Biological Assessment on Continued Operation and Maintenance of the Deschutes River Basin Projects and Effects on Essential Fish Habitat under the Magnuson-Stevens Act

Deschutes, Crooked River, and Wapinitia Projects

U.S. Department of the Interior
Bureau of Reclamation
Pacific Northwest Region

Lower Columbia Area Office
Portland, Oregon

Pacific Northwest Regional Office
Boise, Idaho

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U.S. DEPARTMENT OF THE INTERIOR

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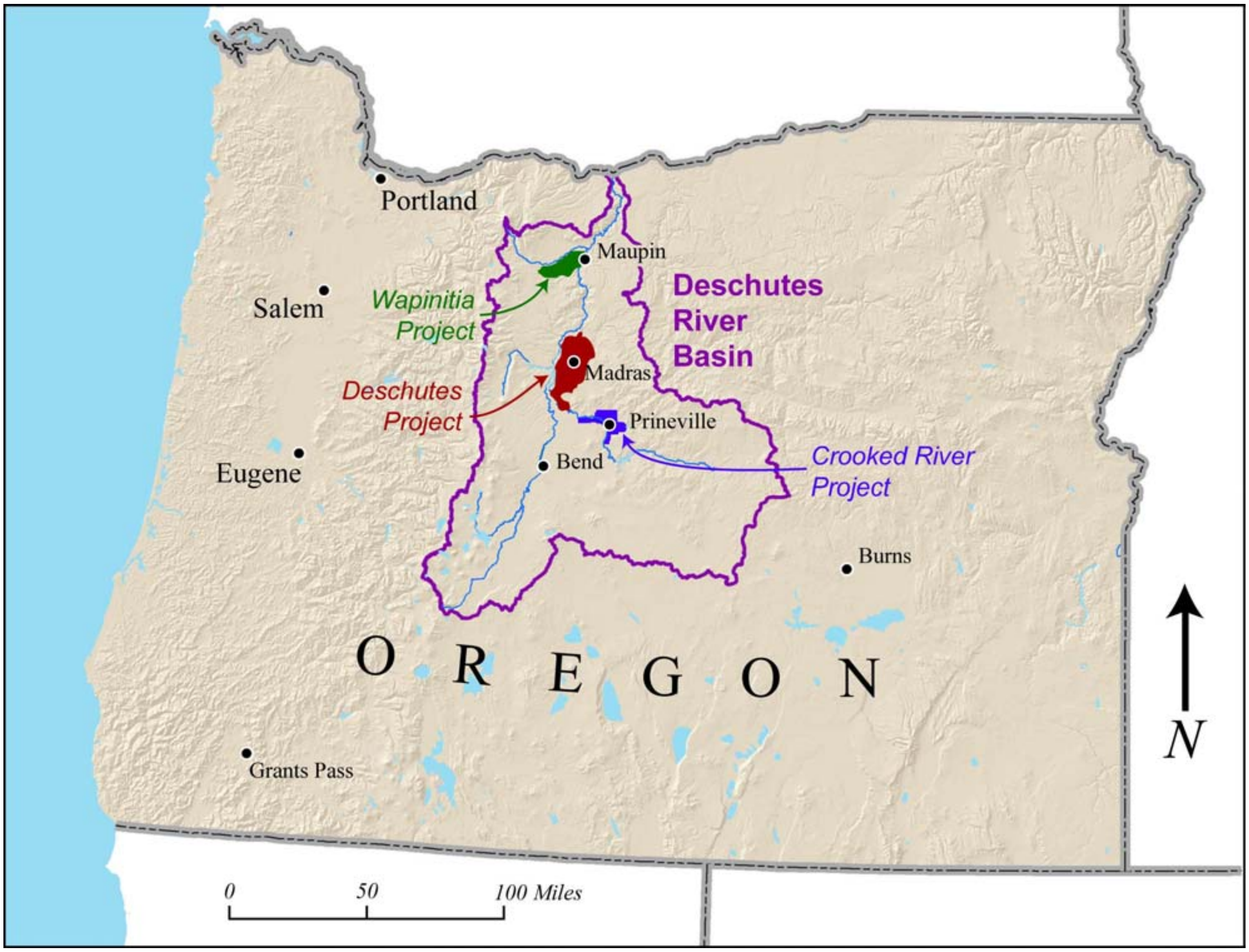

Deschutes River Basin, Reclamation Projects

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SELECTED LIST OF ACRONYMS

BA	Biological Assessment
BE	Biological Evaluation
BiOp or BO	Biological Opinion
BLM	Bureau of Land Management
BPA	Bonneville Power Administration
CCID	Crook County Irrigation District
Cfs	Cubic Feet Per Second
CHU	Critical Habitat Units
COID	Central Oregon Irrigation District
Corps	U.S. Army Corps of Engineers
CTWSRO	Confederated Tribes of the Warm Springs Indian Reservation of Oregon
DRC	Deschutes Resources Conservancy
EA	Environmental Assessment
EFH	Essential Fish Habitat
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FCRPS	Federal Columbia River Power System
JFDIC	Juniper Flats District Improvement Company
LAU	Lynx Analysis Unit
LCAS	Lynx Conservation Agreement and Strategy

MCR	Middle Columbia River
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NUID	North Unit Irrigation District
O&M	Operation and Maintenance
ODEQ	Oregon Department of Environmental Quality
ODFW	Oregon Department of Fish and Wildlife
OID	Ochoco Irrigation District
OSU	Oregon State University
OWRD	Oregon Water Resources Department
PBERP	Pacific Bald Eagle Recovery Plan
PFMC	Pacific Fishery Management Council
PGE	Portland General Electric
Reclamation	U.S. Bureau of Reclamation
RM	River Mile
TMDL	Total Maximum Daily Loads
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

CHAPTER 1.0 OVERVIEW

1.1 PURPOSE OF BA

This BA describes Reclamation's proposed hydrologic operations and maintenance activities for Federal Reclamation projects in the Deschutes River basin, including the Deschutes, Crooked River, and Wapinitia Projects (Figure 1-1). This document also analyzes the effects of these proposed actions on species listed under the ESA.

Reclamation is submitting this BA pursuant to Section 7(a)(2) of the ESA to the USFWS and the NMFS to ensure that the proposed action is not likely to jeopardize the continued existence of listed species. Under the relevant regulation, the "contents of a biological assessment are at the discretion of the Federal agency and will depend on the nature of the Federal action" [50 CFR § 402.12 (f)].

In addition, this BA also addresses potential effects on EFH as required under the Magnuson-Stevens Fishery Conservation and Management Act (as amended by the Sustainable Fisheries Act of 1996 [Public Law 104-267]) (see Chapter 9). The EFH is evaluated for the following Deschutes River basin salmon stocks:

- Spring Chinook salmon
- Summer/fall Chinook salmon
- Coho salmon

1.2 PROPOSED ACTION

Reclamation's proposed action is the continued operation and maintenance of Reclamation project facilities throughout the Deschutes River basin as described in Chapter 2. Subsequent consultations will be initiated if significant changes are anticipated in future project O&M procedures, additional listings of species occurs within the Deschutes River basin potentially affected by O&M activities, or other criteria described in 50 CFR 402.16 apply.

The Reclamation dam and reservoir system in the Deschutes River basin is operated to meet specific project authorized purposes such as irrigation water supply, flood control, fish and wildlife, recreation, and other functions. To accommodate the annual variation in water supply and demands, project operations are tailored to assure that public safety requirements are satisfied (including flood prevention) and that water delivery contractual obligations are met (irrigation). Irrigation operations and flood control management are generally considered to be primary operations and represent a priority in terms of how dams and reservoirs are operated. Irrigation water delivery and flood control procedures require continuous water management adjustments and include many system operating considerations. Nonetheless, other management decisions can be implemented by river and dam operators on a daily basis as long as authorizations and legal constraints are met.

1.3 ACTION AREA

This BA covers specific river, tributary, and reservoir reaches in the Deschutes River basin from headwater reservoirs to the Deschutes River's confluence with the Columbia River. Two of the three Reclamation projects covered in this BA are located in the upper Deschutes basin above Lake Billy Chinook. The third irrigation project is located in the lower Deschutes basin. The frontispiece depicts the Deschutes River basin and the general location of Reclamation projects included in this ESA Section 7 consultation.

Evaluation of ESA-listed species for this BA focuses on the aquatic and terrestrial environments that may be influenced by the O&M of Reclamation water storage and diversion facilities.

In December 1999, Reclamation, the BPA, and the Corps (the action agencies) submitted a BA to NMFS and USFWS that covered updated FCRPS operations, including the hydrological effects to the Columbia River from O&M of several Reclamation irrigation projects. The Deschutes River basin projects are included in the FCRPS consultation. Consequently, the flow impacts of the Deschutes River basin projects are factored into the FCRPS consultations.

1.4 SUMMARY OF THE SECTION 7 ESA CONSULTATION PROCESS

Reclamation began this Section 7 ESA consultation in February 2000 by requesting a listing of threatened and endangered species from the NMFS and USFWS. Reclamation later requested an updated ESA list in February 2001 and again in June 2002. Throughout this process Reclamation has met and communicated with NMFS and USFWS, as well as irrigation districts, the Tribes, and numerous Federal and state agencies (including the USFS, BLM, USGS, ODFW, ODEQ, and OWRD), to seek input and review information. A preliminary draft BA was distributed for review and comment to NMFS, USFWS, and the irrigation districts in July 2001. The proposed action was reevaluated and revised, resulting in revision of the preliminary draft BA.

Deschutes River Basin

Reclamation Projects

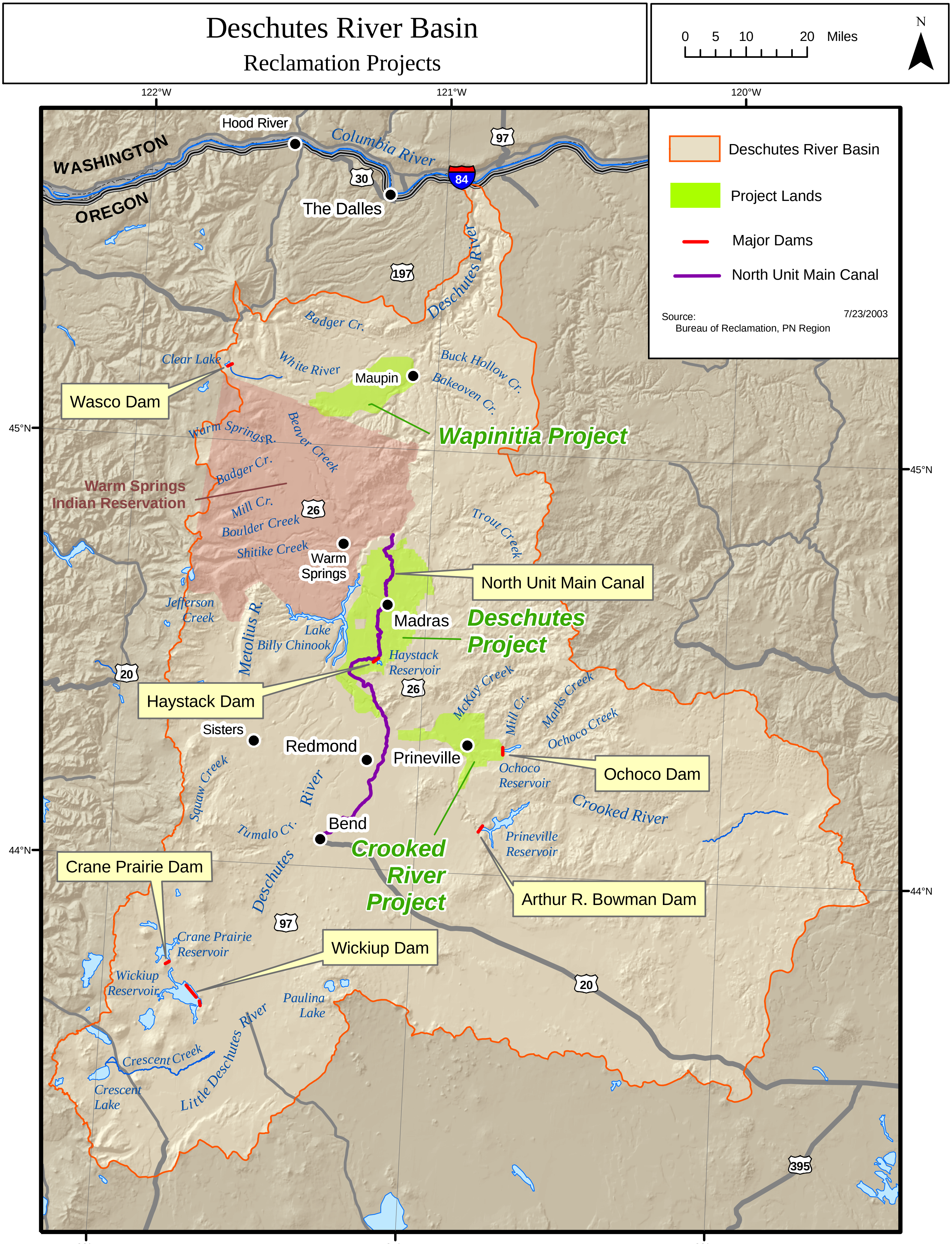


Figure 1-1

The following summarizes the timeline and contacts made between Reclamation, NMFS, and USFWS leading up to the development of this current final BA (September 2003). This September 2003 BA supercedes the July 2001 preliminary draft BA.

August 22, 2001	Written comments on preliminary draft BA received from NMFS.
October 3, 2001	Written comments on preliminary draft BA received from USFWS.
October 23, 2001	Meeting with NMFS and USFWS to discuss comments on preliminary draft BA.
January 25, 2002	Conference call with USFWS to discuss status of ESA consultation and proposed action description.
March 18, 2002	Meeting with USFWS to discuss status of ESA consultation.
July 23, 2002	Meeting with NMFS and USFWS to describe the proposed action and operations at the three Deschutes River basin projects: Deschutes, Crooked River, and Wapinitia Projects.
September 10, 2002	Meeting with NMFS and USFWS to discuss draft environmental baseline sections.
October 22, 2002	Reclamation and USFWS meeting with CTWSRO to discuss ESA consultation.
November 19, 2002	Meeting with NMFS and USFWS to discuss draft proposed action chapter and modeled hydrologic effects analysis.
January 8, 2003	Conference call with NMFS and USFWS to further discuss the draft proposed action chapter and the modeled hydrologic effects analysis.
February 6, 2003	Conference call with NMFS and USFWS to discuss ESA consultation status.
February 26, 2003	Written comments on draft proposed action and hydrologic effects analysis received from USFWS.
June 16, 2003	Reclamation response to USFWS written comments on draft proposed action and hydrologic effects analysis sent to USFWS.

1.4.1 Previous ESA Consultations

Reclamation has consulted under Section 7 of ESA for various projects, programs, activities, and funding assistance in the Deschutes River basin that may have had direct or indirect effects on listed threatened and endangered species and their critical habitats, as applicable (Table 1-1). These projects have included:

- Safety of dams construction activities
- Habitat enhancement projects
- Resource management plans
- Water conservation demonstration projects
- Geological investigations

These actions, as implemented, are part of the environmental baseline for this consultation in the project area. A few Section 7 consultations have also been documented in environmental assessments (EA) or categorical exclusion checklists where there were either no effects or no adverse effects on listed species. Table 1-1 is a partial list of Section 7 ESA consultations that have occurred since 1991.

