Tributary Flows:

Ref #1.
US. Fish and Wildlife Service, Oregon Fish and Wildlife Office. 2008. *Biological Opinion On the Continued Operation and Maintenance of the Willamette River Basin Project and Effects to Oregon Chub, Bull Trout, and Bull Trout Critical Habitat Designated Under the Endangered Species Act.* File Number: 8330.F0224(07) Tails Number: 13420-2007-F-0024, Appendix B, P. 13 Table 9.2-2.

Santiam River:

Ref #2
Risley, John., J. Rose Wallick, Joseph F. Mangano, and Krista L. Jones. 2012. *An Environmental Streamflow Assessment for the Santiam River Basin, Oregon*, , US Department of the Interior US Geological Survey Open-File Report 2012-1133, P.11, Table 3.

Middle Fork Willamette River:

Ref #3
Gregory, Stan ., Linda Ashkenas, Chris Nygaard. 2007. *Summary Report: Environmental Flows Workshop for the Middle Fork and Coast Fork of the Willamette River, Oregon*, Institute for Water and Watersheds, Oregon State University, P. 10, Figure 8.

McKenzie River:

Ref #4
Risley, John., J. Rose Wallick, Ian Waite, and Adam Stonewall. 2010. *Development of an Environmental Flow Framework for the McKenzie River Basin, Oregon*, US Department of the Interior US Geological Survey Scientific Investigations Report 2010–5016, P. 12, Table 4.

Mainstem Flows:

Ref #5.
US. Fish and Wildlife Service, Oregon Fish and Wildlife Office. 2008. *Biological Opinion On the Continued Operation and Maintenance of the Willamette River Basin Project and Effects to Oregon Chub, Bull Trout, and Bull Trout Critical Habitat Designated Under the Endangered Species Act.* File Number: 8330. F0224(07) Tails Number: 13420-2007-F-0024, Appendix B, P. 12 Table 9.2-1.

However, NMFS does not agree with the Action Agencies that other project purposes (i.e. recreation), as expressed by the proposed drafting priority (Table 2-6, in Chapter 2), should take priority over meeting tributary and mainstem flow objectives. For this reason, we include RPA measure 2.4.4 to identify opportunities to manage available water resources in a manner that improves the likelihood of providing flows known to be protective of salmon and steelhead and their critical habitats (see Section 5.5.2.1). The primary difference from the Proposed Action measure is that this measure emphasizes the fisheries objectives for these flows. This measure also requires the Action Agencies to notify NMFS when they are unable to meet both mainstem and tributary flow objectives, and emphasizes that NMFS will provide guidance on fish protection priorities.

The effect of this measure is that it will better ensure adequate flows for UWR Chinook salmon and UWR steelhead that migrate and rear in Project-affected tributaries (Middle Fork Willamette, McKenzie, South Santiam, and North Santiam subbasins) than provided by the Proposed Action. In the various Effects sections for these subbasins (sections 5.2 through 5.6), NMFS found that the proposed tributary flow objectives were sufficient based on existing data. However, NMFS noted that flows released from Project dams for fish protection purposes should be protected throughout the tributary reaches where such flows are needed for spawning, rearing, holding or migration. The Proposed Action limits the Action Agencies' obligation to flow rates at the lowermost Project dam on each tributary, but does not establish flow requirements for reaches downstream from the dams to the mouth of the tributaries because the Action Agencies do not have enforcement authority over water diversions. NMFS adds sub-measures 2.4.1 through 2.4.4 below to address this issue for the lower tributary reaches. Studies required by RPA measure 2.10 below will guide decisions to modify these flow objectives to better protect ESA-listed fish species.

