WATER RESOURCES IMPACT

WILLAMETTE RIVER, OREGON: MOVING TOWARD BASIN-WIDE FLOW AND FLOODPLAIN RESTORATION

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INTRODUCTION

Over the last 50 years, river management has evolved from an emphasis on economic outputs to one that includes consideration of broader human values. Agencies and organizations are "retooling" to account for the changing paradigm, and new and expanded partnerships are forming to meet multiple, and sometimes conflicting, goals. In Oregon's Willamette River Basin, managers and interest groups are using innovative scientific and decision-making approaches to seek this balance. This article describes a process for developing strategies to improve flow regimes and floodplain function in the Willamette Basin. The process is founded on unique partnerships, collaborative approaches for synthesizing scientific information and developing environmental flow recommendations, and an adaptive and integrative framework for implementing these changes.

THE WILLAMETTE RIVER BASIN AND THE RESERVOIR SYSTEM

The Willamette River is the largest river system in Oregon and the 13th largest river, by volume, in the conterminous United States. The mainstem river is 180 miles long and there are over 11,000 miles of streams and rivers within the basin. The river is vital and literally central to the region: 19 cities and towns, including the three largest population centers in Oregon – Portland, Salem, and Eugene-Springfield – are situated along, or near, the banks of the Willamette River and its tributaries. Nearly 70 percent of all Oregonians live within 20 miles of the river.

The Willamette Basin is home to a rich diversity of native fauna and flora including 31 fish, 18 amphibians, 15 reptile, 154 bird, and 69 mammal species (Hulse *et al.,* 2002). The river and its tributaries support important runs of anadromous and resident fish including salmon, steelhead, and trout. The basin's floodplains and wetlands provide habitat for the Oregon Chub, the western pond turtle, Fender's blue butterfly, and many sensitive plant species. The Willamette Valley's location on the Pacific flyway makes it an important area for migrating and wintering waterfowl.

The U.S. Army Corps of Engineers (Corps) operates 13 dams in the Willamette Basin - 11 multiple purpose storage reservoirs and 2 regulating reservoirs. All 13 of the dams are located on major tributaries; there are no Corps dams on the mainstem Willamette River. The dams are operated as a system (Figure 1), with flood damage reduction a primary purpose. Hydropower, navigation, irrigation, municipal and industrial water supply, recreation and flow augmentation for fish, wildlife, and water quality are also authorized purposes. In total, the dams control flows on six major tributaries affecting approximately 27 percent of the total geographic area of the basin and 42 percent of the upper basin above Salem. Operation of the dams has changed the volume and timing of water flow in the river, resulting in reduced peak flows, increased low flows, and limited natural flooding events (Figure 2).

Restoration and conservation of riverine resources will require addressing several other challenges including water temperature control and fish passage at the dams, point-source and nonpoint-source discharge to the rivers, hatchery management, and upland and urban impacts

Modifications to river flow and water temperature, and loss of channel and floodplain habitat, have contributed to the decline of native fish populations. Of the 31 native fish species that occur in the basin, seven are listed by the Federal or state government as endangered, threatened, or sensitive. In 1999, following Federal Endangered Species Act listings of Chinook salmon and winter steelhead, the Corps began implementing changes in Willamette system operations to better meet the flow requirements of the listed species. An Interagency Flow Management Workgroup consisting of approximately 20 Federal, state, and local entities, recommended flow targets in the mainstem river to assist migration of Chinook and steelhead salmon. A critical and important first step, these targets only addressed listed fish species and did not consider impacts to flow in the tributaries, key areas for spawning and rearing. Additional efforts are now focused on providing tributary flows to meet habitat requirements for fish and other aquatic species.

The system of 13 Corps dams on six major tributaries offers a relatively high degree of operational flexibility. The Corps is able to use different combinations of reservoir fill and release to meet both mainstem river and tributary flow requirements, balancing the life cycle needs of multiple aquatic species with other operating purposes. The complex system of reservoirs allows the Corps to account for year to year variability in hydrologic conditions across the major subbasins. To utilize this flexibility most effectively, managers need more information on the flow requirements of native species and communities.

