overall water quality in the mainstem waters of the Clearwater, Snake, and Columbia rivers. The plan may be found on the following website:
http://www.nwd-wc.usace.army.mil/tmt/wq/studies/wq_plan/wq2014.pdf

### 8.1.1. Total Dissolved Gas (TDG) Monitoring

Exposure to high levels of TDG over long periods of time can be harmful or lethal to fish. Monitoring in the waters impacted by operations at the dams is necessary where voluntary spill is employed for juvenile fish passage to ensure that gas levels do not exceed TDG thresholds established in NOAA Fisheries BiOps, and applicable state water quality criteria and waivers. The Corps TDG monitoring program is described in the 2015-2018 TDG Monitoring Plan of Action, which included data quality criteria for fixed monitoring stations, goals related to the accuracy, precision, and completeness of data at each fixed monitoring station and the methodologies that are used in the attempt to achieve those goals, calibration protocols (data quality control), data review and corrections (data quality assurance), and completeness of data. The TDG Monitoring Plan of Action can be found on the following website:
http://www.nwd.usace.army.mil/Missions/Water/Columbia/Water-Quality/

The Reservoir Control Center is responsible for monitoring the TDG and water temperature conditions in waters impacted by Corps projects on the Columbia and Snake rivers. To assess water quality conditions in these waters, the Corps operates TDG and temperature monitors in

the forebays and the tailwaters of the lower Columbia River/lower Snake River dams, and other selected river sites. The Corps prepares a Total Dissolved Gas Management Plan (TDG Management Plan) each year (see Appendix 4). This TDG Management Plan provides information addressing voluntary and involuntary spill, use of the spill priority list, the process for setting spill caps, TDG management policies, and the TDG monitoring program. Spill caps for individual projects may be found on the following website: http://www.nwd-wc.usace.army.mil/tmt/documents/ops/spill/caps/

# 9. Dry Water Year Operations

Flow management during dry years is often critical to maintaining and improving habitat conditions for ESA-listed species. A "dry water year"[4] is defined as the lowest 20th percentile years based on the NWRFC's averages for their statistical period of record (currently 1981-2010) using the May final water supply forecast for the April to August period as measured at The Dalles (currently <72.5 MAF). The AAs will complete the following activities to further the continuing efforts to address the dry water years:

- Within the defined "buckets" of available water (reservoir draft limits identified in RPA Action 4), flexibility will be exercised in a dry water year to distribute available water across the expected migration season to optimize biological benefits and anadromous fish survival. The AAs will coordinate use of this flexibility in the TMT.

- In dry water years, operating plans developed under the Treaty may result in Treaty reservoirs being operated below their normal refill levels in the late spring and summer, therefore, increasing flows during that period relative to a standard refill operation.

- Annual agreements between the U.S. and Canadian entities to provide flow augmentation storage in Canada for U.S. fisheries needs will include provisions that allow flexibility for the release of any stored water to provide U.S. fisheries benefits in dry water years, to the extent possible.

- Under the long term Non-Treaty Storage (NTS) Agreement, the U.S. has firm release rights for up to 0.5 MAF of water during the spring in dry water years, if not exercised in the previous year.

- BPA will implement, as appropriate, its Guide to Tools and Principles for a Dry Year Strategy to reduce the effect energy requirements may pose to fish operations and other project purposes.

# 10. FCRPS Hydrosystem Performance Standards

The AAs will operate the FCRPS hydrosystem as described in this 2017 WMP, in an adaptive management framework, to make progress towards meeting biological performance goals. Those goals are contained in the 2008/2010/2014 NOAA Fisheries BiOp. Adult and juvenile

fish survival estimates from research, monitoring, and evaluation studies will be considered in annual planning as future plans are developed.