**Table 9.2-2 Minimum & Maximum Tributary Flow Objectives below Willamette Dams (USACE 2007a; Donner 2008)**

| DAM | PERIOD | PRIMARY USE | MINIMUM FLOW (CFS) [1] | PERCENT OF TIME FLOW IS EQUALED OR EXCEEDED[4] | MAXIMUM FLOW (CFS) [2] | PERCENT OF TIME FLOW IS EQUALED OR EXCEEDED[4] |
|---|---|---|---|---|---|---|
| Hills Creek | Sep 1 - Jan 31 | Migration & rearing | 400 | 99.9 | | |
| | Feb 1 - Aug 31 | Rearing | 400 | 99.9 | | |
| Fall Creek | Sep 1 - Oct 15 | Chinook spawning | 200 | 95 | 400 through Sep 30, when possible | 25 |
| | Oct 16 - Jan 31 | Chinook incubation | 50 [3] | 99.9 | | |
| | Feb 1 - Mar 31 | Rearing | 50 | 99.9 | | |
| | Apr 1 - May 31 | Rearing | 80 | 99.9 | | |
| | Jun 1 - Jun 30 | Rearing/adult migration | 80 | 99.9 | | |
| | Jul 1 - Aug 31 | Rearing | 80 | 95 | | |
| Dexter | Sep 1 - Oct 15 | Chinook spawning | 1200 | 99.9 | 3,500 through Sep 30, when possible | 10 |

***USFWS Final Biological Opinion on the Willamette River Basin Flood Control Project***

| DAM | PERIOD | PRIMARY USE | MINIMUM FLOW (CFS) [1] | PERCENT OF TIME FLOW IS EQUALED OR EXCEEDED[4] | MAXIMUM FLOW (CFS) [2] | PERCENT OF TIME FLOW IS EQUALED OR EXCEEDED[4] |
|---|---|---|---|---|---|---|
| | Oct 16 - Jan 31 | Chinook incubation | 1200 [3] | 99.9 | | |
| | Feb 1 - June 30 | Rearing | 1200 | 99.9 | | |
| | Jul 1 - Aug 31 | Rearing | 1200 | 99.9 | | |
| Big Cliff | Sep 1 - Oct 15 | Chinook spawning | 1500 | 95 | 3,000 through Sep 30, when possible | 5 |
| | Oct 16 - Jan 31 | Chinook incubation | 1200 [3] | 98 | | |
| | Feb 1 - Mar 15 | Rearing/adult migration | 1000 | 99.9 | | |
| | Mar 16 - May | Steelhead spawning | 1500 | 99.9 | 3,000 | 25 |
| | Jun 1 – Jul 15 | Steelhead incubation | 1200 [3] | 99.9 | | |
| | Jul 16 - Aug 31 | Rearing | 1000 | 99.9 | | |
| Foster | Sep 1 - Oct 15 | Chinook spawning | 1500 | 75 | 3,000 through Sep 30, when possible | 1 |
| | Oct 16 - Jan 31 | Chinook incubation | 1100 [3] | 80 | | |
| | Feb 1 - Mar 15 | Rearing | 800 | 95 | | |
| | Mar 16 - May | Steelhead spawning | 1500 | 80 | 3,000 | 30 |
| | May 16 - Jun 30 | Steelhead incubation | 1100 [3] | 95 | | |
| | Jul 1 - Aug 31 | Rearing | 800 | 99 | | |
| Blue River | Sep 1 - Oct 15 | Chinook spawning | 50 | 99.9 | | |
| | Oct 16 - Jan 31 | Chinook incubation | 50 | 99.9 | | |
| | Feb 1 - Aug 31 | Rearing | 50 | 99.9 | | |
| Cougar | Sep 1 - Oct 15 | Chinook spawning | 300 | 99.9 | 580 through Sep 30, when possible | 60 |
| | Oct 16 - Jan 31 | Chinook incubation | 300 | 99.9 | | |
| | Feb 1 - May 31 | Rearing | 300 | 99.9 | | |
| | Jun 1 - Jun 30 | Rearing/adult migration | 400 | 99.9 | | |
| | Jul 1 - Jul 31 | Rearing | 300 | 99.9 | | |
| | Aug 1 - Aug 31 | Rearing | 300 | 99.9 | | |

[1] When a reservoir is at or below minimum conservation pool elevation, the minimum outflow will equal inflow or the congressionally authorized minimum flows, whichever is higher.