Table 1-1. Partial List of Previous ESA Section 7 Consultations for Reclamation Actions in the Deschutes River Basin

Project Name and (Document)	Listed Species	Consultation Results	Service's Determination
Upper Deschutes River Basin Water Conservation Project (Informal Consultation 1991)	Bald Eagle Peregrine Falcon	No Effect	Informal Consultation - no written response
Arthur R. Bowman Safety of Dams Program, Crooked River Project (BA 1991)	Bald Eagle	No Effect	USFWS March 1, 1991 – Concurrence
Prineville Reservoir Resource Management Plan, Crooked River Project (BA 1992)	Bald Eagle Peregrine Falcon	No Effect	USFWS March 10, 1992 – Concurrence
Ochoco Safety of Dams Program, Crooked River Project (BA 1993)	Bald Eagle	No Effect	No response
On-farm Water Conservation Demonstration Project in Upper Deschutes Basin (Informal Consultation 1993)	Bald Eagle Peregrine Falcon	No Effect	Informal Consultation - no written response
Deschutes River Basin Water Conservation Demonstration Project (Informal Consultation 1996)	Bald Eagle Peregrine Falcon	No Effect	Informal Consultation - no written response
Geological Investigation at Wickiup Dam (BE 1998)	Bald Eagle	No Effect	Informal Consultation - no written response

Project Name and (Document)	Listed Species	Consultation Results	Service's Determination
Wasco Safety of Dams Program, Wapinitia Project (BA 1999)	Bald Eagle Peregrine Falcon N. Spotted Owl	No Adverse Effect	USFWS April 15, 1999 – Concurrence
Bend Feed Canal Pipeline Replacement, Tumalo Irrigation District (EA 2000)	Bald Eagle Bull Trout	No Effect	No response
Juniper Flats No-Till – DRC* (Informal Consultation 2000)	Steelhead	No Effect	NMFS Feb. 8, 2000 – Concurrence
Macks Canyon – DRC* (Informal Consultation 2000)	Steelhead	No Adverse Effect	NMFS Feb, 24, 2000 – Concurrence
Ten Mile Creek Riparian Fencing – DRC* (Informal Consultation 2000)	Steelhead Bald Eagle	No Adverse Effect No Effect	NMFS May 30, 2000 – Concurrence
Trout Creek Infiltration Gallery - DRC (BA 2000)*	Steelhead Bald Eagle	No Adverse Effect	NMFS June 9, 2000 – Concurrence USFWS - informal response – Concurrence
Rhode Infiltration Gallery - DRC (Informal Consultation 10/00)*	Steelhead	No Adverse Effect	NMFS - informal response – Concurrence
NUID Supplemental Irrigation Water, Crooked River Project (Informal Consultation 2001)	Steelhead Bald Eagle Bull Trout	No Adverse Effect	NMFS - informal response – Concurrence USFWS – no record of response
Higgins Creek – DRC (Informal Consultation 2001)*	Steelhead EFH	No Effect No Effect	No response
Wickiup Safety of Dams Modification, Deschutes Project (EA/BA 2000)	Bald Eagle Canada Lynx Oregon Spotted Frog, a candidate species	No Adverse Effect Adverse Effect, mitigation provided	USFWS August 4, 2000 – Concurrence
Prineville Reservoir Resource Management Plan, Crooked River Project (EA/BA 2003)	Bald Eagle Canada Lynx Oregon Spotted Frog, a candidate species	No Adverse Effect No Effect No Effect	USFWS May 5, 2003 – Concurrence

***** Project partially funded by Reclamation.

BA = Biological Assessment; **BE** = Biological Evaluation; **EA** = Environmental Assessment; **DRC** = Deschutes Resources Conservancy

1.4.2 Future Consultations

It is likely that Reclamation will continue to evaluate, seek funding for, and implement projects, programs, and activities within the Deschutes River basin similar to those displayed in Table 1-1. Reclamation will continue to pursue those actions that will meet contractual obligations, water management goals, and facility O&M needs in the Deschutes River basin.

As specific actions are identified, Reclamation will continue to comply as required with the consultation requirements of Section 7 of ESA.

1.5 ESA-LISTED SPECIES EVALUATED IN THIS BA

This ESA consultation determines the effects of the proposed action on species listed as threatened or endangered under the ESA. NMFS and USFWS most recently provided lists of ESA listed, proposed, and candidate species and species of concern by return letters dated July 3, 2002 and June 28, 2003 (see Appendix A). The lists contain species that are potentially present in the action area or potentially affected by Reclamation water operations in the Deschutes River basin. ESA-listed species evaluated in this BA include:

- Bald eagle, a threatened species
- Bull trout, a threatened species
- Middle Columbia River steelhead, a threatened species
- Canada lynx, a threatened species
- Northern spotted owl, a threatened species

1.6 ARRANGEMENT OF THIS BA

The arrangement of this BA starts with an overview and proceeds with a discussion of the proposed action, description of the environmental baseline, analysis of the effects of Reclamation actions, and an appendix of information. The focus of each chapter is summarized below:

- Chapter 1 provides background and sets the stage for the ESA Section 7 consultation.

- Chapter 2 describes the proposed action, which is continuing current ongoing O&M of Federal Reclamation project facilities in the Deschutes River basin.

- Chapter 3 discusses the existing and historic hydrologic conditions and a general history of irrigation development in the Deschutes River basin.

- Chapter 4 provides information on ESA-listed species potentially affected by the proposed action.
- Chapter 5 provides information on the environmental baseline, including past and present impacts of all Federal, state, or private actions and other human activities in the action area to ESA-listed species.
- Chapter 6 discusses the effects of the proposed action on the various ESA-listed species and any designated habitat.
- Chapter 7 discusses the cumulative effects of future non-Federal, state, or private activities that are reasonably certain to occur within the action area.
- Chapter 8 provides a summary of the proposed action effects including a determination for each species.
- Chapter 9 is Reclamation's evaluation of the proposed action effects on essential fish habitat.
- Chapter 10 is a list of literature cited.

CHAPTER 2.0
DESCRIPTION OF PROPOSED ACTION

2.1 INTRODUCTION

This chapter provides information and references materials that describe the proposed action. The proposed action is the continuance of the current O&M programs for Reclamation project facilities in the Deschutes River basin. Reclamation projects included in this consultation are the Deschutes Project in the upper Deschutes River basin; the Crooked River Project in the Crooked River subbasin; and the Wapinitia Project located in the White River subbasin, tributary to the lower Deschutes River. The *Operations Description of the Deschutes River Basin Projects* report (Reclamation 2003a) provides a comprehensive description of Project operations and hydrologic conditions.

2.1.1 Federal Facilities Included in the Proposed Action

A list of storage and diversion facilities associated with the three projects is provided in Table 2-1. Not all of the facilities listed in Table 2-1 are included in the proposed action. Reclamation holds title to only some of the diversion facilities within the Federal Reclamation projects; water rights related to most of the Federal facilities are primarily held by the respective irrigation districts. The Oregon State Watermaster oversees the delivery of water from these facilities according to existing water rights and consistent with state water law. Further, actual day-to-day operations are conducted by the primary irrigation districts associated with these Federal projects.

This consultation involves O&M activities associated with those facilities for which Reclamation has authority to operate, largely defined by Reclamation ownership. Storage, diversion, and delivery facilities comprising the proposed action include:

Deschutes Project

- Crane Prairie Dam and Reservoir
- Wickiup Dam and Reservoir
- Haystack Dam and Reservoir
- North Unit Headworks and Main Canal
- Distribution system for NUID project lands

Crooked River Project

- Bowman Dam and Prineville Reservoir
- Crooked River Diversion Dam and Feed Canal
- Crooked River Distribution Canal
- Barnes Butte and Ochoco Relift Pumping Plants
- Nine small pumping plants and associated canals

Wapinitia Project

- Wasco Dam and Clear Lake

Other facilities associated with the Federal Reclamation projects are owned, operated, and maintained by the irrigation districts or other parties. Reclamation has no authority in directing operations associated with these private facilities. Limited actions associated with these facilities are interrelated and interdependent to the proposed action in this consultation and include:

- Diversion of Crane Prairie Reservoir storage water by Arnold, Central Oregon, and Lone Pine Irrigation Districts
- Diversion of natural flow water into the North Unit Main Canal by NUID
- Diversion of water from the Crooked River by NUID's Crooked River Pumping Plant
- Storage, flood control operations, release, and diversion of Ochoco Reservoir storage water by OID
- Diversion of natural flow from the Crooked River by the Crooked River Diversion Dam
- Conveyance of Prineville Reservoir storage water into diversion facilities owned by OID
- Diversions of Prineville Reservoir storage water by privately-owned canals, including Rice Baldwin, Central Ditch, Lowline Ditch, and People's Ditch
- Diversion of Clear Lake storage water by JFDIC's Clear Creek Diversion.

Table 2-1. Major Facilities Associated with Federal Projects in the Deschutes River Basin

Facility	Ownership	Stream	Year Constructed or Rehabilitated	Entity Responsible for O&M	Comments
DESCHUTES RIVER PROJECT					
Crane Prairie Dam and Reservoir	United States	Deschutes River	1940	COID (Transferred)[1]	55,300 acre-feet active storage
Wickiup Dam and Reservoir	United States	Deschutes River	1949	NUID (Transferred)	200,000 acre-feet active storage
Haystack Dam and Equalizing Reservoir	United States	Off-stream	1957	NUID (Transferred)	5,600 acre-feet active storage
Arnold Diversion Dam and Canal	Arnold ID	Deschutes River	1951	Arnold ID	Diverts Deschutes River water comprised of storage from Crane Prairie Reservoir and privately-held natural flow water rights.
Central Oregon Diversion Dam and Canal	COID	Deschutes River	1900	COID	Diverts Deschutes River water comprised of storage from Crane Prairie Reservoir and privately-held natural flow water rights.
North Canal Dam	Private	Deschutes River	1912-1914		Private - Owner not established
North Unit Headworks and Main Canal	United States	Deschutes River	1949	NUID (Transferred)	Diverts Deschutes River water comprised of storage from Wickiup Reservoir and privately-held natural flow water rights.
North Canal Diversion Dam and Pilot Butte Canal	COID	Deschutes River	1900	COID	Diverts Deschutes River water comprised of storage from Crane Prairie Reservoir and privately-held natural flow water rights.
Crooked River Pumping Plant	NUID	Crooked River	1968	NUID	Diverts Crooked River water using water right held by NUID and delivers to Deschutes Project lands and to non-Project Crooked River lands.
CROOKED RIVER PROJECT					
Arthur R. Bowman Dam and Prineville Reservoir	United States	Crooked River	1961	OID (Reserved[2])	148,640 acre-feet active storage (150,216 acre-feet storage capacity)
Ochoco Dam and Reservoir	OID	Ochoco Creek	1918-1920; 1950; 1995	OID	39,000 acre-feet active storage 5,266 acre-feet storage accessed by pump

Facility	Ownership	Stream	Year Constructed or Rehabilitated	Entity Responsible for O&M	Comments
Crooked River Diversion Dam and Feed Canal	United States	Crooked River	1961; 2000	OID (Transferred)	Diverts Crooked River Water comprised of Prineville Reservoir storage water and privately-held natural flow water rights.
Barnes Butte and Ochoco Relift Pumping Plants	United States	Off-stream	1961	OID (Transferred)	Pumps water from Crooked River Feed Canal to Crooked River Distribution Canal and Ochoco Main Canal, respectively.
Crooked River Distribution Canal	United States	Off-stream	1961	OID (Transferred)	Distributes Crooked River water to OID project lands
Central Ditch People's Ditch Rice Baldwin Ditch Lowline Ditch	All Private	Crooked River		All Private	Diverts Crooked River water comprised of Prineville Reservoir storage water and privately-held natural flow water rights
Ochoco Main Canal	OID	Ochoco Creek	1917	OID	Diverts water from Ochoco Dam
9 small pumping plants and distribution canals	United States	Off-stream	Various	OID (Transferred)	Pumps water from Crooked River Distribution Canal or Ochoco Main Canal into distribution canals.
Rye Grass Canal	OID	Ochoco Creek	1897	OID	Diverts from Ochoco Creek and captures return flows in the system.
WAPINITIA PROJECT					
Wasco Dam and Clear Lake	United States	Clear Creek (White River tributary)	1959	JFDIC (Transferred)	11,900 acre-feet active storage
Clear Creek Diversion Dam	JFDIC	Frog Creek and Clear Creek	Unknown	JFDIC	

[1] "Transferred Works" are facilities in which daily responsibility for O&M activities are transferred to and financed by the irrigation district.
[2] "Reserved Works" are facilities in which the O&M is the responsibility of the United States. Daily O&M responsibility may be contracted to another entity, but the United States maintains the financial responsibility.

Reclamation facilities may be transferred or reserved works. Transferred works mean that daily operation and maintenance activities have been transferred to and are financed by the contracting entity (usually an irrigation district), but the ownership remains with the U.S. Government.

Reserved works, typically dams and reservoirs which serve more than one function, are operated and maintained by Reclamation, either directly or by contract with one or more irrigation districts. Reclamation maintains financial responsibility and collects O&M costs from contracting entities who receive water from that project. All of the Federal facilities included in the proposed action are transferred works, with the exception of Bowman Dam in the Crooked River Project which is a reserved work operated by OID under contract.

Reclamation conducts regular inspections of dams that it has jurisdiction over to ensure that structural integrity, safety, and maintenance requirements are met by the designated operating entities. Reclamation provides runoff forecasts to dam operators and at times requires specific operations to protect the facility.

Reclamation's water management is dictated by its authorities, annual water supply, water rights, contracts, and irrigation demand. An explanation of how Reclamation operates the water storage and delivery system is lengthy. This BA provides a summary of these operations and refers to accompanying documents that provide more detailed information.

Operations Description of the Deschutes River Basin Projects [Reclamation 2003a] (Operations Report)

The Operations Report describes O&M activities at Reclamation's Deschutes, Crooked River, and Wapinitia Projects. A comprehensive overview is provided about irrigation development, associated facilities, project authorizations, water rights, contracts, and general system operation for each project. Information contained in this report is referenced throughout this chapter.

2.2 DESCRIPTION OF THE PROPOSED ACTION

Operating strategies for Reclamation projects are based on legal and statutory requirements, including Congressional authorizing legislation, state water law, and contractual obligations. Specific legal and statutory requirements for each of the projects are described later in this chapter in Section 2.3. All Reclamation projects in the Deschutes River basin are authorized for the purpose of irrigation, primarily to develop more reliable water supplies. Legislation subsequent to the 1902 and 1939 Reclamation

Acts also authorizes some storage facilities to be used for flood control, limited recreation, and fish and wildlife purposes. In addition, all dams must be operated in a manner that protects them from potential failure. These three purposes—irrigation water supply, flood control, and preservation of the dam—are the primary strategies for operating the reservoirs. General operating strategies for achieving these purposes are summarized below.

2.2.1 General Operations

Reservoirs that are operated for irrigation and flood control have three major operating seasons:

- **Winter operations (approximately November – early March)** — There are no releases for irrigation; low winter releases are made. A specific amount of space may be required to control potential winter rain-on-snow or other flooding events. Water is released, if necessary, to achieve or maintain the required space. Space may also be required during this period in anticipation of spring runoff from melting snow. Typically, irrigation demand has drawn the reservoirs well below winter/spring flood control levels and they refill during the winter until reaching flood control levels.

- **Spring flood control and/or refill (approximately March – June)** — Reservoirs without flood control obligations store available inflow. Reservoirs with flood control operations are maintained to help control runoff, with releases dependent on the forecast runoff volume and timing. These reservoirs are filled for irrigation water supply as the runoff diminishes and generally reach their highest surface level in May. In the Deschutes River basin, Prineville Reservoir is the only Federally-owned reservoir officially operated for formal flood control in this manner.

- **Summer drawdown season (approximately June – October)** — This season begins when natural flow is insufficient to meet irrigation demand, i.e., inflow is less than the demand. Release of storage (drafting of the reservoir) is required to meet the demands. In dry years, drawdown may begin before June.

2.2.1.1 Flood Control

Many Reclamation storage facilities are operated for flood protection by drafting the reservoir during non-flooding periods to provide space to store high flows that result from rainfall and snowmelt. Flood control operations may be formal or informal. Formal flood control means that operating criteria were developed under Section 7 of the Flood Control Act of 1944. In practice, the Corps and Reclamation jointly develop the criteria in a manner that balances flood control potential with irrigation water supply potential. Bowman Dam and Ochoco Dam are the only dams in the Deschutes River basin operated under formal flood control rules and signed agreements. Informal flood control follows operating rules developed by Reclamation and does not involve coordination with the Corps.

2.2.1.2 Incidental Operations

Operations do consider recreation and fish and wildlife needs, although they are secondary or incidental to operation for irrigation and flood control.

2.2.1.3 Special Operational Requests

There are instances when Reclamation can accommodate a special request for a change in routine operations while still meeting primary requirements. Sometimes these operational changes are made in response to emergency circumstances. For example:

- Reservoir releases may be reduced temporarily to improve the likelihood of finding a drowned victim.
- Water releases may be changed in response to unexpected equipment malfunction or breakdown.
- River flows may be reduced temporarily for construction of bridges, placement of stream gages, and installation of shoreline revetments.

In these instances, Reclamation would look for an opportunity to release needed storage from another reservoir.

Within applicable constraints, Reclamation has altered operational approaches to improve conditions for fish and wildlife or the environment. These changes are implemented consistent with Reclamation's authorities, state water law, and only if contractual obligations and public safety are not impacted.

Specific operation of Reclamation facilities comprising the proposed action are summarized in the remainder of this chapter. A detailed description is provided in the Operations Report and is referenced as appropriate.

2.2.2 Deschutes Project Operations

The Deschutes Project lands stretch north and northeast from the city of Bend to Madras, Oregon (Figure 2-1). Approximately 85,000 acres are irrigated to produce grain, hay, mint, potatoes, seeds, and irrigated pasture. Additional lands are irrigated in the area using privately developed water supplies. Principal federally-owned features included in the proposed action are Crane Prairie Dam and Reservoir, Wickiup Dam and Reservoir, Haystack Dam and Reservoir, and North Unit Headworks and Main Canal. Total active capacity of the Federal reservoirs is 255,300 acre-feet. In addition, Haystack Reservoir functions as a re-regulating reservoir and temporarily restores water transported in the irrigation system.

