

## **Appendix B**

# **Willamette Mainstem Flow Operations Strategy**

*Submitted by:*

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*Submitted to:*

**National Marine Fisheries Service  
U.S. Fish and Wildlife Service**

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# **Willamette Project Supplemental Biological Assessment**

# Willamette Mainstem Flow Operations Strategy

## 1. Introduction

In March 2001, the National Marine Fisheries Service (NMFS) provided to the Portland District, U.S. Army Corps of Engineers (USACE) preliminary drafts of Reasonable and Prudent Alternative (RPA) and Incidental Take Statement (ITS) sections of a joint [with the U.S. Fish and Wildlife Service (USFWS), in combination called the Services] draft Willamette Project Biological Opinion (BiOp) for review and comment<sup>1</sup>. The second measure under the draft BiOp's RPA dealt with continuation (since 1999) of the spring and early summer mainstem minimum flow levels (i.e. biological flow objectives) needed to support salmon and steelhead migration.

In the Portland District response back to the Services, concern was expressed that under drier than average conditions (such as were experienced in 2001), it would be impossible to implement the proposed flow objectives. The USACE agreed to develop a decision-making protocol and operational criteria for meeting the flow objectives across a range of different hydrologic conditions for further consideration by the Services.

This paper describes the conceptual basis for an approach to operating the Willamette projects in a way that will satisfy the biological requirements for mainstem flows for species listed under the Endangered Species Act (ESA) while allowing the USACE to continue to meet, when possible, other authorized project purposes across a range of varying annual hydrologic conditions. The intent of this paper is to promote coordination between the Action Agencies [USACE, Bonneville Power Administration (BPA) and Bureau of Reclamation (Reclamation)] and the Services regarding possible alternative flow management approaches.

At the time of this update, the USACE has successfully implemented the essential aspects of this flow management strategy since the year 2000. Over the ensuing time period, the interagency process used to implement the operating strategy each year has continued to evolve and mature. We anticipate that this cooperative process will continue into the foreseeable future. The Action Agencies have used monthly meetings and weekly coordination teleconferences to provide updates on current environmental and flow conditions in the Willamette Basin and to discuss appropriate courses of action over the ensuing management period.

## 2. Spring Mainstem Flow Objectives

Starting in 2000, the Services recommended implementation of biologically based, weekly average and instantaneous minimum flow objectives for the Willamette River at Salem, Oregon. These flows are defined for April 1 to June 30 (Table B-1) each year. The biological minimum flow objectives were first recommended by Oregon Department of Fish and Wildlife (ODFW) and then recognized and adopted by the Services. They were the basis of consideration for operations beginning in 1999, through to the present.

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<sup>1</sup> Federal Review Draft – Biological and Conference Opinion on the Effects of the Operation of 13 Flood Control Dams and Maintenance of 93 Miles of Streambank Revetments, Upper Willamette Basin, Oregon, on various fishery. USACE, NMFS, and USFWS, September 22, 2000.

**Table B-1. Biological Minimum Flow Objectives for the Willamette River at Salem from April 1 to June 30**

Time Period	Weekly Average Minimum Flow (cfs)	Instantaneous Minimum Flow (cfs)
April 1-15	17,800	14,300
April 16-30	17,800	14,300
May 1-31	15,000	12,000
June 1-15	13,000	10,500
June 16-30	8,700	7,000

The USACE was unable to meet all of the flow objectives in 2001 because of extreme low water conditions that year. The biological minimum flow objectives are based on the best currently available information regarding the biological needs of ESA-listed fish species, as described in a report prepared by the ODFW<sup>2</sup>. The NMFS Science Center has reviewed the ODFW research and concurs with the mainstem flow objectives as biologically justified. In addition to April through June flow objectives for fish, the Services recognized the need for continuation of the summer and fall (June-October) flows shown in Table B-2. Continuation of the minimum flow at Albany in the summer is important for meeting the USACE responsibility to help in maintaining suitable water quality.