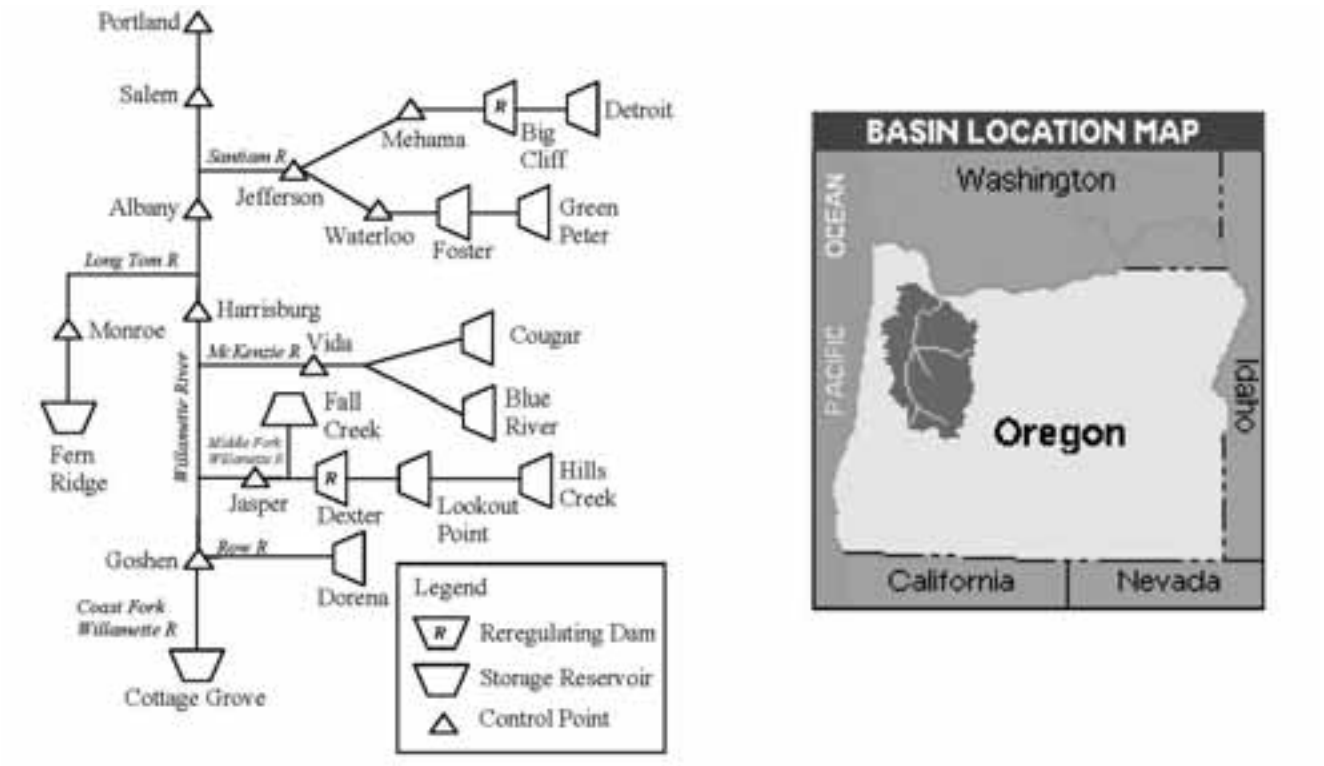

Figure 1. Map of Willamette Bsin and Schematic of Willamette Reservoir System.