Four irrigation districts have contracts for this storage water, including NUID, COID, Lone Pine Irrigation District (also known as Crook County Improvement District No. 1), and Arnold Irrigation District. Arnold, Lone Pine, and Central Oregon Irrigation Districts use storage in Crane Prairie Reservoir to supplement water supplies obtained from other privately developed sources. COID irrigates about 45,000 acres; Lone Pine ID irrigates about 2,400 acres; and Arnold ID irrigates about 4,400 acres. All diversion and distribution facilities for these three irrigation districts are privately owned and operated. The water right to divert the stored water is privately held. The proposed action includes storing water in and releasing water from Crane Prairie Reservoir for diversion at several privately-owned diversions. Diversion of stored water by COID, Lone Pine ID, and Arnold ID is an interrelated and interdependent action.

NUID uses storage in Wickiup and Haystack Reservoirs to provide a full supply of water to irrigate its lands. Project water is used to irrigate about 50,000 acres. NUID irrigates an additional 8,800 acres using non-project water obtained from water pumped from the Crooked River. The pumping of Crooked River water is interrelated and interdependent to the proposed action.

To summarize, the following project operations are included in the proposed action. Refer to pages 32-49 in the Operations Report for a more detailed description.

- Storage in and release of water from Crane Prairie Dam and Reservoir for diversion (an interrelated and interdependent action is diversion of storage water by private facilities)

- Storage in and release of water from Wickiup Dam and Reservoir for diversion

- Diversion of Wickiup Reservoir storage water by North Unit Headworks and Main Canal (an interrelated and interdependent action is the diversion of natural flow water)

- Storage in and release of water from Haystack Dam and Reservoir for diversion

Deschutes Project, Oregon

Major Facilities

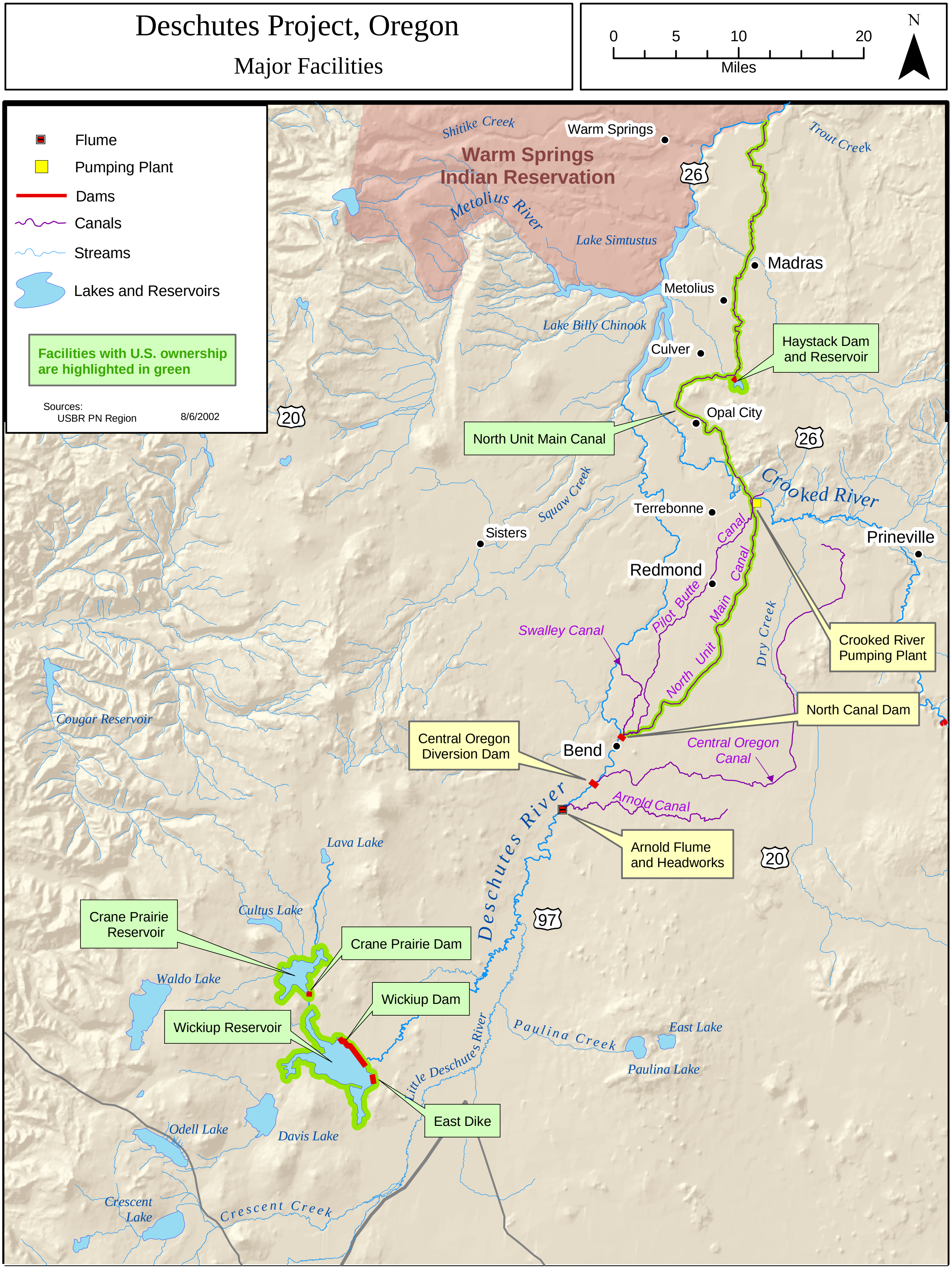


Figure 2-1

2.2.2.1 Storage and Delivery of Water

Crane Prairie and Wickiup Reservoirs store water for use in the Deschutes Project and are operated together as a combined system. The operation of these two reservoirs is generally governed by the January 4, 1938, inter-district contract and the water rights associated with storage of the Deschutes River water.

The inter-district contract stipulates the priority for storing water between the two reservoirs. Following the irrigation season, water can be stored in Crane Prairie Reservoir at any time or at any rate provided that storage is below 30,000 acre-feet. After storage has reached 30,000 acre-feet, inflow is bypassed to Wickiup Reservoir until storage in Wickiup Reservoir reaches 180,000 acre-feet, at which time storage is resumed at Crane Prairie Reservoir until a total of 45,000 acre-feet of storage is filled. Wickiup Reservoir is then filled to a total of 200,000 acre-feet (full pool) prior to further filling of Crane Prairie Reservoir.

Crane Prairie Reservoir has a maximum storage capacity of 50,000 acre-feet, of which 30,000 acre-feet is identified as "reliable storage supply" in the inter-district contract, and 20,000 acre-feet is identified as "surplus water available." Table 2-2 shows the storage is allocated as follows:

Table 2-2. Crane Prairie Reservoir Storage Allocation

District	Allocation of Reliable Storage Supply (acre-feet)	Allocation of Surplus Storage (acre-feet)	Total Allocation (acre-feet)
Lone Pine ID	10,500		10,500
Arnold ID	10,500	3,000	13,500
COID	9,000	17,000	26,000
TOTAL	30,000	20,000	50,000

Allocation of the surplus storage water is complex. Of the first 15,000 acre-feet, 1/5 accrues to Arnold ID, up to a maximum of 3,000 acre-feet, and 4/5 accrues to COID, up to a maximum of 12,000 acre-feet. The remainder of the surplus storage (5,000 acre-feet) accrues to COID.

At the time of the inter-district contract, it was anticipated that the capacity of Crane Prairie Reservoir would be 50,000 acre-feet. The actual capacity of the reservoir is 55,300 acre-feet. In the wettest years water is stored above 50,000 acre-feet, but only after Wickiup Reservoir has reached or is assured to reach full capacity of 200,000 acre-feet. Any water stored above 50,000 acre-feet is released during the subsequent irrigation season as excess flow (above irrigation demand) to augment the Deschutes River in the Bend area (Gorman 2002).

Reservoir refill operations are managed to maximize storage each year and maintain to the extent possible uniform flows below each reservoir. With modern satellite telemetered reservoir outflows and snowpack measurements, operations are becoming more responsive to changes in water conditions through the winter. Typically, the irrigation season ends and storage commences in October.

Reservoir outflows are determined after considering the amount of reservoir storage and the present inflow. Daily changes on the river are organized by the Watermaster, an OWRD employee, to meet storage requirements and irrigation demands. Irrigation personnel are contacted to implement the changes in releases at the projects.

Crane Prairie and Wickiup Dams are operated under informal flood control rules, which are rarely invoked. The reservoirs undergo an annual review of hydrologic conditions as they approach full capacity. If the review indicates elevated inflow is likely, a flood plan is developed by Reclamation in cooperation with the irrigation districts and the Oregon State Watermaster.

Crane Prairie Dam and Reservoir Operation

Reclamation has title to Crane Prairie Dam and Reservoir; however, as a transferred work, daily O&M is the responsibility of COID personnel. Reclamation owns no water rights for storing or diverting Crane Prairie stored water.

Irrigation releases typically begin by mid-to-late April. Nonirrigation releases may occur earlier if the reservoir is full and must pass inflow. The reservoir does not typically begin to draft appreciably until late May or early June. Irrigation releases typically peak in June and July between 200 cfs and 500 cfs, but can be higher or lower depending on the water supply. In dry years, lower flows are maintained in order to stretch the water supply over the entire season. An effort is made to set a summer flow that can be maintained without constant adjustments. Releases are typically reduced to minimum downstream flows in late October or early November. Although Crane Prairie Reservoir has no minimum flow requirements, the watermaster and the irrigation districts have a non-binding agreement to release a minimum of 30 cfs to protect instream resources. Winter flows below Crane Prairie Dam are often higher than this in all but the driest years.

Table 2-3 summarizes operations at Crane Prairie Dam and Reservoir. Table 2-4 shows the average monthly flow exceedance for water years 1990 to 2001 below Crane Prairie Dam. From the table, the 90 percent exceedance for October was 64 cfs, meaning that 90 percent of the time average monthly October flows equal or exceed 64 cfs. Figure 2-2 and Figure 2-3 show annual hydrographs of river flows below Crane Prairie Dam for the period 1991 through 2001, which includes dry and wet year sequences.

Table 2-3. Summary of Crane Prairie Dam and Reservoir Operations

Item	Comment
Releases	
30 cfs	Informal (non-binding) minimum release by agreement of watermaster and irrigation districts.
200-500 cfs	Typical peak irrigation release.
Rate of rise (maximum)	No standard ramping rate as it depends on the flows, trying not to make sudden changes.
Rate of drop (maximum)	No standard ramping rate as it depends on the flows, trying not to make sudden changes.
Reservoir Content	
Minimum pool	None required; typically stays above 10,000 acre-feet. Recorded minimum of 9,470 acre-feet in 1980.[1]
24,000 acre-feet	Average end-of-September carryover (1961-2001 period of record).
30,000 acre-feet	Maximum storage level until Wickiup Reservoir reaches 180,000 acre-feet
45,000 acre-feet	Maximum storage level until Wickiup Reservoir reaches 200,000 acre-feet
55,300 acre-feet	Full pool; achieved in about 1 out of every 3 years
Allocation of Reservoir Content	
COID	26,000 acre-feet
Arnold ID	13,500 acre-feet
Lone Pine ID	10,500 acre-feet

[1]1961 - 2002 period of record. For the period 1925-1960, the reservoir reached empty or near empty in 14 of the years, with the latest occurring in 1950.

Table 2-4. Average Monthly Flow (cfs) Exceedance below Crane Prairie Dam, Deschutes River Basin

Gage Location (period of record)	Percent Exceedance	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Deschutes River													
Below:	90%	64	45	51	74	45	29	65	160	131	134	117	109
Crane Prairie Res.	50%	195	163	132	126	124	151	148	271	268	269	271	276
(water years 1990-2001)	10%	432	338	302	427	333	310	264	525	578	536	503	487

* Information from http://pn.usbr.gov/hydromet/index.html

Figure 2-2. Daily Average Flow (QD) for the Deschutes River below Crane Prairie Dam, 1991-1995 (dry year series)

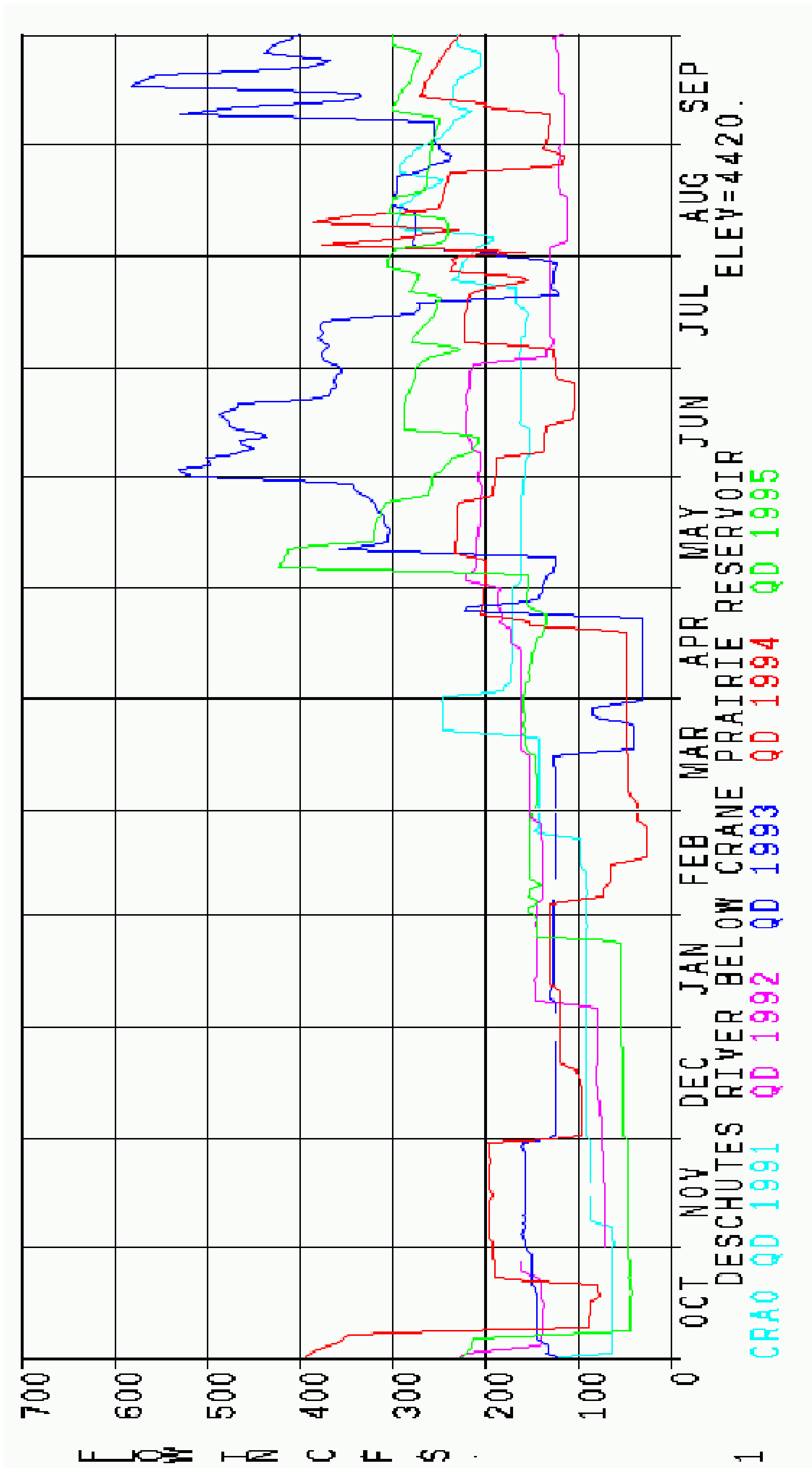
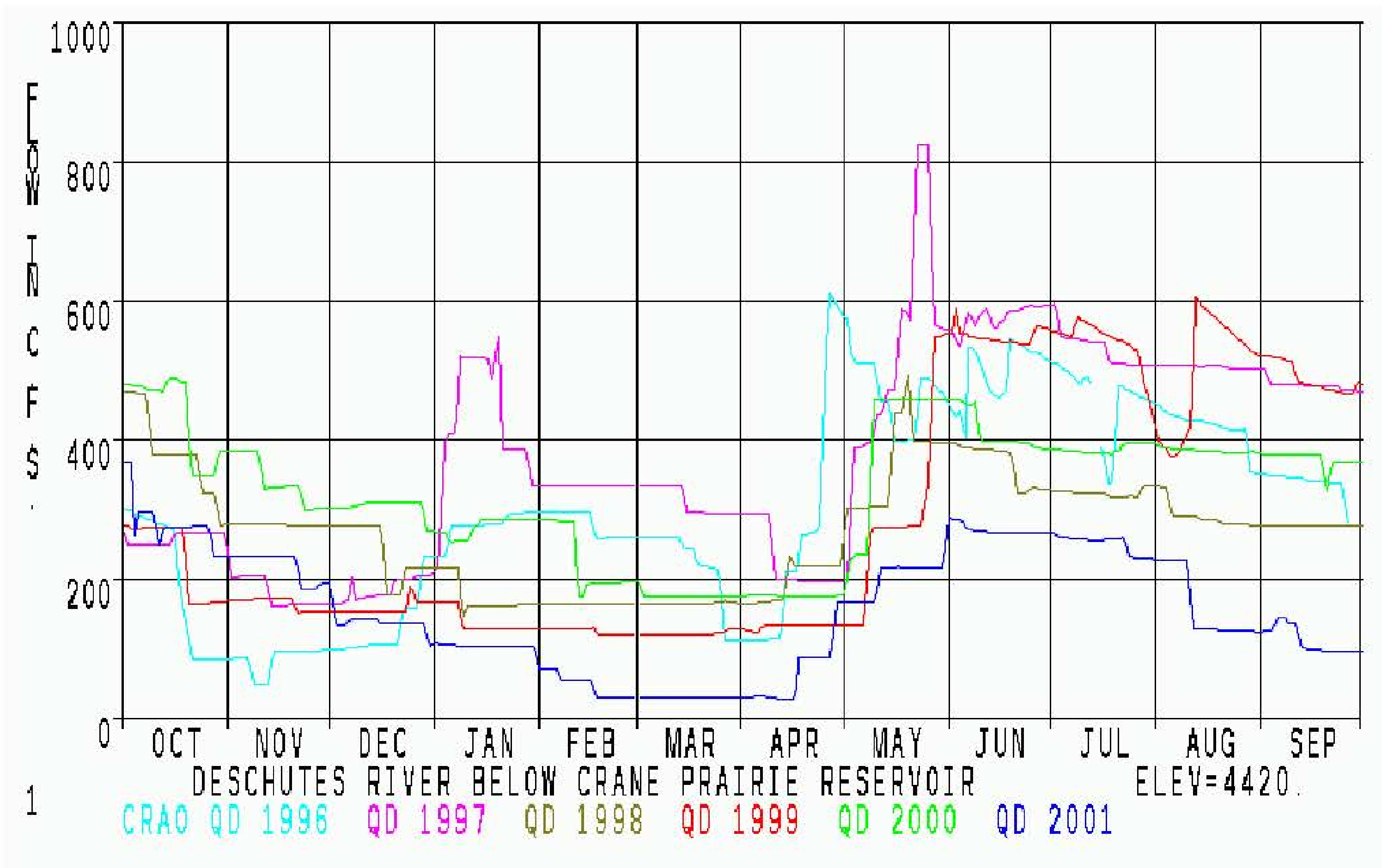