[2] Maximum flows are intended to minimize the potential for spawning to occur in stream areas that might subsequently be dewatered at the specified minimum flow during incubation.

[3] The USACE will attempt to avoid prolonged releases in excess of the recommended maximum spawning season discharge to avoid spawning in areas that would require high incubation flows that would be difficult to achieve and maintain throughout the incubation period. When maximum flow objectives are exceeded for a period of 72 hours or longer, the WATER Flow Management Committee will review available monitoring information (e.g., regarding redd deposition in relation to flow rates), projected runoff, and reservoir storage, and will formulate a recommendation for an appropriate and sustainable incubation flow rate prior to the initiation of the subsequent incubation period.

[4] Flow duration estimates are based on HEC-ResSim model output data for the Biop operation. Period of Record of model data is Water Years 1936-2004.

## Environmental Regulatory Issues

In early 1999, the National Marine Fisheries Service (NMFS) listed Upper Willamette River Chinook salmon (*Oncorhynchus tshawytscha*) and the Upper Willamette River steelhead (*Oncorhynchus mykiss*) in the Santiam River basin and other upper Willamette River basins as threatened under the Federal Endangered Species Act (ESA). In 1993, the U.S. Fish and Wildlife Service (USFWS) listed the Oregon chub (*Oregonichthys crameri*) as endangered in Marion and Linn Counties, which includes the Santiam River basin. In 2010, the Oregon chub was reclassified from endangered to threatened. As a result of these listings, the USACE submitted its first Biological Assessment in 2000 and a supplemental Biological Assessment in 2007 for the Willamette River basin that included specific recovery plans for the Santiam River basin (U.S. Army Corps of Engineers, 2000, 2007).

In July 2008, NMFS released their decision on the Biological Assessment plans through a Willamette Project Biological Opinion (National Marine Fisheries Service, 2008a; 2008b). The USFWS also released a Biological Opinion for the Willamette River basin because they have jurisdiction over the Oregon chub (U.S. Fish and Wildlife Service, 2008). NMFS and the USFWS decided that the USACE Biological Assessment plans were insufficient for mitigating the effect of the water projects on critical habitat. The Biological Opinion ordered additional measures, which included improved fish passage, temperature control, and changes in downstream streamflows. The Biological Opinion includes flow-release targets for Big Cliff and Foster Dams for different seasonal life histories for the ESA-listed fish (table 3). The Biological Opinion also includes a measure for implementing environmental flow releases from the dams.

**Table 3.** Minimum and maximum streamflow objectives below Big Cliff and Foster Dams.
[Source: National Marine Fisheries Service, 2008]

These are same as Ref #1

| Period | Primary Use | Minimum flow ($ft^3/s$) | Maximum flow ($ft^3/s$) |
|---|---|---|---|
| **Big Cliff Dam** | | | |
| September 1–October 15 | Chinook spawning | 1,500 | 3,000 |
| October 16–January 31 | Chinook incubation | 1,200 | |
| February 1–March 15 | Chinook rearing/adult migration | 1,000 | |
| March 16–May 31 | steelhead spawning | 1,500 | 3,000 |
| June 1–July 15 | steelhead incubation | 1,200 | |
| July 16–August 31 | steelhead rearing | 1,000 | |
| **Foster Dam** | | | |
| September 1–October 15 | Chinook spawning | 1,500 | 3,000 |
| October 16–January 31 | Chinook incubation | 1,100 | |
| February 1–March 15 | Chinook rearing | 800 | |
| March 16–May 15 | steelhead spawning | 1,500 | 3,000 |
| May 16–June 30 | steelhead incubation | 1,100 | |
| July 1–August 31 | steelhead rearing | 800 | |

## Workshop Results

Flow recommendations focused primarily on the Middle Fork below Dexter dam and the mainstem Willamette above Springfield. Neither working group developed specific recommendations for operations/reaches on the Middle Fork below Fall Creek and Hills Creek dams. Groups did not develop specific flow recommendations for the Coast Fork Willamette, but noted that flow management does not alter flows in the Coast Fork to the degree observed in the Middle Fork. Relationships between flows and water quality issues, particularly temperature, did not receive as much attention as the groups and organizers felt warranted.