**Table B-2. Congressionally Authorized Minimum Flow Objectives for the Willamette River at Salem and at Albany (extending September flow objective through October 31)**

Time Period	Average Flow at Albany (cfs)	Average Flow at Salem(cfs)
June 1-30	4,500	N/A
July 1-31	4,500	6,000
August 1-15	5,000	6,000
August 16-31	5,000	6,500
September 1-30	5,000	7,000
October 1-31	5,000	7,000

### 3. Effectiveness Monitoring

Monitoring, evaluation and reporting requirements related to the provision of mainstem flows will be developed in collaboration with the Services and may be incorporated into the BiOps. It is important to recognize that the mainstem spring flow objectives described in Table 1 may be temporary actions and are subject to review and revision in accordance with the results of appropriate monitoring and evaluation.

<sup>2</sup> Biological and Technical Justification for the Willamette River Flow Proposal of the Oregon Department of Fish and Wildlife, Mamoyac, Buckman, and Tinus, Draft August 8, 2000.

## 4. Definition of Key Terms

**“Biological minimum flow objective”** refers to the minimum level of flow that the fisheries agencies have indicated are needed for migrating adult and juvenile salmon and steelhead during the spring (April through June) runoff period. Spring biological flow objectives for fish are based on the best currently available scientific information. The spring flow objectives, or minimum levels of flow recommended to sustain anadromous fish populations in the Willamette Basin on a long-term basis, do not change based on the availability of water. When possible, it is preferable for mainstem Willamette River flows to exceed these biological minimum flow objectives. However, in some years there will be insufficient water available to meet the flow objectives.

**“Congressionally authorized minimum flow objectives”** during summer and fall (July through September), as measured in the mainstem Willamette River at Salem and at Albany are those that were included in the original formulation and authorization of the Willamette System Project. The Congressionally authorized flow levels during summer and fall were originally based on depths for navigation in the Willamette. They have become base flows used to maintain water quality standards in the mainstem Willamette. Minimum flow objectives for September have been used through low flow periods extending into October.

**“Operational flow target”** refers to the actual level of flow that managers will attempt to achieve during a given time period in the mainstem Willamette River at Salem. Flow targets are guided by corresponding flow objectives but may differ from them depending on the availability of water in any given water year and on other operational constraints and concerns. Flow targets will meet or exceed biological minimum flow objectives whenever possible. In low flow years, flow targets may be less than their corresponding biological flow objectives. This strategy recognizes that even under natural (i.e. unaltered) environmental conditions, there were some years in which flows were insufficient to meet the flow needs of migrating fish populations.

**“Deficit flow thresholds”** were those used (achieved or exceeded) on the mainstem Willamette River at Salem during the 2001 water year. This water year was the driest encountered to date since implementation of this flow management strategy in 2000. These 2001 flow levels were agreed upon following extensive hydrologic modeling analysis and multi-agency efforts to carefully balance risks associated with the multiple uses for Willamette Basin flow and storage, including the needs of ESA-listed species. The flow levels were developed under the ongoing ESA Section 7 consultation activity. Use of the Deficit Flow Thresholds recognizes, in part, the historic physical limitations of the Willamette Basin ecosystem over the period of record. However, 16% of the period-of-record years have actually been drier than 2001.

**“Storage volume targets”** are those volumes of system-wide storage (with regard to the combined Willamette River federal projects) that are determined to be necessary to meet specified project purposes in a particular type of water year. Storage volume targets are defined for four levels of storage availability: “deficit,” “insufficient,” “adequate,” and “abundant.” The Willamette Valley Project total available active storage is 1.594 million acre feet (MAF). Table B-3 identifies the storage ranges for each of these levels by May 10-20 of any given year.

**“Interim draft limits”** are storage limits that the projects will be operated at, or above, in order to meet minimum tributary and mainstem flows later in the summer and early fall months. These limits will be most important in the “insufficient” and “deficit” runoff years when a balance between spring and summer flows will be more difficult to manage.

## 5. Willamette Conservation Plan Development

The designation of a conservation season runoff forecast as abundant, adequate, insufficient, or deficit will lead to differing management tactical approaches. Table B-3<sup>3</sup> summarizes the designation of Willamette Basin runoff observed over a 64-year period of record.