Figure 2-3. Daily Average Flow (QD) for the Deschutes River below Crane Prairie Dam, 1996-2001 (wet year series)



Wickiup Dam and Reservoir Operation

NUID operates Wickiup Dam and Reservoir according to the terms of the inter-district contract described earlier. Day-to-day operations are directed by the Watermaster to meet storage requirements and irrigation demands. Reclamation does not hold the water right for storing or diverting Wickiup stored water.

The irrigation season extends from April 1 to October 31, with the reservoir typically beginning to refill by mid-October. The filling schedule must adhere to the terms of the inter-district contract, which allows Wickiup Reservoir to fill at any time and at any rate provided that storage is below 180,000 acre-feet, while meeting minimum downstream releases (discussed later in this chapter). After storage has reached 180,000 acre-feet, outflow from Crane Prairie Reservoir is curtailed until that reservoir reaches 45,000 acre-feet. Wickiup Reservoir is then filled to 200,000 acre-feet (full pool) prior to further filling of Crane Prairie Reservoir beyond 45,000 acre-feet.

Irrigation releases typically begin by mid-April and the reservoir commences drafting. In wet years this can be delayed until early May, and in extremely wet years the reservoir may not draft until early June. Irrigation releases typically peak in July between about 1,400 cfs and 1,600 cfs, but can be higher. Irrigation demand begins to diminish in September and releases are typically down to minimum flows by the middle of October.

During the nonirrigation season, a minimum flow of 20 cfs is normally maintained at the gaging station about 1,000 feet downstream from Wickiup Dam. This minimum flow was established following a hearing held in September 1954 on the amended application to increase the storage in Wickiup Reservoir. The Oregon State Engineer identified a minimum release of 20 cfs for downstream conservation. Under normal storage conditions, this amount can be readily obtained from the downstream toe drain along the toe of the dam. Flows higher than 20 cfs can usually be supplied in a series of wet years without risk to refill (and thus to storage rights), as was the case from 1997 to 2001.

Wickiup Dam and Reservoir operations are summarized in Table 2-5. Table 2-6 shows the average monthly flow exceedance for water years 1990 through 2001 below Wickiup Dam. From the table, the 90 percent exceedance for October was 215 cfs, meaning that 90 percent of the time average monthly October flows equal or exceed 215 cfs. Figure 2-4 and Figure 2-5 show annual hydrographs of river flows below Wickiup Dam for the period 1991 through 2001, which includes sequences of dry and wet years.

Table 2-5. Summary of Wickiup Dam and Reservoir Operations

Item	Comment
Releases	
20 cfs +200 cfs	Minimum release by order of Oregon State Engineer in 1954 Typical minimum release in wetter years (roughly 40 percent of years)
1400-1600 cfs	Typical peak irrigation release
Rate of rise (maximum)	Existing limits are 1 foot per hour, but watermaster voluntarily operates to ½ foot per day. USFS proposed rates are 0.1 foot per 4-hours; adhered to when possible. Reservoir elevation, flood operations, and downstream conditions will dictate the release criteria.
Rate of drop (maximum)	Daily limits same as above. USFS proposed hourly limit is 0.2 foot per 12 hours; adhered to when possible.
Reservoir Content	
Minimum pool	None required; typically stays above 25,000 acre-feet. Recent recorded minimum was 15,600 acre-feet (1994).[1]
61,000 acre-feet	Average end-of-September carryover.
180,000 acre-feet	Maximum storage limit until Crane Prairie Reservoir fills to 45,000 acre-feet.
200,000 acre-feet	Full pool; achieved or nearly achieved in approximately 70 percent of years.

[1] The reservoir reached 8,100 acre-feet and 8,800 acre-feet in 1955 and 1970, respectively, and reached 1,980 acre-feet in 1952.

Table 2-6. Average Monthly Flow (cfs) Exceedance below Wickiup Dam, Deschutes River Basin*

Gage Location (period of record)	Percent Exceedance	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Deschutes River													
Below:	90%	215	20	19	17	19	22	101	711	899	1209	1237	905
Wickiup Res.	50%	493	25	36	23	33	94	585	1003	1294	1458	1419	1172
(water years 1990-2001)	10%	919	710	573	914	1053	739	784	1364	1557	1772	1630	1422

* Information from http://pn.usbr.gov/hydromet/index.html

Figure 2-4. Daily Average Flow (QD) for the Deschutes River below Wickiup Dam (WICO), 1991-1995 (dry year series)

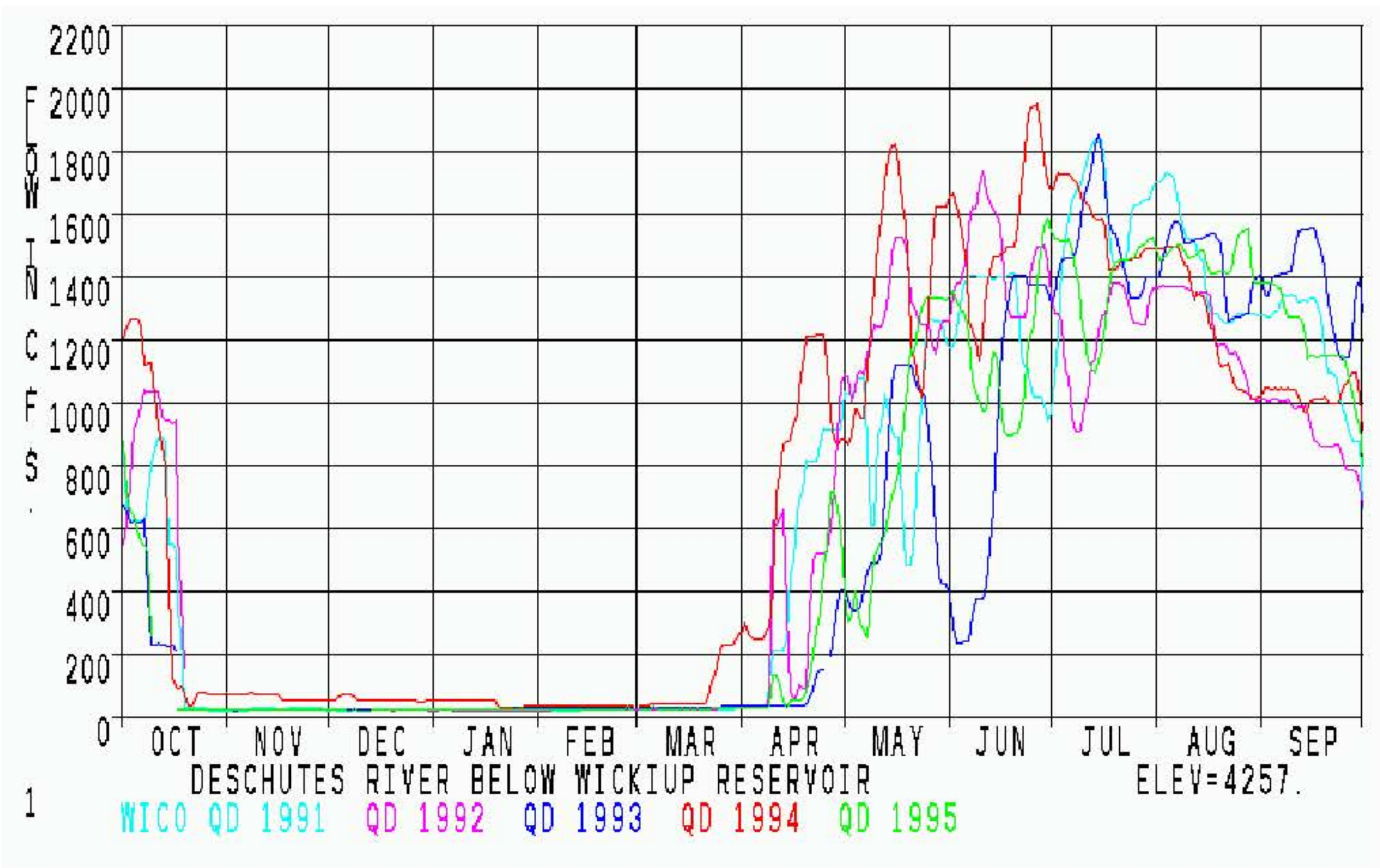
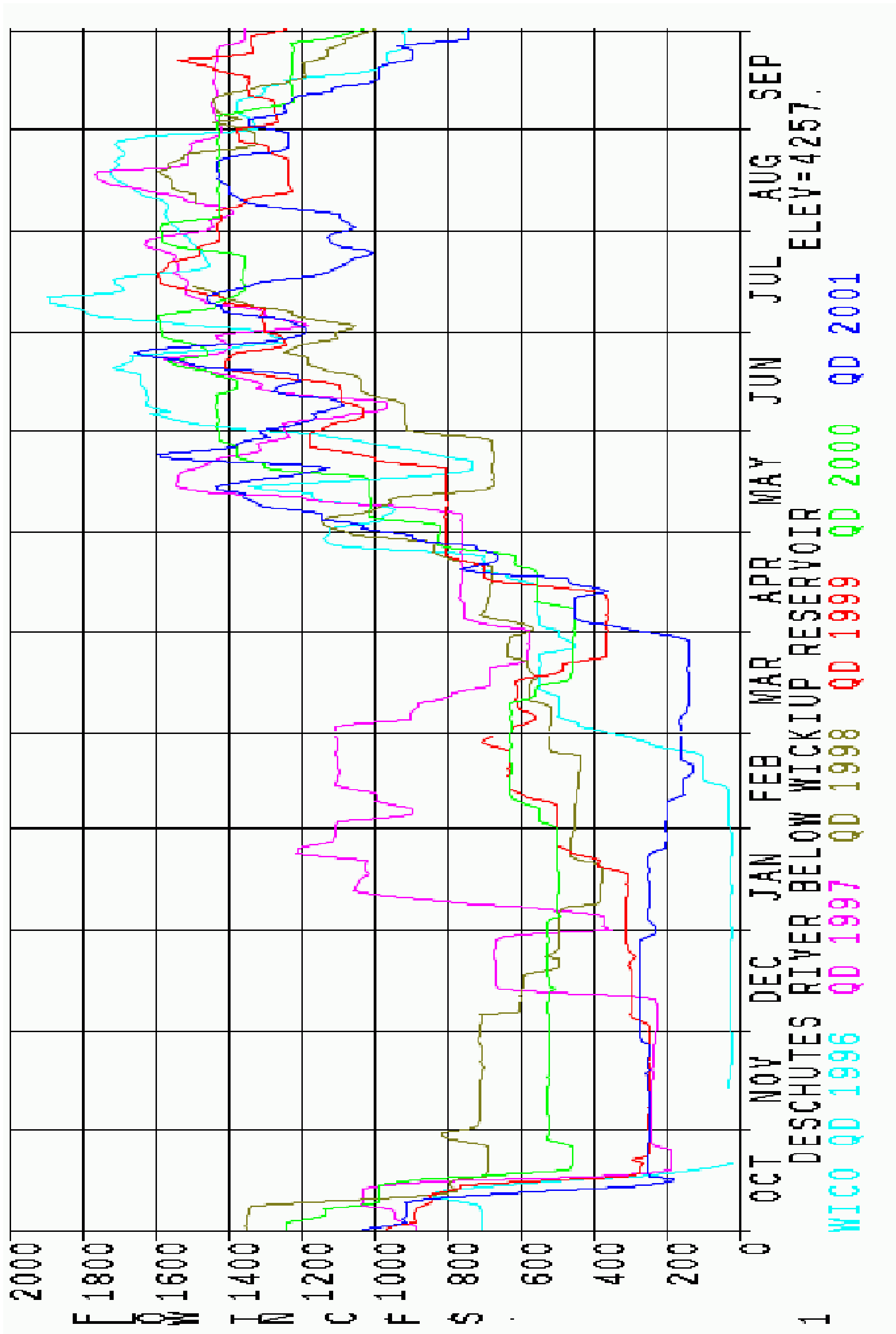


Figure 2-5. Daily Average Flow (QD) for the Deschutes River below Wickiup Dam (WICO), 1996-2001 (wet year series)



Haystack Dam and Reservoir Operation

Haystack Dam and Reservoir is an off-stream storage facility. Because of the distance from Wickiup Reservoir to the NUID project lands (about 100 miles), the regulatory storage provided by Haystack Reservoir is required. Inflow to Haystack Reservoir is primarily provided by two diversions: (1) from the Deschutes River near Bend, Oregon, by means of North Unit Main Canal, and (2) the Crooked River Pumping Plant at a point where the North Unit Main Canal crosses the Crooked River. In addition, natural inflow can occur from Haystack Creek, although this is typically minor compared to the canal feeds. Infrequent rain-on-snow flood events are the only source of appreciable inflow from Haystack Creek.

If the reservoir levels go into surcharge conditions (more than 100 percent full), Haystack Feeder Canal acts as a spillway for emergency releases. During the nonirrigation season, the Haystack Feeder Canal control gates are kept in the full open position as a precaution in order to insure the capability to bypass flood flows up to 800 cfs.

During the irrigation season, which usually runs from early to mid-April through mid-October, the reservoir typically operates between elevations of about 2828 feet to 2841 feet (2,900 acre-feet to 5,500 acre-feet) in order to supply irrigation releases. Operations follow a cyclic pattern where the reservoir is drafted and then refilled periodically to maintain its operating range. In October following the irrigation season, the reservoir is typically refilled to an elevation range of 2835 feet to 2838 feet (4,150 acre-feet to 4,750 acre-feet). During the nonirrigation season, all outflows from the reservoir are curtailed and the reservoir is maintained at a fairly constant elevation until the following April.

Because it is an off-stream reservoir and discharges to the NUID canal, there are no minimum flows or ramping rates associated with the operation of Haystack Reservoir. The typical minimum reservoir level of approximately 2,900 acre-feet is sufficient to maintain fishery and recreational resources associated with the reservoir. There is no established minimum pool.

2.2.2.2 Diversion of Water

The primary diversion point for Deschutes project water occurs at the North Canal Dam on the main Deschutes River near Bend at RM 164.8. Due to numerous changes in canal companies and ownerships over the years, it is unclear who owns North Canal Dam. However, it is clear that Reclamation does not own the feature, and therefore, bears no responsibility for the O&M of the dam.