### Middle Fork Willamette River

The results of the two working groups were integrated into a single hydrograph, which is referred to as the "unified ecosystem flow recommendation" in this report. Critical components of the ecosystem flow recommendations include 1) small fall pulses, 2) winter bankfull flows, 3) small floods above current bankfull flows (2-yr to 10-yr regulated flows), 4) larger floods (2-yr to 10-yr unregulated flows), 5) spring pulse flows, 6) spring to summer transition flows, and 7) summer low flows. The components are identified in the hydrograph illustrated in Figure 8 and explained in greater detail below. Differences between the recommendations of the two groups, where they exist, are highlighted. Graphs from RPT are used to illustrate the ecosystem flow components.

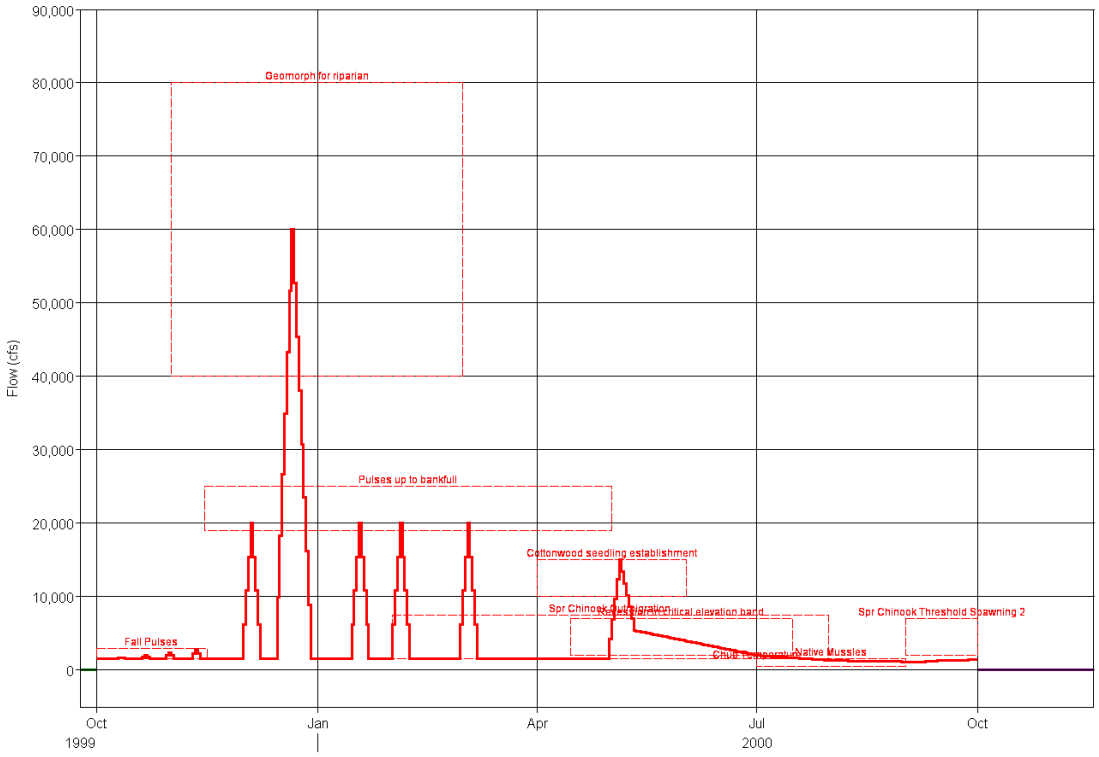


Figure 8. Unified Ecosystem Flow Recommendations for the Middle Fork Willamette River.