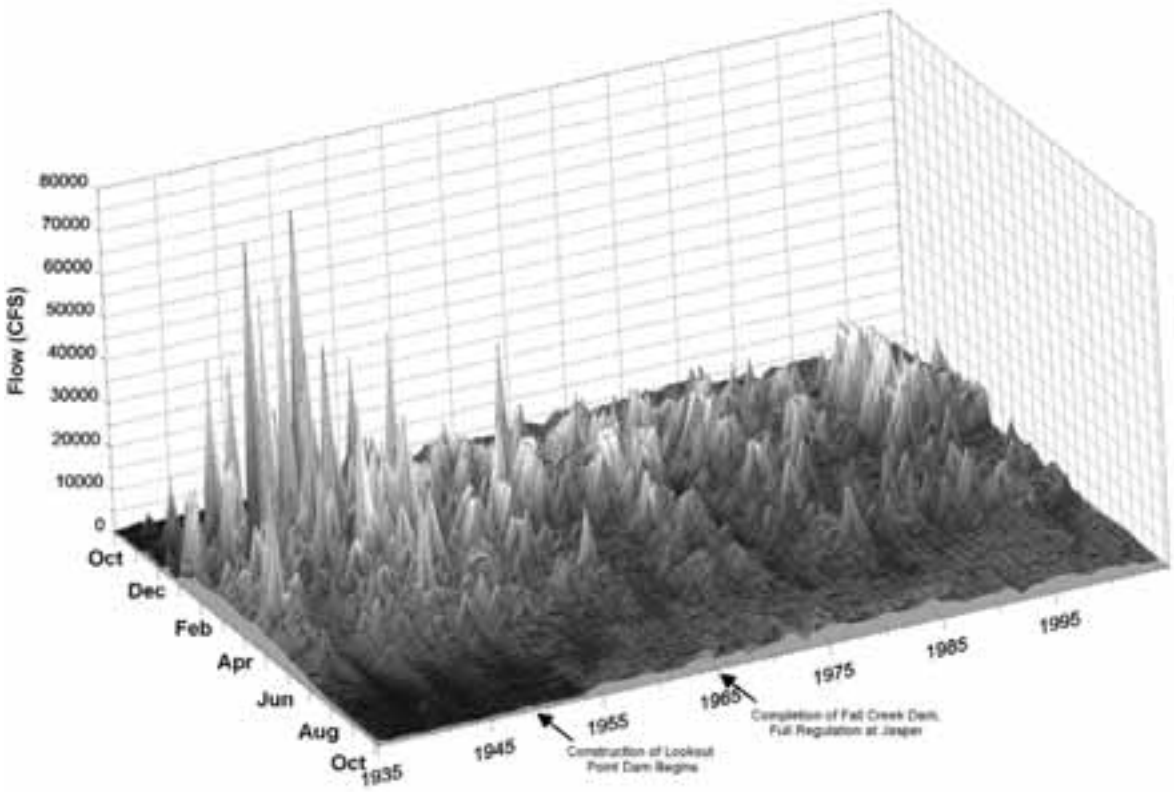

Figure 2. Graph Showing Changes in Observed Flow on the Middle Fork River at Jasper, Oregon, Following Construction of Lookout Point and Falls Creek Dams.

UNDERSTANDING THE SCIENCE: DEVELOPING ENVIRONMENTAL FLOW RECOMMENDATIONS

In 2006, The Nature Conservancy (TNC) and the U.S. Corps of Engineers (Corps) launched a project to determine environmental flow requirements for the Willamette River and its tributaries, and to design and test alternative flow releases from the dams that can meet these requirements without compromising the other purposes of the dams. As part of the Sustainable Rivers Project – a national partnership between TNC and the Corps – the Willamette is one of nine demonstration sites around the United States where scientists are addressing environmental flows and floodplain mangement (see article by Andrew Warner in this issue). The work expands upon the flow targets established by the Interagency Flow Management Workgroup by integrating information on additional species and communities, and by considering flow targets in the tributaries.

Initial efforts are focused on a pilot study in the Middle and Coast Fork subbasins of the Willamette River, which contain 6 of the 13 Corps dams in the basin. In conjunction with the flow study, these tributaries are currently the focus of an ongoing study to identify opportunities to restore natural floodplain function and promote ecosystem restoration, natural flood storage and other benefits.

In January 2007, the TNC and the Corps brought together leading biologists, hydrologists, and engineers from numerous state and Federal agencies, academic institutions, and nongovernmental organizations to develop environmental flow recommendations for the Middle and Coast Forks. The workshop discussions were informed by a literature review and summary report on the flow requirements of key species and ecological processes in the Willamette Basin compiled by the Institute for Water and Watersheds at Oregon State University (Gregory *et al.,* 2007) as well as information on channel dynamics and floodplain morphology. A key tool utilized during the flow workshop was the Regime Prescription Tool (RPT), a graphical interface developed jointly by TNC and the Corps designed to help workshop participants visualize streamflow data and proposed environmental flow recommendations (see article by John Hickey in this issue). The workshop resulted in recommendations for specific environmental flow components, including summer low flows, winter bankfull flows, and fall and spring pulse flows, to meet key ecosystem functions (Figure 3). Workshop participants defined these flow components in terms of magnitude, duration, frequency, and rate of change.