Four irrigation districts divert water into their respective canals at the North Canal Dam – NUID using the North Unit Main Canal, Lone Pine ID and COID using the North Canal (also called the Pilot Butte Canal), and Swalley ID using the Swalley Canal. Only NUID, Lone Pine ID, and COID divert Federal project water.

Diversion of Crane Prairie storage water by COID, Arnold ID, and Lone Pine ID occurs through privately owned and operated diversion facilities. Reclamation does not own or operate these diversion facilities or possess the diversion water rights. The Oregon State Watermaster regulates diversion of this water. Delivery and diversion of Crane Prairie storage water into these private facilities is interrelated and interdependent to the proposed action.

The North Canal Dam is the last major diversion point for irrigation water from the Deschutes River, and marks the low flow point on the river just downstream of the dam. The diversion of natural and storage flows, mostly by private diversions, along with diversions of Deschutes project water essentially dewaters the Deschutes River by the time it passes the North Canal Dam. Irrigators early on recognized the need to provide a minimum release past the North Canal Dam, and since the early 1960s a non-binding “gentlemen’s agreement” among several of the major irrigation districts has provided at least 30 cfs. The parties to this agreement include NUID, COID, Tumalo ID, and Swalley ID. In addition to the 30 cfs, the Watermaster must pass about 5 cfs to meet several small irrigation demands further downstream.

The DRC and other interested parties have made a significant effort in the last few years to improve flows past North Canal Dam (along with other locations in the basin) by leasing or purchasing water rights from traditional irrigation users. The combination of leases, “gentlemen’s agreements,” and irrigation flow totaled approximately 45 cfs passing North Canal Dam during the 2002 irrigation season. This “minimum” will vary from year-to-year depending on the water supply and demands and leasing arrangements negotiated.

North Unit Headworks and Main Canal

The North Unit Main Canal, with headworks located at North Canal Dam, is the principal water delivery feature for the Deschutes Project. This is the only federally-owned diversion facility associated with the Deschutes Project. The canal has a maximum diversion capacity of 1,100 cfs, although diversions during the irrigation season are generally from 247 cfs in October to 640 cfs in July. Annual average diversions are 193,559 acre-feet/year (based on period of record from 1961-2000) which includes storage water from Wickiup Reservoir and natural flow water rights (LaMarche 2001).

NUID has been able to reduce their peak demand and increase the reliability of their storage water through conservation and efficiency improvements. In the past, maximum diversion into the North Unit Main Canal was often at the 1,100 cfs capacity, where maximum demand now will typically call for about 800 cfs (although higher flows may sometimes be needed for short periods to keep the system in balance).

The diversion contains a fish screen complex constructed in 1945 which does not meet current fish screening standards. Reclamation has completed preliminary designs to upgrade the fish screen to comply with current standards.

The irrigation diversion season is generally April 1 to November 1. NUID diverts both natural flows and storage water into the North Unit Main Canal. Anytime natural flows on the Deschutes River are above about 1,500 cfs, as calculated by the Watermaster, some or all of NUID's demands can be met from natural flows. However, NUID's natural flow rights are junior to all major irrigators on the river, and once Deschutes River natural flows drop to 1,500 cfs or less, it relies entirely on storage water from Wickiup Reservoir. Because of this heavy reliance on stored water and the uncertainty of reservoir refill in future years, NUID operates in a very conservative manner to maximize the carryover water in Wickiup Reservoir.

The average monthly flow exceedance for water years 1915 through 1991 below North Canal Dam are shown in Table 2-7. These flows reflect hydrologic effects of diversions associated with the proposed, interrelated and interdependent, and private actions. The diversion of natural flow rights by COID, Lone Pine ID, Arnold ID, Tumalo ID, and Swalley ID are not part of the proposed or interrelated and interdependent actions.

Table 2-7. Average Monthly Flow (cfs) Exceedance below North Canal Dam, Deschutes River Basin*

Gage Location (period of record)	Percent Exceedance	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Deschutes River													
Below: Bend (water years 1915-1991)	90% 50% 10%	70 241 802	372 661 1140	450 798 1217	482 835 1274	478 863 1320	441 845 1408	88 286 1161	34 106 680	29 106 627	29 73 352	25 83 430	26 113 512
* Information from http://pn.usbr.gov/hydromet/index.html													

2.2.3 Crooked River Project Operations

The Crooked River Project is located near Prineville, Oregon (Figure 2-6). About 23,000 acres are irrigated using project water, with OID irrigating about 21,000 of those acres. A number of smaller irrigation associations or individual users irrigate less than 2,000 acres with Prineville Reservoir storage water. Irrigated acres produce grain, hay, garlic, turf, grass seed, mint, and irrigated pasture on farm units ranging in size from large livestock ranches to small suburban residential tracts.

Principal federally-owned features included in the proposed action are Arthur R. Bowman Dam, Prineville Reservoir, and the Crooked River Diversion Dam, Feed Canal, and Distribution Canal. Additionally, Reclamation has title to several off-stream pumping plants and distribution canals within the OID irrigation system. Reclamation also holds a water right to store water behind Bowman Dam and divert the stored water into federally and privately-owned facilities.

Ochoco Dam and Reservoir, which stores and releases Ochoco Creek water, is a privately-owned facility operated by OID. Reclamation does not hold the water right for storing or diverting Ochoco Creek water. However, operation of OID-owned facilities is coordinated with operation of Bowman Dam and Prineville Reservoir and other Federal facilities in the Crooked River Project; therefore, operations of OID-owned facilities are included as interrelated and interdependent activities in this consultation.

The following is a brief summary of project operations included in the proposed action. Refer to pages 66-81 in the Operations Report for a detailed description. The proposed action includes:

- Storage and release of water from Prineville Reservoir and Bowman Dam.
- Diversion of Prineville Reservoir storage water by contractors into the Crooked River Feed Canal and other private facilities. (Diversion of natural flow water into the Crooked River Feed Canal is an interrelated and interdependent action.)
- Conveyance of Prineville Reservoir storage water in federally-owned facilities

2.2.3.1 Storage and Delivery of Water

The total active capacity of Prineville Reservoir is 148,640 acre-feet. Prineville Reservoir serves as a primary water supply for some lands within OID, as well as a supplemental water supply to the district and other individuals. Additionally, OID relies on storage water in Ochoco Reservoir to provide primary and supplementary supplies of water to district members. Operations of Bowman Dam are part of the proposed action. Operations at Ochoco Dam are interrelated and interdependent to the proposed action.

Crooked River Project, Oregon

Major Facilities

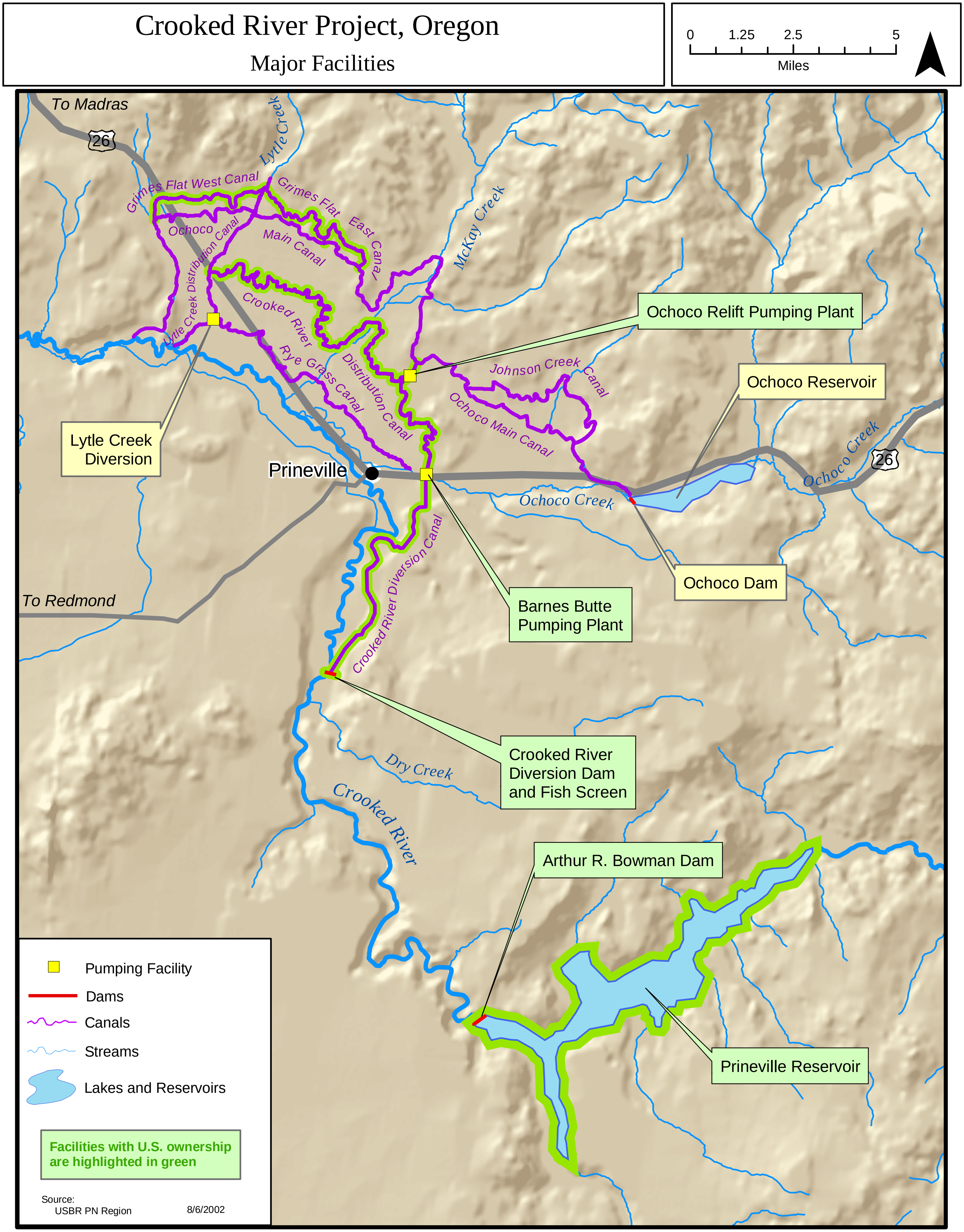


Figure 2-6

Reclamation forecasts runoff for the Crooked River at Prineville Reservoir and Ochoco Creek at Ochoco Reservoir for effective utilization of storage space for flood control and water conservation. Prineville and Ochoco Reservoirs are filled concurrently, based on runoff forecasts.

Bowman Dam and Prineville Reservoir Operation

Crooked River flows are comprised of winter snowfall and spring runoff in its upstream watershed and from spring flows as the river approaches its confluence with the Deschutes River. Upper Crooked River flows are highly variable, both seasonally and annually. This reach of the river is fed mostly by surface runoff, and soils are shallower and less porous than in the Deschutes River subbasin. Nearly all of the annual volume of reservoir inflow typically occurs during the December through June period (95 percent). Inflows from July through September account for less than 1 percent of the total, with inflows often less than 10 cfs.

Prineville Reservoir has a much better refill probability than Ochoco Reservoir. Maximum fill occurs at Prineville Reservoir in approximately 3 out of 4 years, where Ochoco Reservoir only fills about 50 percent of the years. Therefore, priority is placed on using irrigation water from Prineville Reservoir to the maximum extent feasible, with Ochoco Reservoir releases made only to serve those lands with insufficient or no access to Prineville Reservoir water.

Reclamation has contracted with OID to perform O&M at Bowman Dam and Prineville Reservoir. Reservoir releases are made by OID between April 1 and October 31 as required to meet irrigation demand. OID coordinates water delivery requests within the district and calls orders into the damtender who makes releases from Prineville Reservoir.

Bowman Dam is operated under formal flood control rules and signed agreements. Flood control criteria at Bowman Dam involves flood control rule curves established by the Corps that prescribe the amount of reservoir space needed to control the predicted volume of runoff. A series of rule curves or tables determine the space requirement for a given water supply forecast on a particular date. Rule curves were developed using historic runoff, system storage potential, and downstream flow restrictions (i.e., downstream channel capacity).

Flood control operation for Bowman Dam begins with no less than 60,000 acre-feet of evacuated space (equivalent to a maximum storage of 88,640 acre-feet of water) in Prineville Reservoir on November 15 through February 15. During this time, water may not be stored if only 60,000 acre-feet of space is vacant. After February 15, the reservoir can be filled as determined by a special forecast runoff equation and related established rule curve through April 30. Final fill may occur between April 1 and April 30 depending on forecasted runoff volume. Once flood control space has been filled, flow begins to occur over the uncontrolled spillway crest. Releases from the outlet works are managed to minimize property damage.

Authorizing legislation for the Crooked River Project mandates a minimum 10 cfs release through Prineville Reservoir. Currently, Reclamation maintains minimum releases ranging between 10-75 cfs below Bowman Dam. Storable inflows are bypassed if existing contractual obligations are not impacted. The lower flows in that range are released in drier years and extended drought conditions when refill of the reservoir is jeopardized. The uncontracted storage in Prineville Reservoir is used to achieve these releases. The legal mandated minimum release remains 10 cfs.

Recreation on Prineville Reservoir is a consideration of current operations, although not specifically an authorized purpose. If sufficient storage exists and spaceholder contracts can be met, an attempt is made to keep enough water in Prineville Reservoir to maintain boat access at ramps at Prineville State Park through peak visitation periods (typically May - August).

Table 2-8 summarizes operations at Bowman Dam and Prineville Reservoir. Table 2-9 shows the average monthly flow exceedance for water years 1990 through 2001 below Bowman Dam (Prineville Reservoir). From the table, the 90 percent exceedance for October was 44 cfs, meaning that 90 percent of the time average monthly October flows equal or exceed 44 cfs. Figure 2-7 and Figure 2-8 show annual hydrographs of river flows below Bowman Dam for the period 1991 through 2001, which includes sequences of dry and wet years.

Table 2-8. Summary of Bowman Dam and Prineville Reservoir Operations

Item	Comment
Releases	
10 cfs	Minimum authorized release
30-35 cfs	Typical informal minimum release during extreme drought, but may be as low as 10 cfs.
75 cfs	Informal minimum release target provided by bypassing inflows from Reclamation's uncontracted storage space
200-240 cfs	Typical peak irrigation releases
2,000 cfs	Informal target, not to exceed for flood control; increased bank erosion above this level
Rate of change (maximum)	None
Reservoir Content	
Minimum pool	None required; recent recorded minimum pool was 22,450 acre-feet in 1993.
Maximum winter flood control pool (November 15 - February 15)	88,640 acre-feet
83,000 acre-feet	Average end-of-October carryover storage
148,640 acre-feet	Full pool; achieved roughly 3 out of 4 years

Table 2-9. Average Monthly Flow (cfs) Exceedance below Bowman Dam*, Crooked River

Gage Location (period of record)	Percent Exceedance	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Crooked River													
Near: Prineville below Bowman Dam (water years 1990-2001)	90% 50% 10%	44 115 297	33 74 160	31 68 782	30 65 1308	31 91 1636	26 218 1548	79 373 2742	159 249 1022	179 228 1090	187 222 315	196 227 372	122 206 262

* Information from http://pn.usbr.gov/hydromet/index.html

Figure 2-7. Daily Average Flow (QD) for the Crooked River below Prineville Reservoir (PRVO), 1991-1995 (dry year series)