## Previous McKenzie River Basin Studies

In recent years, numerous research papers and reports have been published specific to hydrologic, ecological, and biological issues in the McKenzie and Willamette River basins. Stearns (1928), Ingrebritsen and others (1994), Manga (1997), Tague and Grant (2004), Jefferson and others (2006), and Tague and others (2007) discussed the geologic framework of the High Cascades in the upper McKenzie River basin and its relationship to spring-dominated streamflow. For more than 50 years, research on forest hydrologic, geomorphic, and ecological dynamics has been based on field data collected in the H.J. Andrews Experimental Forest, which is a Long-Term Ecological Research (LTER) site in the Lookout Creek basin (in the Blue River basin) (H.J. Andrews Experimental Forest, 2009).

In the 1990s, the USFS, BLM, and Weyerhaeuser produced a series of watershed analyses for various streams in the basin. Many of these studies were related to timber harvesting and its effects on fisheries and ecological habitat. These analyses included the lower and middle reaches of the McKenzie River (Bureau of Land Management, 1998a, 1998b), the upper McKenzie River basin (U.S. Forest Service, 1995), Blue River (U.S. Forest Service, 1996), Horse Creek (U.S. Forest Service, 1997), South Fork McKenzie River (U.S. Forest Service, 1994), Quartz Creek (Ecosystems Northwest, 1998), and the south and north sides of the lower McKenzie River basin (Weyerhaeuser, 1994, 1995).

A series of publications has resulted from the Federal Energy Regulatory Commission (FERC) relicensing applications for the EWEB projects (Eugene Water and Electric Board, 2008a, 2008b; Karl Morgenstern, Eugene Water and Electric Board, oral commun., 2009). The Walterville and Leaburg hydroelectric projects were relicensed by FERC in 1997, and those licenses will not expire until 2037. An outcome of the relicensing was implementing minimum streamflows of 1,000 $ft^3/s$ in the reaches of the McKenzie River where EWEB diverts as much as 2,500 $ft^3/s$ for its Leaburg power canal and 2,577 $ft^3/s$ for its Walterville power canal. The Carmen-Smith Hydroelectric Project Final License Application was submitted to FERC in November 2006 and a Settlement Agreement with 16 signatories was submitted in October 2008 (Stillwater Sciences, 2006a, 2006b; Eugene Water and Electric Board, 2008b). Because the Cougar and Blue River Dams are owned by a Federal agency (USACE) and not a power utility, they are not regulated under the FERC relicensing process.

Bull trout (*Salvelinus confluentus*) throughout the Klamath and Columbia River basins was listed as threatened by the U.S. Fish and Wildlife Service (USFWS) in 1998. In early 1999, the National Marine Fisheries Service (NMFS) listed spring Chinook salmon (*Oncorhynchus tshawytscha*) in the McKenzie River basin and other upper Willamette River basins as threatened. As a result of these listings, Endangered Species Act (ESA) consultations began between the Federal agencies whose operations were affecting the listed species (known as "Action Agencies") and the NMFS and USFWS (known as the "Services"). During an ESA consultation, the Action Agencies are required to create Biological Assessments (BA), which are submitted to the Services. The BA also includes a proposed recovery plan that outlines how the Action Agency will reduce its effect on the critical habitat of the listed species. In the Willamette ESA consultation, the Action Agencies include the USACE, Bonneville Power Administration, and Bureau of Reclamation. The USACE submitted its first BA in 2000 and a supplemental BA in 2007 for the Willamette River basin that included specific recovery plans for the McKenzie River basin (U.S. Army Corps of Engineers, 2000, 2007). In July 2008, NMFS released their decision on the BA plans through a Willamette Project Biological Opinion (National Marine Fisheries Service, 2008a, 2008b). NMFS decided that the BA plans were insufficient for mitigating the effect of the water projects on critical habitat. The Biological Opinion ordered additional measures, which included improved fish passage, temperature control, and changes in downstream streamflows. Included in the Biological Opinion are flow release targets for Cougar and Blue River dams for different seasonal life histories for the ESA-listed fish (table 4).