MAKING IT WORK: IMPLEMENTING ENVIRONMENTAL FLOW RECOMMENDATIONS

The flow recommendations generated through the literature review and workshop process can be grouped into three categories for implementation: (1) flow volume and timing adjustments that are within the operational flexibility of the Corps under current project authorizations and water control manuals; (2) larger scale adjustments that may fall within current operational flexibility and authority but will require more detailed evaluation of

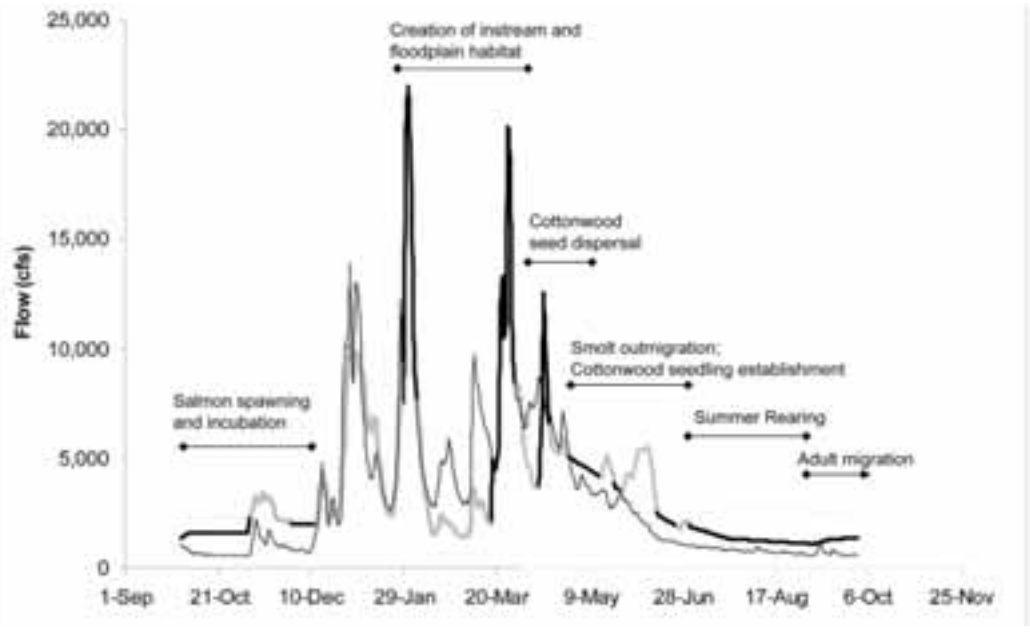

Figure 3. Example of How the Hydrograph of a Single Year, Water Year 2003, Could be Modified to Meet the Recommendations of the Flow Workshop. A hydrograph consistent with the recommendations, represented by the thick line, consists of flows already provided by the managed hydrograph (gray line) and modifications to the managed flows required to meet the recommendations (black line). The thin, dashed gray line shows the managed hydrograph during those periods where the recommended hydrograph departs from the managed hydrograph. The thin, solid black line shows the unregulated hydrograph for that water year.

tradeoffs; and (3) major changes in operation which are clearly outside of the Corps' operational discretion and would require a thorough feasibility evaluation and possible reauthorization action. The recommendations falling into Category (1) are currently being integrated into the 2007 Willamette Conservation Plan (WCP), which guides reservoir operations during the conservation storage and release season. The Corps hopes to be able to implement some of the recommendations, including pulsed flow releases up to bankfull, during annual reservoir drawdown in fall 2007, and again during spring refill in 2008. Monitoring and evaluation will be critical to determining the success of these initial flow recommendations. Computer modeling and field monitoring will be conducted to evaluate the response of the ecosystem to flow changes and will be used to adaptively adjust dam operations as needed.

Category 2 and Category 3 recommendations will require more thorough modeling and evaluation of different alternatives on downstream volume and timing of flows and on reservoir refill and storage conditions before they can be implemented. One example of these kinds of recommendations is small-scale flood-like events over bankfull limits. The Corps may also need to complete decision documents, environmental compliance, and public review under the National Environmental Policy Act prior to implementing these actions.

Community participation is a critical element of the process. With large population centers located along the river, restoring environmental flows and floodplain function will be challenging. In addition, the dams provide a variety of goods and services, including energy production that does not contribute to greenhouse gas emissions, and major recreational opportunities. These issues cannot be fully addressed through the flow management process, and will require further assessment by state and local governments and stakeholders. At the onset of the flow management project, a meeting was held to inform key stakeholders about the project. The meeting was attended by 86 individuals representing 34 entities, including city and county governments, state and federal agencies, and river-related organizations. Continued participation by this stakeholder group will be essential for successful implementation.

Flow and floodplain restoration are only part of the solution. Restoration and conservation of riverine resources will require addressing several other challenges including water temperature control and fish passage at the dams, point-source and nonpoint source contaminant discharge to the rivers, hatchery management, and upland and urban impacts. Despite the uncertainties and challenges, a diverse group of partners is committed to working together to develop flow regimes that can balance multiple goals, and then to implement, learn from, and adapt the flow targets as one step in restoration of the Willamette River.

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