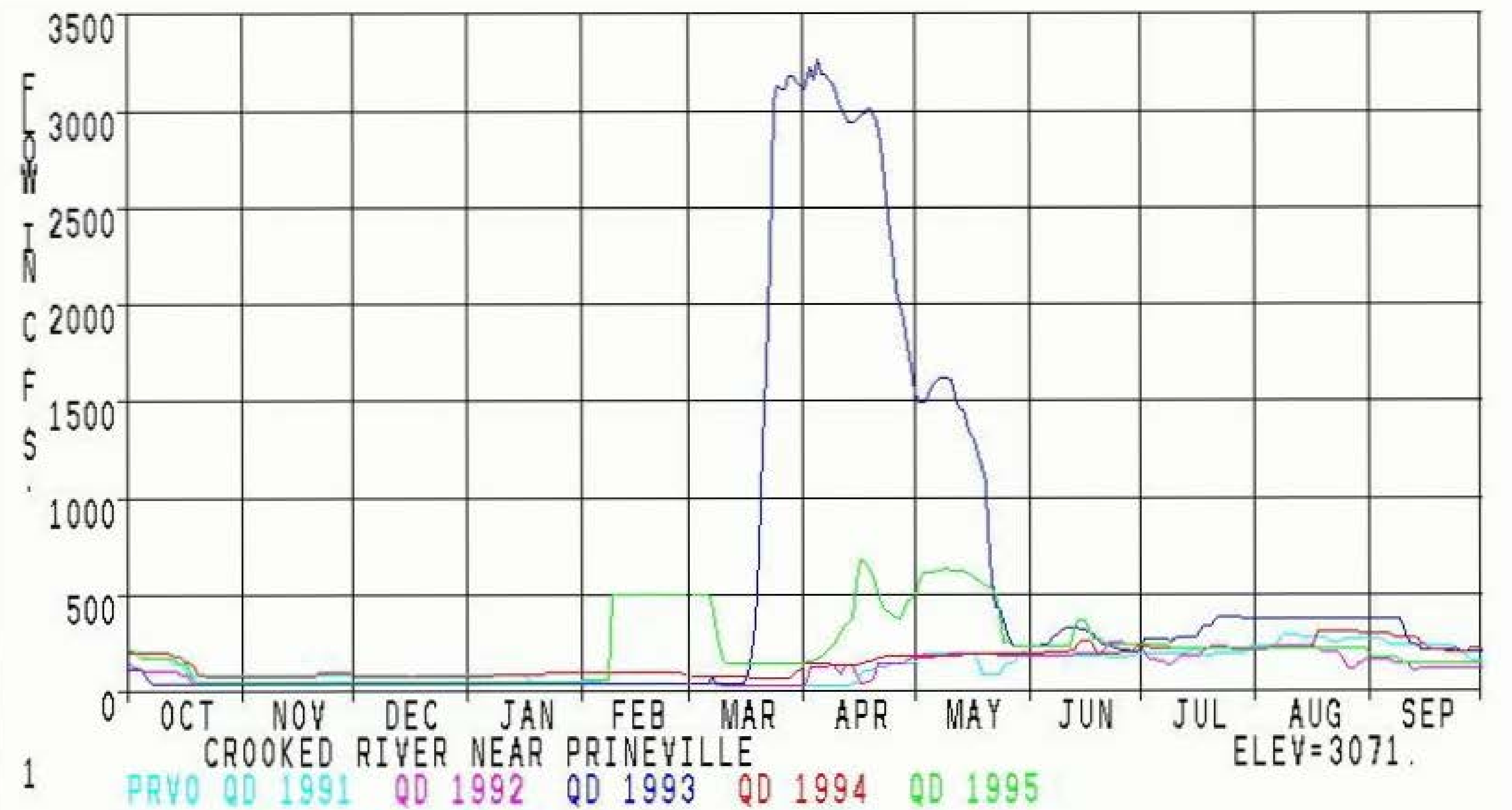
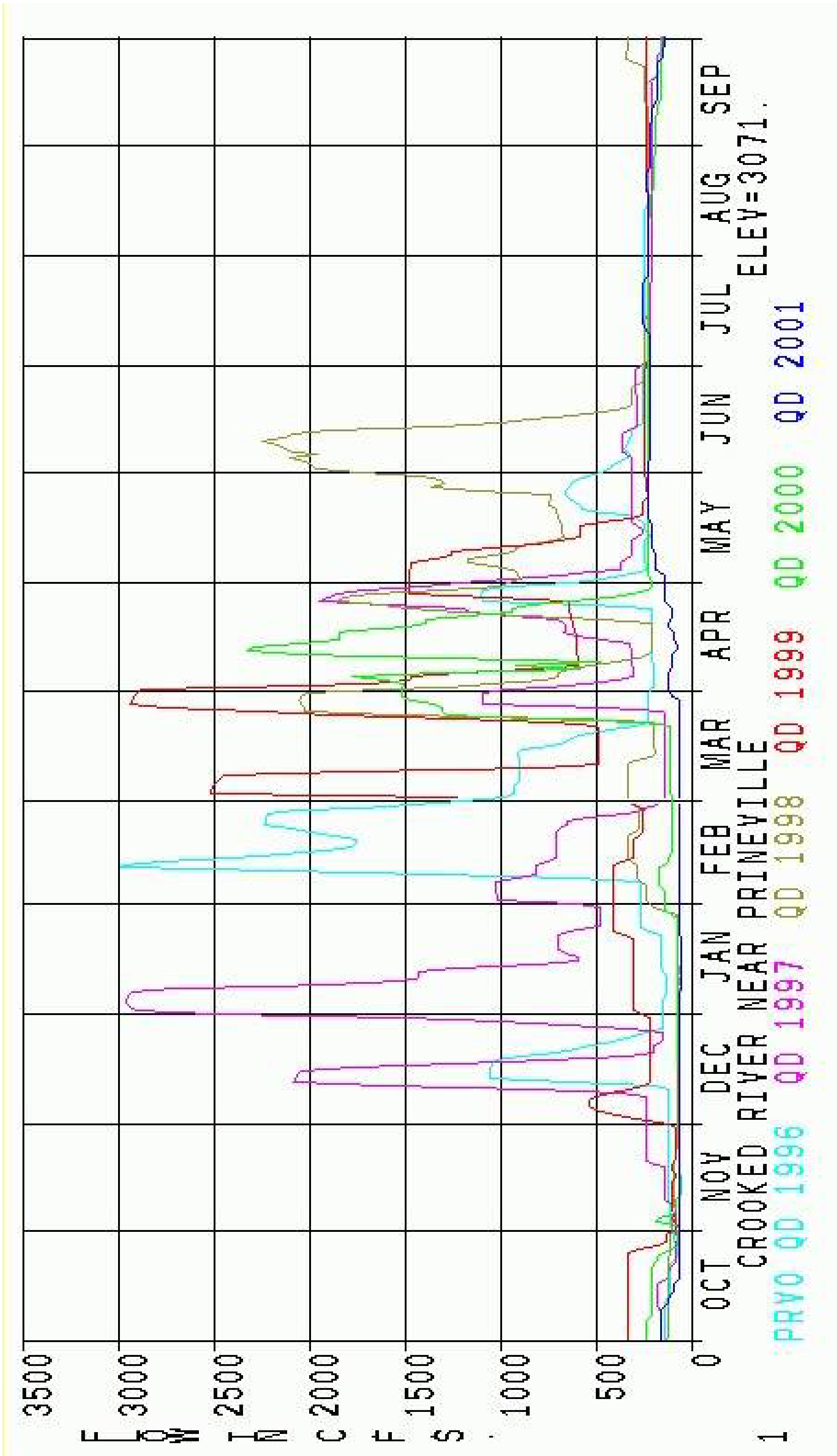


Figure 2-8. Daily Average Flows (QD) for the Crooked River below Prineville Reservoir (PVRO), 1996-2001(wet year series)



2.2.3.2 Diversion of Water

Prineville Reservoir storage water is diverted primarily by the Crooked River Diversion Dam into the Feed Canal, located upstream from the city of Prineville at RM 56 on the Crooked River. This is the only federally-owned diversion facility on the Crooked River. In 2000, Reclamation constructed a new diversion weir, fish screen, and fish bypass and outfall structure to improve resident fish protection at the diversion. Design of the new features was reviewed and approved by the USFWS and ODFW.

The canal capacity is 180 cfs. Average 1994 through 2001 flows diverted into the Crooked River Feed Canal are 50,985 acre-feet per water year, comprised of Prineville storage water and natural flow rights held by OID. Approximately 40 cfs bypasses this diversion to meet non-OID irrigation diversions with water rights to natural flows and/or contracted storage water, and to maintain flows in the Crooked River. OID and Reclamation have cooperatively made the non-binding decision to maintain at least 10 cfs through the low flow point on the Crooked River, roughly the stretch between the golf course near the city of Prineville to the confluence with Ochoco and McKay Creeks, to prevent the river from drying up.

From the diversion dam, the Crooked River Feed Canal runs north 8.3 miles and is siphoned under Ochoco Creek to the Barnes Butte Pumping Plant, serving irrigable lands along its course. The Barnes Butte Pumping Plant lifts a maximum of 147 cfs from the end of the Feed Canal to the head of the 15.8-mile-long Crooked River Distribution Canal which runs through the center of district lands. Operation of the Barnes Butte Pumping Plant requires extra water to be diverted in the Feed Canal to allow continuous pump operation and avoid short cycling or potential pump damage. This extra water is spilled back into Ochoco Creek.

The Ochoco Relift Pumping Plant is located on the Crooked River Distribution Canal at about mile 5 and lifts a portion of the flow to replenish the Ochoco Main Canal that serves lands east and west of McKay Creek. The distribution canal continues in a northwest direction, crossing McKay Creek at Reynolds Dam by siphon, where spills are made into the creek. The Crooked River Distribution Canal terminates at Lytle Creek, where the flows join any remaining spills coming from the Ochoco Main Canal and are routed down Lytle Creek to the Crooked River. In addition to the Barnes Butte and Ochoco Relift Pumping Plants, Reclamation has developed several smaller offstream pumping plants that distribute Project storage water and convey natural flow water (under a water right held by OID) to Crooked River project lands within OID's boundaries. These pumping plants take water from the Crooked River Feed Canal, Distribution Canal, or Ochoco Main Canal as described in the Operations Report on pages 60-62.

OID has strived to modify its diversion operations and facilities to improve fish passage and habitat by enhancing instream fish passage, minimizing diversion of fish into canals, and improving instumentation at existing streamflow gaging sites through partnerships with a wide variety of entities. Some examples include:

- Design and construction of several infiltration galleries,
- Replacement of outdated weirs with advanced inverted weirs to allow fish passage,
- Construction of several siphons which separate the irrigation ditch from the stream to avoid dewatering or chemical contamination of the creek,
- Upgrades on numerous gaging (streamflow monitoring) stations to include temperature monitoring; and
- Construction of year-round fish ladders.

OID has also strived to eliminate virtually all of its diversion dams that have historically blocked fish passage.

2.2.4 Wapinitia Project Operations

The Wapinitia Project consists of approximately 2,100 acres of irrigated lands in the White River subbasin (Figure 2-9). The Wapinitia Project, Juniper Division, is located near the confluence of the White and Deschutes Rivers and adjacent to Maupin in north-central Oregon. Project lands are located on Juniper Flat, a plateau 3- to 6-miles-wide and approximately 17 miles long. The project lands produce pasture, hay, and wheat; storage provides supplemental water supply for about 2,000 acres.

Federally-owned project features included in the proposed action are Wasco Dam and Clear Lake. Wasco Dam is the only storage facility in the Wapinitia Project, with a total active capacity of 11,900 acre-feet. The dam was constructed in 1959 at the outlet of Clear Lake, a natural lake. JFDIC uses storage in Clear Lake to supplement other privately developed water supplies.

The following is a brief summary of project operations included in the proposed action. Refer to pages 91-94 in the Operations Report for a detailed description. The proposed action includes the storage behind and release of water from Wasco Dam for diversion at the Clear Creek Diversion. Storage water is diverted into the privately owned and operated Clear Creek Diversion facilities under water rights held by JFDIC. Diversion of this storage water is interrelated and interdependent to the proposed action.

2.2.4.1 Storage and Delivery of Water

Wasco Dam and Clear Lake Operations

Project water is stored in Clear Lake behind Wasco Dam, about 35 miles west of Maupin, Oregon. The drainage area comprises over 8 square miles and is fed from seasonal precipitation, principally in the form of winter snowfall. Wasco Dam storage is used to supplement the irrigation flows on the project when the natural flows begin to decrease in July during wet years and as early as April in dry years. The total amount of water diverted from natural streamflow and storage for the Wapinitia Project is about 5,000 acre-feet annually. The diversion of the storage water is an interrelated and interdependent action; the diversion of the natural flow is by private facilities and not part of the proposed or interrelated and interdependent actions.

Summer inflows are received from many springs in the immediate reservoir area. In order to refill the reservoir for the irrigation season, the emergency gate is closed every year from October through April, with the regulating gate remaining open to bypass possible flood flows. If the elevation of the lake were to reach 3511 feet during the closure period, flood flows would discharge via the overflow weirs and through the open regulating gate.

Operation of Wasco Dam and Clear Lake are summarized in Table 2-10.

Table 2-10. Summary of Wasco Dam and Clear Lake Operations

Item	Comment
Releases	
Minimum release	None required. Some seepage occurs.
20-45 cfs	Typical peak irrigation release from dam.
50 cfs	Typical maximum diversion into Clear Creek diversion works.
52.9 cfs	JFDIC water right at Clear Creek diversion works.
Rate of change (maximum)	No limits.
Reservoir Content	
Minimum pool	None. The original natural lake volume remains when all storage water is used. Storage is nearly emptied in most drought years.
2,540 acre-feet	Average end-of-October carryover.[1]
11,900 acre-feet	Full pool (active capacity). Refills completely less than 20 percent of the years.
[1] Active capacity that is carried over on an average basis.	

Wapinitia Project, Oregon

Major Facilities

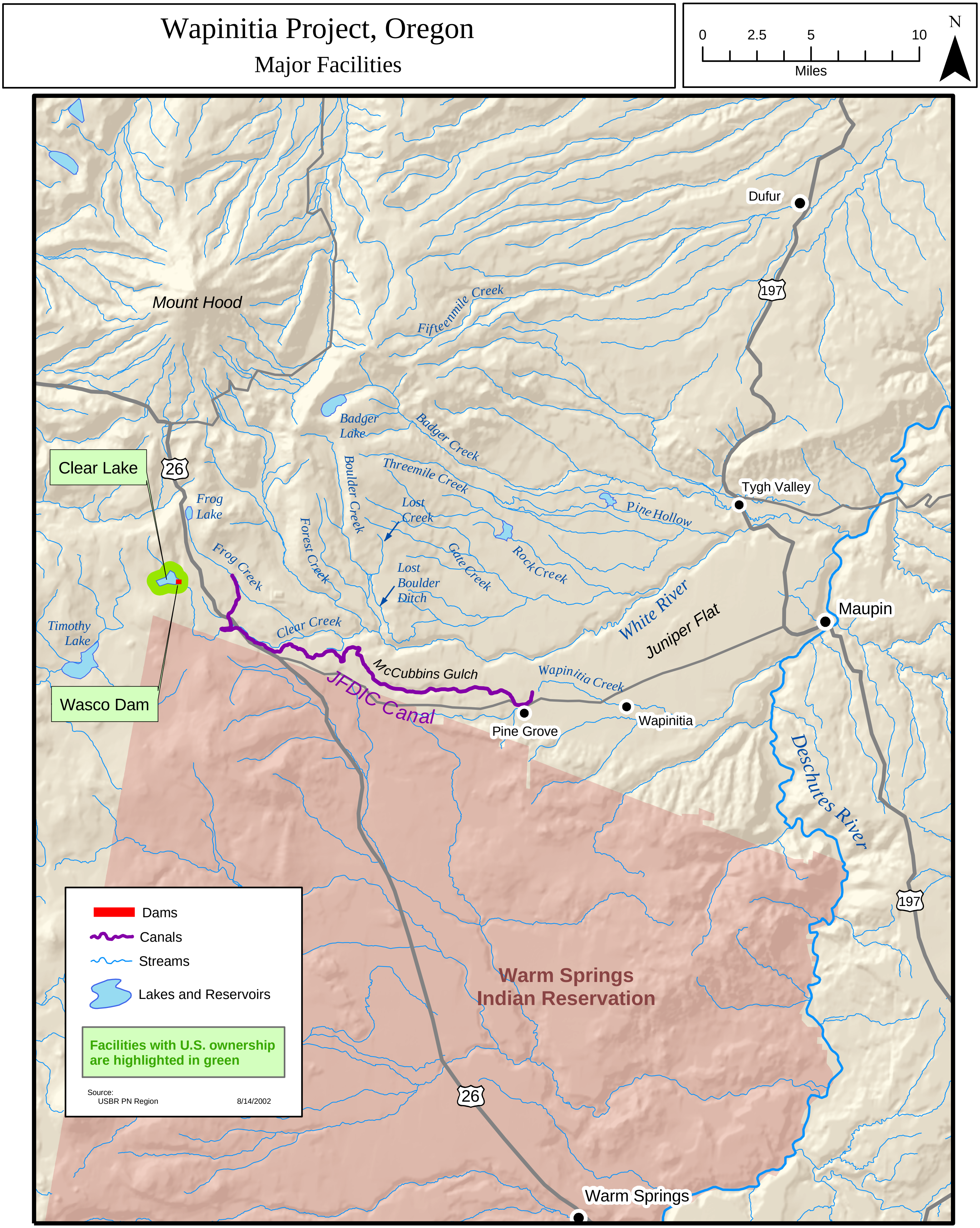


Figure 2-9

2.2.4.2 Diversion of Water

JFDIC has a water right to divert a maximum of 52.9 cfs at the Clear Creek diversion works. In normal years, natural flows from Clear Creek and Frog Creek will typically meet irrigation demands until some time in May or June before releases are needed from Wasco Dam. In wet years, reservoir releases may not be needed until late June or early July; in very dry years releases may be needed in April. Clear Creek is essentially dewatered at the Clear Creek diversion works during the irrigation season (except for early season water in excess of irrigation demand), but some leakage occurs and springs begin to replenish the live flow within about a mile downstream (Reclamation 2003a).