**Table 4.** Minimum and maximum streamflow objectives below Blue River and Cougar Dams, McKenzie River, Oregon.

[Data from National Marine Fisheries Service (2008b). **Abbreviations**: $ft^3/s$, cubic feet per second; –, no data]

| Period | Primary use | Streamflow ($ft^3/s$) | |
|---|---|---|---|
| | | Minimum | Maximum |
| Blue River Dam | | | |
| September 1 – October 15 | Chinook spawning | 50 | – |
| October 16 – January 31 | Chinook incubation | 50 | – |
| February 1 – August 31 | Rearing | 50 | – |
| Cougar Dam | | | |
| September 1 – October 15 | Chinook spawning | 300 | 580 |
| October 16 – January 31 | Chinook incubation | 300 | – |
| February 1 – May 31 | Rearing | 300 | – |
| June 1 – June 30 | Rearing/adult migration | 400 | – |
| July 1 – July 31 | Rearing | 300 | – |
| August 1 – August 31 | Rearing | 300 | – |

These are same as Ref #1

and upstream migrating adult Chinook. However, NMFS noted that additional data are needed to better define fish flow needs in the mainstem Willamette. This measure gives the Services approval authority over any proposed changes in the flow objectives. In the event that the RM&E studies required by measure 9 in section 9.9 indicate that different flow objectives should be established, the Action Agencies and NMFS would work together to identify flow objectives that protect ESA-listed fish species and their critical habitats.

**Table 9.2-1 Mainstem Willamette Flow Objectives for "Adequate" & "Abundant" Years.[1]**

| TIME PERIOD | 7-DAY MOVING AVERAGE [2] MINIMUM FLOW AT SALEM (CFS) USGS 141910004 | INSTANTANEOUS MINIMUM FLOW AT SALEM (CFS) USGS 14191000 | MINIMUM FLOW AT ALBANY (CFS) [3] USGS 141740005 |
|---|---|---|---|
| April 1 - 30 | 17,800 | 14,300 | --- |
| May 1 - 31 | 15,000 | 12,000 | --- |
| June 1 - 15 | 13,000 | 10,500 | 4,500 [3] |
| June 16 - 30 | 8,700 | 7,000 | 4,500 [3] |
| July 1 - 31 | --- | 6,000 [3] | 4,500 [3] |
| August 1 - 15 | --- | 6,000 [3] | 5,000 [3] |
| August 16 - 31 | --- | 6,500 [3] | 5,000 [3] |
| September 1 - 30 | --- | 7,000 [3] | 5,000 [3] |
| October 1 - 31 | --- | 7,000 | 5,000 |

[1] Appendix D defines "Adequate" and "Abundant" water years, and also describes how flow objectives can be decreased in "Deficit" water years.
[2] An average of the mean daily flows in cubic feet per second (cfs) observed over the prior 7-day period.
[3] Congressionally authorized minimum flows (House Document 531). September flows were extended into October.
4 USGS gage 14191000 Willamette River at Salem, OR
[5] USGS gage 14174000 Willamette River at Albany, OR

*2.4* **Tributary Flow Objectives –Project Release Minimums: The USACE will operate Willamette project dams as described in this subsection to meet or exceed minimum tributary flow objectives listed in Table 9.2-2 to ensure adult fish access to existing spawning habitat below USACE dams, protect eggs deposited during spawning, and provide juvenile rearing and adult holding habitat for listed salmonids and other fishes within system constraints described in Appendix D. If, during annual operations, the system of Willamette Projects is unable to meet both mainstem and tributary flow objectives, the Action Agencies will notify NMFS and will coordinate through WATER to determine a suitable course of action to protect priority fish habitat needs. Consistent with Appendix D, USACE will operate to meet interim draft limits.**

***Rationale/Effect of RPA 2.4:*** This measure is based on a similar action described in section 3.3.6 of the Supplemental BA (USACE 2007a). The minimum and maximum tributary flow objectives are the same as in the Proposed Action. NMFS also recognizes that it will not be possible to meet these flow objectives under all hydrologic conditions.