**Table B-3. Evaluation of Spring Runoff and Conservation Operation (period of record 1936-1999 using Tables 1 and 2 flow objectives)**

Volume in Storage by 10-20 May (MAF)	Designation	Occurrences (years)	Percent of Years
< 900	Deficit	10	16
900 – 1.19	Insufficient	6	9
1.20 – 1.48	Adequate	11	17
> 1.48	Abundant	37	58
1.59	Maximum *	---	---

\* Maximum useable conservation storage. Total transient system storage is somewhat more.

For years designated as **abundant** or **adequate**, minimum flow objectives during spring, summer, and fall (Tables B-1 and B-2) would be met or exceeded whenever possible (e.g., considering factors such as the accuracy of weather forecasts, constraints in the accuracy of operational adjustments at dams, and delayed system response time between the points of storage release and Salem). During an **insufficient** runoff season, it will likely be necessary to reduce flow targets at Salem and Albany to levels below the biological and Congressional minimum flow objectives. The flow targets would be less than the minimum flow objectives, proportional to the expected mid-May system-wide storage capability, down to a minimum of the deficit flow thresholds shown in Table B-4. For **deficit** runoff years, it is unlikely that even the weekly average deficit flow thresholds (Table B-4) would be attainable. Extensive coordination, cooperation, and adaptive management will be required in such years to balance storage use between flows needed to protect ESA-listed fish species and other uses. In both insufficient and deficit runoff years, it will be increasingly important to balance flows needed to protect ESA-listed fish species against other uses that, in general, are important for protecting human health and safety (e.g., maintaining water quality later in the year). Reservoir-specific draft limits will likely constrain flow releases in such years. Four of the 10 identified deficit years (from 1936-1999) resulted in less than 600,000 acre-feet of storage by mid-May.

**Abundant.** An *abundant* system-wide conservation storage volume is characterized by the expectation of having greater than 1.48 MAF in system storage by mid-May and having a relatively high probability of filling the three high-priority recreation reservoirs (Detroit, Fern Ridge, and Foster) throughout the summer (May through August) while fully meeting flow objectives at Salem (see Tables B-1 and B-2). When hydrologic modeling indicates that the system-wide storage volume is expected to reach or exceed 1.48 MAF between 10-20 May, weekly average flow targets will be established which fully meet or exceed the biological minimum flow objectives shown in Table B-1. Due to the high level of runoff, it is anticipated

<sup>3</sup> This information was developed using HEC-5 reservoir system operation model of the Willamette Project. The results are based on meeting unmodified biological minimum flow objectives regardless of effects on other authorized purposes. Details are published in a study report.

that these objectives would be exceeded without specific operational input. Under these conditions, it is expected that all lakes will fill at close to the prescribed (i.e., rule curve) rate while passing additional flow downstream. Lower priority recreation reservoirs could be drafted later in the summer to meet flow objectives, possibly reducing the extent of their recreation season.

**Table B-4. Weekly Average Minimum Flow Objectives and Minimum Deficit Flow Targets for the Willamette River at Salem**

<b>Time Period</b>	<b>Minimum Flow Objective Weekly Averages (Biological and Congressional from Tables 1 &amp; 2 in cfs)</b>	<b>Deficit Flow Threshold Weekly Averages (based on 2001 flows in cfs)</b>
April 1-15	17,800	15,000
April 16-30	17,800	15,000
May 1-31	15,000	15,000
June 1-15	13,000	11,000
June 16-30	8,700	5,500
July 1-31	6,000	5,000
August 1-15	6,000	5,000
August 16-31	6,500	5,000
September 1-30	7,000	5,000
October 1-31	7,000	5,000

**Adequate.** An adequate system-wide conservation storage volume is characterized by the expectation of having 1.20 to 1.48 MAF in system storage by mid-May and having a relatively high probability of filling the three high-priority recreation reservoirs through most but not necessarily all of the summer while fully meeting flow objectives at Salem (see Tables B-1 and B-2). In these years, it is anticipated that spring flow objectives on the mainstem Willamette at Salem will be met or exceeded to enhance survival of migrating listed species. When it is determined that 1.20 MAF has been stored on or before mid-May, we will continue to store additional water on a system-wide basis only when we are exceeding mainstem flow objectives at Salem (Table B-1) by at least 10% (e.g., when we are meeting or exceeding 16,500 cfs in May).