Water is conveyed from the Clear Creek diversion works through the JFDIC Main Ditch to McCubbin's Gulch, a natural watercourse. Water is then carried down McCubbin's Gulch to the extreme western edge of the district where it becomes part of the district's delivery system at Pine Grove. Flows at Pine Grove typically need to be 20 to 25 cfs to meet irrigation demand, with 30 cfs being the maximum capacity.

2.2.5 Facilities Maintenance

Maintaining facilities in good operating condition is important. Failure of features, such as outlet works stuck in the open or closed position or major cavitation/erosion damage, can quickly lead to significant damage to the structure and possible uncontrolled water releases which can be devastating to life, property, and the environment. The purpose of maintenance programs is to maintain facilities in good operating condition and to identify potential problems and repair features before failure occurs. Nonetheless, unexpected failure does occur. These failures can happen at any time and often require emergency repair operations to avoid major damage to the structure.

Federally-owned water conveyance and control facilities and facilities included in Reclamation's Safety of Dams program, require periodic inspection, maintenance, and repair; all major features undergo a major review of operation and maintenance at 3-year intervals. Periodic inspection may require operation of features at specific reservoir water surface elevations to assure continued reliable operation. Times of inspections are generally accomplished near the end of the irrigation season. When underwater dive inspections are required, minimum flows during inspections are coordinated with ODFW. Specific times, duration of flow interruptions, and minimum flow needs are coordinated with the ODFW, OWRD, and USFS. Repairs consist of repairing eroded concrete, recoating or replacing corroded metalwork, repairing cavitation damage to control gates, removing rock and debris from intake and outlet structures, and repairing metal and concrete outlet conduits. Dewatering of various features is often required for inspections, repairs, and other maintenance activities. Reduced or increased riverflow, lowering or raising the reservoir water surface, installation of bulkheads, and construction of cofferdams for temporary diversion of flows may be required.

Transferred works are routinely inspected jointly by Reclamation and the operating entity under the Review of Operation and Maintenance Program. If required maintenance is identified in an inspection, the operating entity prepares the specifications and is required to submit those specifications to Reclamation for review and approval.

Maintenance activities at one facility in a system may require system operation changes that affect reservoir levels and flows at other facilities. Emergency actions conducted by Reclamation which result in significant changes in flows or pool levels at reservoirs are coordinated with resource management agencies and other parties with major interests in the operation. When damage is identified or appears likely to occur, the risks are evaluated and a decision is made to make repairs immediately (emergency or unscheduled repairs) or, if practical, to delay repairs until the regular maintenance schedule.

The Operations Description report describes routine maintenance activities specific to Reclamation's Deschutes River basin project facilities (pages 49-51, 83, and 95). Work planned is subject to change depending on funding appropriations, additional study, or other unforeseen events. Non-routine maintenance activities potentially affecting ESA-listed species would entail a separate Section 7 consultation.

2.3 LEGAL AND STATUTORY AUTHORITIES

Reclamation's authority in operating and maintaining its projects is determined by numerous legal and statutory authorities and obligations. These include Congressional authorizations, state water law and associated water rights, and contractual obligations with contractors. The proposed action for this consultation is consistent with these authorities. This section elaborates on those authorities, responsibilities, and obligations to explain the rationale and limitations involved in operating Reclamation projects. The Operations Description report provides additional information and will be referenced as appropriate.

2.3.1 Congressional Authorizations

Reclamation must receive authorization from Congress before constructing a project. Authorizing legislation states the authorized purpose of the project or facilities that determines the uses of storage water and the limits within which a Federal facility can be operated. Irrigation is the primary purpose of all authorized projects in the Deschutes River basin. Other incidental uses are sometimes authorized for projects. For example, general authorizations for recreation and fish and wildlife apply to management of water and land surfaces and the development of facilities for recreation or safety purposes. They do not authorize reallocation of project water supply for these purposes. The following describes authorizing language for each of the Deschutes River basin projects.

2.3.1.1 Deschutes Project

The Deschutes Project was authorized by a finding of feasibility by the Secretary of the Interior on September 24, 1937; it was approved by the President on November 1, 1937 pursuant to the Act of June 25, 1910 (36 Stat. 836) and the Act of December 5, 1924 (43 Stat. 702). Construction of Haystack Dam was authorized by the Congress in Public Law 83-573 dated August 10, 1954. Irrigation is the authorized purpose of the Deschutes Project.

2.3.1.2 Crooked River Project

The Crooked River Project was authorized under the Act of August 6, 1956, specifically to provide irrigation water for lands in the Crooked River Project and other beneficial purposes, including flood control. The Act authorized the construction of minimum basic public recreation (health and safety) facilities and structures to promote the preservation and propagation of fish and wildlife. The authorized fish and wildlife purposes were specifically described as the construction of a fish screen and ladder at the Crooked River Diversion structure and a minimum release of 10 cfs from Bowman Dam to maintain the downstream fishery when releases are not being made for irrigation or flood control. Although no space in Prineville Reservoir is specifically allocated for health and safety facilities or for the minimum 10 cfs release, these purposes are considered during annual planning of reservoir operations.

The authorizing act was amended in 1959 to extend the Crooked River Project by increasing the land area receiving water, and again in 1964 to permit construction of additional irrigation facilities. Both amendments were intended to utilize uncontracted space in Prineville Reservoir for irrigation.

The Act does not authorize the use of the storage space for any purpose other than irrigation and flood control. Natural flow from the upper Crooked River is passed through Prineville Reservoir without being stored and is released from Bowman Dam to meet the minimum 10 cfs release requirement.

2.3.1.3 Wapinitia Project

Congress authorized the Wapinitia Project, Juniper Division, in Public Law 84-559 dated June 4, 1956. The authorized purpose of the project was for the irrigation of about 2,100 acres. Construction of minimum basic recreation facilities to allow public access and maintain health and safety were also authorized.

2.3.2 State Water Law

The western states obtained ownership of streams and control of the water within each state upon admission to the United States. Section 8 of the Reclamation Act of 1902 recognizes this principle by requiring that the acquisition and use of water for Reclamation projects shall proceed in conformity with state law. Reclamation storage and release of water for project purposes has complied and continues to comply with state water law.

State laws regulate the acquisition and the use of water and limit use of water to beneficial purposes determined by the state. Reclamation secures state water rights for its projects that are consistent with the authorized project purposes. Water rights are secured in accordance with state water law, and water rights granted by the state are defined in terms of the type of water use, period of use, the source of the water, the location of the point of diversion and place of use, and the rate and total volume that may be diverted, if applicable (some rights do not involve a diversion). Any changes in water use from those described in the water right definition must generally be authorized by the state through an approval of a transfer of a water right. Watermasters oversee the diversion and use of water to assure compliance with water rights of record.

Federal law provides that Reclamation obtain water rights for its projects and administer its projects pursuant to state law relating to the control, appropriation, use, or distribution of water, unless the state laws are inconsistent with expressed or clearly implied Congressional directives [43 U.S.C. ' 383; *California v. United States*, 438 U.S. 645, 678 (1978); appeal on remand, 694 F.2d 117 (1982)]. Water can only be stored and delivered by a project for authorized purposes for which Reclamation has asserted or obtained a water right in accordance with Section 8 of the Reclamation Act of 1902 and applicable Federal law. Reclamation must operate projects in a manner that does not impair senior or prior water rights. Reclamation has an obligation to deliver water to the project water users in accordance with the project water rights and contracts between Reclamation and the water users (which may be through an irrigation district). Water lawfully stored in project reservoirs can be used for project purposes to the extent the water is applied to beneficial use within the project.

In Oregon, as in most western states, a water right is obtained through application followed by beneficial use proof (see ORS 537.010). Likewise, Oregon law is similar to the laws of most other western states in that actual application of the water to the land is required to perfect a water right for agricultural use. Federal law concerning Reclamation projects, which is consistent with Oregon law, also provides that the use of water acquired under the Reclamation Act of 1902 "shall be appurtenant to the land irrigated, and beneficial use shall be the basis, measure, and the limit of the right" (43 U.S.C. ' 372). Beneficial use is determined in accordance with state law to the extent it is not inconsistent with Congressional directives (see *Alpine Land & Reservoir Co*., 697 F.2d at 853-854; see also *California v. United States*, 438 U.S. at 678). Reclamation has no general authority to reallocate project water without passage of legislation by Congress. These authorities and the contracts with the United States create and define the extent of the water users' rights.

In the Deschutes River basin, water rights to store water behind Reclamation facilities and to divert project storage water are held by the water users, with the exception of the Crooked River Project. Reclamation has water rights for storage of water behind Bowman Dam and also for diversion of Crooked River Project water for irrigation. (Tables 5, 13, and 19 in the Operations Report identify water rights associated with project facilities.)

Reclamation has limited authority to control diversion of storage water released from Reclamation facilities for circumstances where they do not hold the water right or own the diversion facilities, as is the case for Crane Prairie Reservoir and Clear Lake. The OWRD regulates the conveyance of water in the river and it protects flows from illegal diversion to the point where the water is diverted into canals. The proposed action includes storing water in and releasing water from Crane Prairie Reservoir and Clear Lake for diversion, but diversion of this water is an interrelated and interdependent action.

Although Reclamation does not hold the water right to store or divert Wickiup Reservoir storage water, it does own the storage and diversion facilities. The proposed action includes storing water in and releasing water from Wickiup Reservoir and diverting stored water into the North Unit Main Canal.

For the Crooked River Project, Reclamation possesses the water right for storing water behind Bowman Dam, releasing water into the Crooked River, and diverting Prineville Reservoir water. These actions are included in the proposed action for this consultation.

2.3.3 Contracts

Under provisions of the Reclamation Act, specific authorizations for features of the Deschutes Project, and subsequent contractual obligations, project costs were to be repaid by the beneficiaries, i.e., those entities who received project water or whose original irrigation facilities may have been improved or enlarged by the United States. In accordance with Reclamation law, the United States entered into various forms of repayment contracts with entities for reservoir storage, rehabilitation, and/or enlargement of existing facilities (that were privately owned at the time), or for the construction of a new storage and delivery system (e.g., Wickiup Dam and the delivery system for the NUID) in exchange for repayment of the construction costs allocated to irrigation and the allotted operations and maintenance costs.

The use of the water stored in Federal reservoirs is administered in conjunction with water rights and provisions of state water law. Reclamation operates reservoirs according to the contracts so that operations do not negatively affect storage without the permission or direction of the contractors. Repayment and other contracts having implications for the operation of Deschutes River basin project facilities are described in the Operations Report and referenced as appropriate in the section that follows.

2.3.3.1 Deschutes Project

Reclamation has current contracts with COID for operation of Crane Prairie Reservoir and with NUID for operation of Wickiup and Haystack Reservoirs. The Operations Description report at pages 30-32 provides details about these contracts.

The January 4, 1939, repayment contract with COID requires Reclamation to provide 50,000 acre-feet of storage in Crane Prairie Reservoir. The contract has specific language regarding the coordination of storage and releases between Wickiup and Crane Prairie Reservoirs. The contract contains language that allocates storage in the reservoirs according to the January 4, 1938, contract entered into between Arnold ID, COID, Lone Pine ID, and NUID.

Under provisions of the repayment contract between Reclamation and NUID, Reclamation agreed to construct facilities to provide 200,000 acre-feet of storage space to NUID to irrigate 50,000 acres in exchange for repayment by NUID of a portion of construction, operation, and maintenance costs. The contract also notes that project water supply is subject to the terms of the January 4, 1938, inter-district contract (between NUID, COID, Lone Pine, and Arnold ID) referred to earlier and a January 4, 1939, contract between the United States and COID. Table 2-11 summarizes the allocation of storage space in the two Deschutes Project reservoirs as defined by the relevant contracts. Storage in both reservoirs is fully contracted. Haystack Reservoir serves as a reregulating reservoir for releases made out of Wickiup Reservoir; therefore, it is not included in Table 2-11.

Table 2-11. Water Storage Allocation for Deschutes River Basin Federal Reservoirs

Reservoir	Spaceholder/Contractor	Storage Allocations (acre-feet)
DESCHUTES PROJECT		
Crane Prairie Reservoir	COID	26,000
	Arnold ID	13,500
	Lone Pine	10,500
	TOTAL	50,000
Wickiup Reservoir	NUID	200,000
CROOKED RIVER PROJECT		
Prineville Reservoir	OID	57,899
	Other [1]	10,374
	Uncontracted	80,360
	TOTAL	148,633
WAPINITIA PROJECT		
Clear Lake	JFDIC	11,900
1 Includes 14 other contracts ranging from about 3,500 to 19 acre-feet each		

2.3.3.2 Crooked River Project

Reclamation has repayment contracts with OID and 14 other water users for operation of Bowman Dam and storage water from Prineville Reservoir. The Operations Description report at pages 64-65 provides details about these contracts. Under the contract provisions, Reclamation agreed to construct facilities and provide almost 68,000 acre-feet of irrigation storage space in Prineville Reservoir to spaceholders in exchange for repayment of a portion of construction, operation, and maintenance costs. Almost 53 percent of the storage space in Prineville Reservoir is currently uncontracted. Reclamation has had a moratorium in place since the 1970s for new repayment contracts.

2.3.3.3 Wapinitia Project

Reclamation and JFDIC entered into a repayment contract for provision of 11,900 acre-feet of storage from Clear Lake in exchange for repayment of a portion of construction, operation, and maintenance costs. JFDIC has repaid the construction costs associated with construction of project facilities. Storage in the project is fully contracted. The Operations Description report on page 91 provides details about these contracts.

2.4 SUMMARY

Reclamation proposes to operate the three Federal projects in the Deschutes River basin to store, release, divert, and deliver project water (from storage) consistent with applicable law and historic operation of the recent past. Project operations have evolved over time to the current operations, but have remained fairly stable since the beginning of the 1990s. Irrigation storage from project reservoirs is released from the dams, diverted downstream at diversion dams and pump stations, and delivered through canals to project beneficiaries. Table 2-12 provides a summary of proposed and interrelated and interdependent actions associated with the major facilities connected with current Federal projects in the Deschutes River basin.

Reclamation is not responsible for effects on listed species of all water development and land management activities throughout the basin. For example, Reclamation is not responsible for the streamside rural development, road building, forest management, private water diversions, on-farm applications of pesticides and herbicides, or grazing influences that other state, Federal, and private agencies, organizations, and individuals have implemented in the Deschutes River basin.

Table 2-12. Summary of Proposed and Interrelated and Interdependent Actions

	Proposed Action	**Interrelated & Interdependent Actions**
Deschutes Basin		
Crane Prairie Dam & Reservoir	✔ storage & release of water	✔ diversion into private facilities
Wickiup Dam & Reservoir	✔ storage & release of water	
North Unit Headworks & Main Canal	✔ diversion of Wickiup Reservoir storage water	✔ diversion of natural flow water
Haystack Dam & Reservoir	✔ storage & release of water	
Arnold Diversion Dam & Canal, Central Oregon Headworks & Canal, North Canal (Pilot Butte)		✔ diversion of Crane Prairie Reservoir storage water only
Crooked River Pumping Plant		✔ diversion of Crooked River water
Crooked River Project		
Bowman Dam & Prineville Reservoir	✔storage & release of water	
Crooked River Diversion Dam and Feed Canal	✔ diversion of Prineville Reservoir storage water	✔ diversion of natural flow water
Crooked River Distribution Canal	✔ delivery of Prineville Reservoir storage water	✔ conveyance of natural flow water
Barnes Butte Pumping Plant & Ochoco Re-lift Plant	✔ delivery of Prineville Reservoir storage water	✔ conveyance of natural flow water
9 small pumping plants	✔ delivery of Prineville Reservoir storage water	✔ conveyance of natural flow water
Ochoco Dam & Reservoir		✔ storage & release of Ochoco Creek water
Ochoco Main Canal, Rye Grass, & other distribution canals		✔ conveyance of Prineville Reservoir storage water
Rice Baldwin, Central Ditch, People's Ditch, Lowline Ditch	✔ diversion of Prineville Reservoir storage water	
Wapinitia Project		
Wasco Dam and Clear Lake	✔ storage & release of water	
Clear Creek Diversion, JFDIC Main Ditch		✔ diversion of Clear Lake storage water

CHAPTER 3.0 HYDROLOGIC CONDITIONS

3.1 INTRODUCTION

The hydrologic regime in the Deschutes River basin has been altered by over 100 years of irrigation, hydropower, and other water development activities. Irrigation development first began in the basin in the 1860s when farmers diverted water from tributaries of the Deschutes River. Irrigation became widespread in the early 1900s when several small irrigation companies were formed. Reclamation built or rehabilitated the major irrigation reservoirs in the basin in the 1940s and 1950s. The following section describes the hydrologic changes that have occurred in the Deschutes River basin as a result of water development activities that may have impacted species which are now listed under ESA. These hydrologic effects described here are part of the environmental baseline for this consultation.