**Insufficient and Deficit.** For these categories, there would not be a sufficient amount of runoff to meet all of the flow objectives in Tables B-1 and B-2 while permitting high priority Willamette reservoirs to fill to a level that would support recreational use throughout most of the summer. This situation occurs when the system-wide conservation storage level in the Willamette Basin is not anticipated to reach 1.20 MAF by mid-May. Below this level of system-wide conservation storage, inflow to reservoirs will be shared between that needed for storage to address summer and fall flow targets. Reservoir-specific interim draft limits will be used to avoid over-draft of stored water during the early part of the flow management season.

An insufficient designation for system-wide conservation storage volume occurs when the anticipated storage by mid-May is expected to be between 0.90 and 1.20 MAF, while attempting to fully meet biological and Congressional minimum flow objectives presented in Tables B-1 and B-2. In these years, mainstem operational flow targets for spring, summer, and fall will be based on a sliding-scale proportion of the minimum flow objectives presented in Table B-4 between

minimum flow objectives and deficit flow thresholds. The proportion of flow provided between the minimum flow objectives and the deficit flow thresholds will be equal to the proportion of system-wide storage anticipated to be obtained by mid-May between 0.90 MAF and 1.20 MAF. This threshold volume is based on results of water management actions implemented in 2001 to carefully balance risks associated with the multiple uses for Willamette Basin flow and storage, including the needs of ESA-listed fish species.

A deficit designation occurs when the runoff season is so low that the projected system storage by mid May is less than 0.90 MAF. Under these circumstances, it may not be possible to meet the biological and Congressional minimum flow objectives in Tables B-1 and B-2. Mainstem operational flow targets for spring, summer, and fall will be determined through the annual Willamette Conservation Plan development process, as described below, but are likely to be below the deficit flow thresholds shown in Table B-4. Under such severe conditions, coordination, cooperation, and adaptive management based on modeling of reservoir inflow and releases and on use of interim reservoir draft limits will be used to monitor and adjust flows, balance needs, and minimize impacts to ESA-listed fish species while meeting other water uses related, in general, to human health and safety. It will be especially important during deficit years to balance needs for flows during spring to support spawning and incubation of ESA-listed winter steelhead with needs for storage to provide flows during summer for water quality and during fall for spawning and incubation of ESA-listed spring Chinook salmon.

In both insufficient and deficit year cases, storage for recreational use would be considered a low priority. Hydropower generation, irrigation, and other authorized uses will be met to the fullest extent possible through both discharges of reservoir inflows during spring and release of storage during summer and fall to meet mainstem flow management targets. Priority will be given to those flow needs directly related to human health and safety. Reservoir inflow in excess of that needed to meet the mainstem operational flow targets during spring will be stored in a manner that maximizes the likelihood of being able to meet minimum discharge rates, mainstem Willamette River flow objectives at Albany and Salem during June through October, and Willamette Basin hydropower production needs.

## **6. Flow Management Coordination**

As required by Congressional authorities, the USACE has traditionally managed the Willamette Project to meet multiple responsibilities, including flood control, power production, pollution abatement, recreation, irrigation, municipal and industrial water supply, navigation, and conservation of fish and wildlife within the project area. The approach in this strategy will help to meet the USACE responsibility under the ESA to avoid jeopardy to the continued existence of ESA-listed fish species. In making operational decisions to meet the requirements of the ESA, the Action Agencies must take all appropriate actions within their authorities to protect ESA-listed species. In some years, water resources will be insufficient to completely meet all of the traditional USACE responsibilities as well as the ESA responsibilities for the Willamette Project.

In accordance with individual project operation limits, the USACE prepares each year an operating plan for the conservation storage and release seasons (February-October) in the Willamette Basin. This plan is called the Willamette Conservation Plan (WCP). The WCP describes how the authorized project purposes will be accomplished during the conservation storage and release seasons given the volume of water forecasted to be available during the water year. The preparation of the WCP is initiated in January following the release of the initial water supply forecast for the basin from the Natural Resources Conservation Service (NRCS). The

WCP is finalized by late May. Historically, the USACE has prepared the WCP in coordination with state and federal agencies, including the Services. In the future, it is anticipated that a technical Flow Management (FM) Committee of the Willamette Action Team for Ecosystem Restoration (WATER) will play a key role in coordinating with the USACE for development of the WCP.

**Willamette Action Team for Ecosystem Restoration (WATER).** The preliminary draft BiOps called on the USACE to convene a forum of the Action Agencies, Services and other agencies responsible for planning and implementing flow management in the Willamette Basin. Among other actions, WATER will be responsible for working with the USACE to coordinate annual development of the WCP and real-time operations for the projects during the conservation season (April through October). It is anticipated that a flow management subcommittee of WATER will supplant the ad-hoc interagency committee that has been coordinating with the USACE on Willamette Project operations since 1999.

**Flow Management Planning.** The following paragraphs describe a protocol for developing the WCP across a full range of water years. The protocol is based on adaptive management that will spread risk of insufficient water among all authorized project purposes. Included among these uses are minimum tributary flows needed to protect ESA-listed fish species.

Adaptive management of flows involves making adjustments to reservoir operations and flow releases based on current and forecasted hydrologic conditions and will spread risk of insufficient water among all authorized project purposes. These purposes are described in detail in Chapter 2 of the USACE Willamette Project Biological Assessment (BA; update to new BA supplement)<sup>4</sup>. The Services, Action Agencies, and other WATER members will continue to work cooperatively each year during the conservation storage and release season to adjust flows to meet requirements of ESA species and other project purposes. Adaptive management is preferable to establishing fixed operating criteria because the Willamette Basin is a highly rain-dependent system with variable springtime flows. Current forecast methods do not differentiate between the significant contribution of snowmelt and the highly variable rainfall contribution. It is not possible to foresee, describe, and model all of the possible management scenarios and contingencies.

Under the protocol, beginning in or before January of each year, the USACE will determine if there is likely to be a sufficient volume of water in the Willamette Basin throughout the conservation season (February through October) to meet all of the identified flow and storage needs, including both the spring minimum flow objectives in Table B-1 and Congressionally authorized summer and fall flow objectives in Table B-2. Development of a flow management plan for the conservation season will be guided by the forecasted availability of water. It is important to recognize that in a rain-driven system like the Willamette Basin the best available hydrologic modeling early in the season may result in forecasts that differ significantly from actual conditions later in the conservation season. Since the plan calls for setting operational flow targets at Salem beginning on April 1, based on a storage forecast for mid-May, flows may be adjusted through the season. The availability of water will be re-assessed monthly or as necessary during January through May and related changes in management strategy will be made.

The USACE will use hydrologic modeling techniques to convert water supply forecasts for the Willamette Basin, provided by the NRCS, and perhaps other sources into an estimate of runoff volume available for the ensuing conservation management season. The estimate of runoff

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<sup>4</sup> Biological Assessment of the Effects of the Willamette River Basin Flood Control Project on Species Listed Under the Endangered Species Act; Portland District, USACE, April 2000.

volume will be used to guide development of an annual flow management operational plan (WCP). The WCP will estimate mainstem flows and reservoir storage volumes likely to occur over the conservation season based on system operational alternatives and constraints. Consideration will be given to system operational constraints and to the resulting operation of the USACE Willamette reservoirs for the impending spring, summer, and fall periods. The modeling will consider the likelihood of meeting the spring flow objectives in Table B-1 and the Congressionally authorized summer and fall flow objectives at Salem and Albany in Table B-2, in conjunction with the likelihood that each of the reservoirs will fill.

## **7. Strategy Statement**

The operational flow targets as determined under the process described above, and the associated flow management guidelines, are intended to balance the risks to listed fish species under low water year conditions with the risks to other uses authorized by Congress for the Willamette Valley Project. Key among these authorized uses are those significant to human health and safety. These include flood damage reduction, hydropower production for use within the Willamette Basin, and summer and fall low flow augmentation for maintenance of local water supply and water quality.