3.2 HYDROLOGIC DATA

Observed hydrologic data from the last 70 to 80 years of record were analyzed to determine current basin conditions resulting from historic management practices. Data were obtained from historical databases of the USGS, the OWRD, and Reclamation. Reservoir elevations are end-of-month elevations for each month of the year for the period of record. Historic river flow hydrographs are plotted from the average daily flows over the period. A flow exceedance analysis was done on the average monthly flows calculated from the average daily flows.

Hydrologic data is reported by water year. A water year is the 12-month period from October 1 through September 30. The water year is designated by the calendar year in which it ends. For example, the 2003 water year consists of the period from October 1, 2002 through September 30, 2003.

Reservoir elevations of Crane Prairie and Wickiup Reservoirs on the Deschutes River, Prineville Reservoir on the Crooked River, and Clear Lake on the White River are analyzed. Historic river flows for the following are summarized:

- Deschutes River below Crane Prairie and Wickiup Reservoirs
- Deschutes River below Bend, near Culver, Madras, and at Moody
- Crooked River below Arthur Bowman Dam (Prineville Reservoir)
- Crooked River near Culver and below Opal Springs
- Clear Creek below Clear Lake
- White River below Tygh Valley

A diagram of the water distribution system for the Deschutes River basin is shown in Figure 3-1. This figure is not comprehensive but intended only to illustrate the sequence of major storage, inflows, outflows (diversions), and major stream gages described in this report.

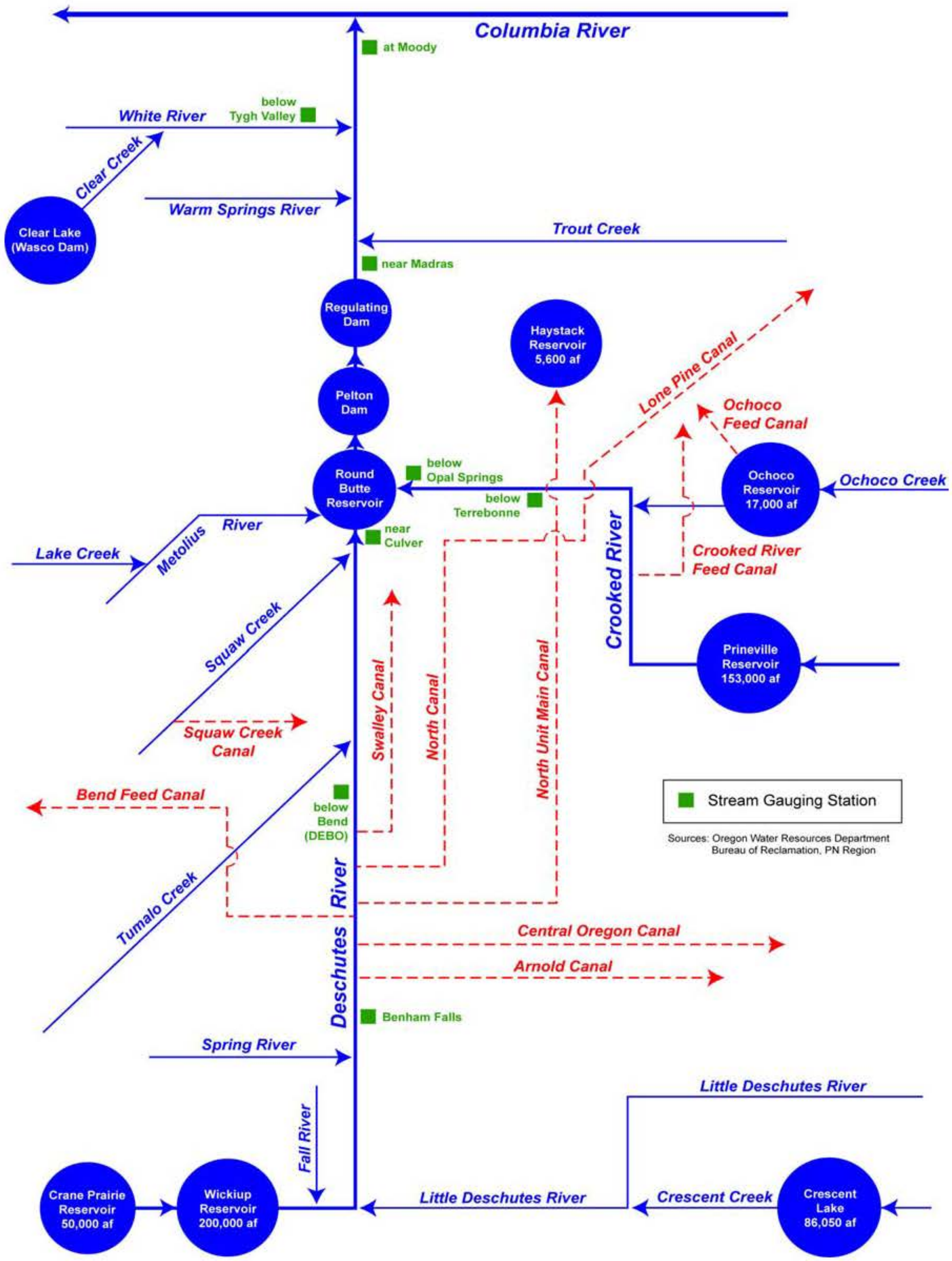


Figure 3-1. Deschutes River Basin Water Distribution System

3.3 DESCHUTES RIVER

3.3.1 Crane Prairie Reservoir

Crane Prairie Dam was privately constructed in 1922 as a rock-filled timber-crib structure and was later rehabilitated by Reclamation in 1940. Operation of Crane Prairie Dam and Reservoir changed with the construction of Wickiup Reservoir in 1949. Figure 3-2 displays the historic end-of-month elevations of Crane Prairie Reservoir for water years 1941 through 2001. The reservoir achieved full pool (elevation 4445 feet) about once every 3 years. Prior to construction of Wickiup Dam in 1949, there was a greater fluctuation in annual elevation and lower minimum elevations at Crane Prairie Reservoir. The less variable elevations and the higher minimum elevations after 1949 are most likely due to the coordinated management of Crane Prairie and Wickiup Reservoirs for filling, which is described in pages 32-42 of the Operations Report. A Crane Prairie Reservoir unofficial minimum discharge of 30 cfs was also set in the mid-1950s.

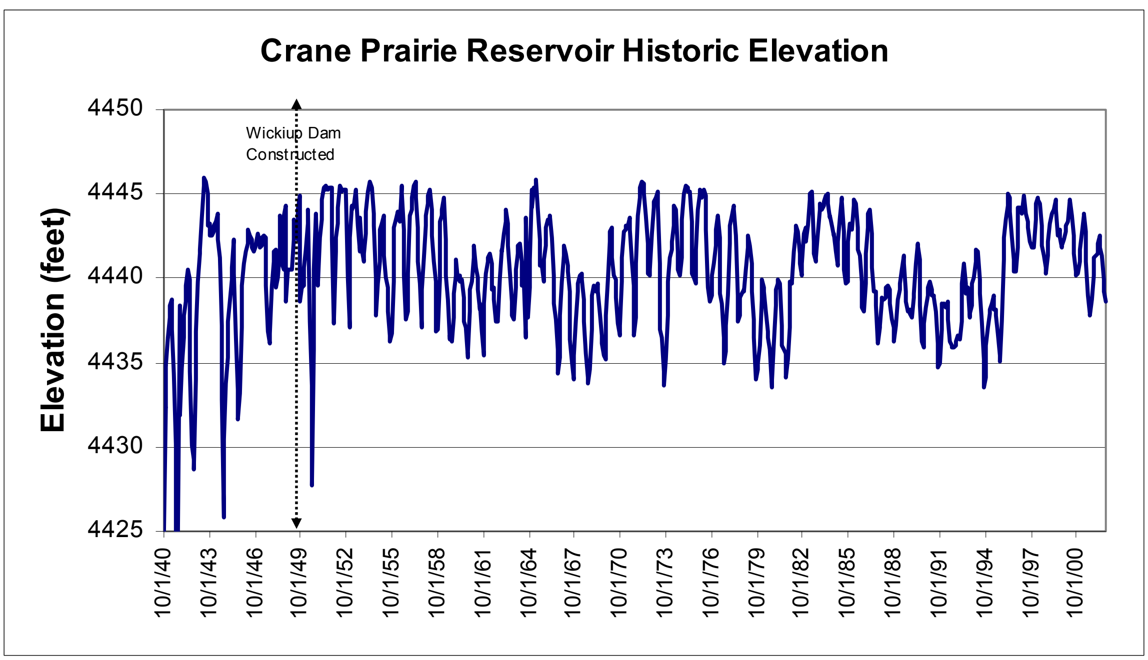


Figure 3-2. Crane Prairie Historic End-of-Month Reservoir Elevations (Water Years 1941-2001)

3.3.2 Deschutes River below Crane Prairie Dam

Figure 3-3 shows the historic average daily flow downstream from Crane Prairie Reservoir for water years 1923 through 2001; Figure 3-4 shows these flows that were less than 50 cfs. The historical record for Crane Prairie was divided into three periods: 1) water years 1923 through 1938 before Crane Prairie Dam was rehabilitated and Wickiup Dam was built, 2) water years 1939 through 1949 the period during which Crane Prairie Dam was rehabilitated and Wickiup Dam was built, and 3) the period 1950 through 2001 when both reservoirs were built and operating. The average monthly flow percent exceedance plots for water years 1923 through 1938 are shown in Figure 3-5 and water years 1950 to 2001 are shown in Figure 3-6. These two periods were chosen to compare river flows before the reservoirs were built to flows after both Crane Prairie and Wickiup Dams were built and operating.

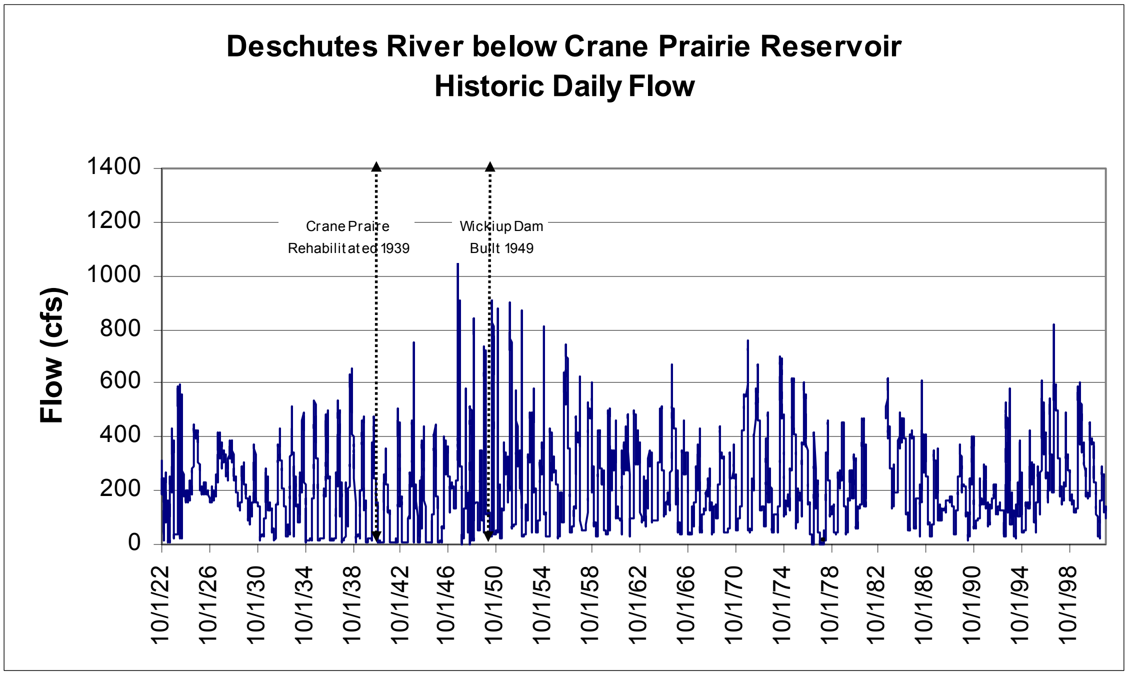


Figure 3-3. Deschutes River below Crane Prairie Reservoir, Historic Average Daily Flow (Water Years 1923-2001).

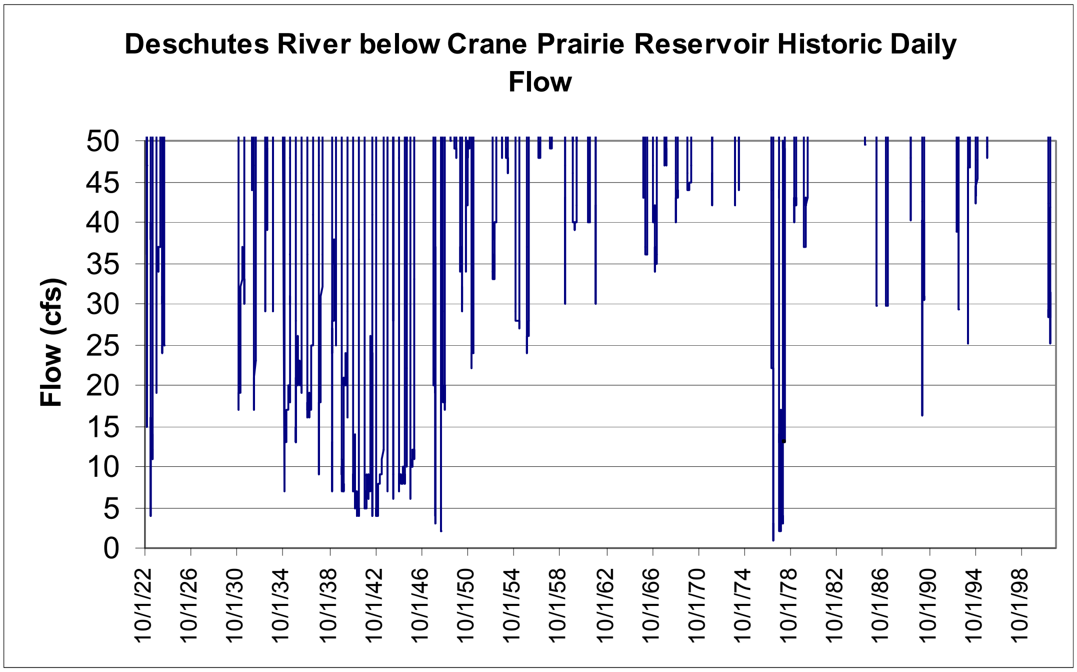


Figure 3-4. Deschutes River below Crane Prairie Dam, Historic Average Daily Flow less than 50 cfs (Water Years 1923-2001)

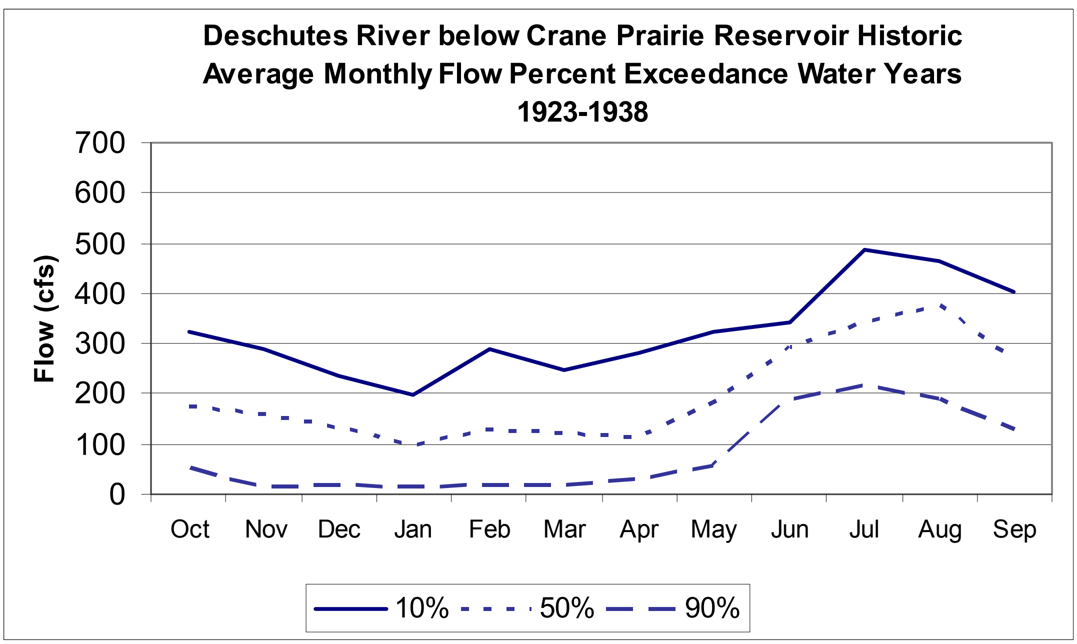


Figure 3-5. Deschutes River below Crane Prairie Dam, Average Monthly Flow Percent Exceedance Prior to Construction of Wickiup Dam (Water Years 1923-1938)

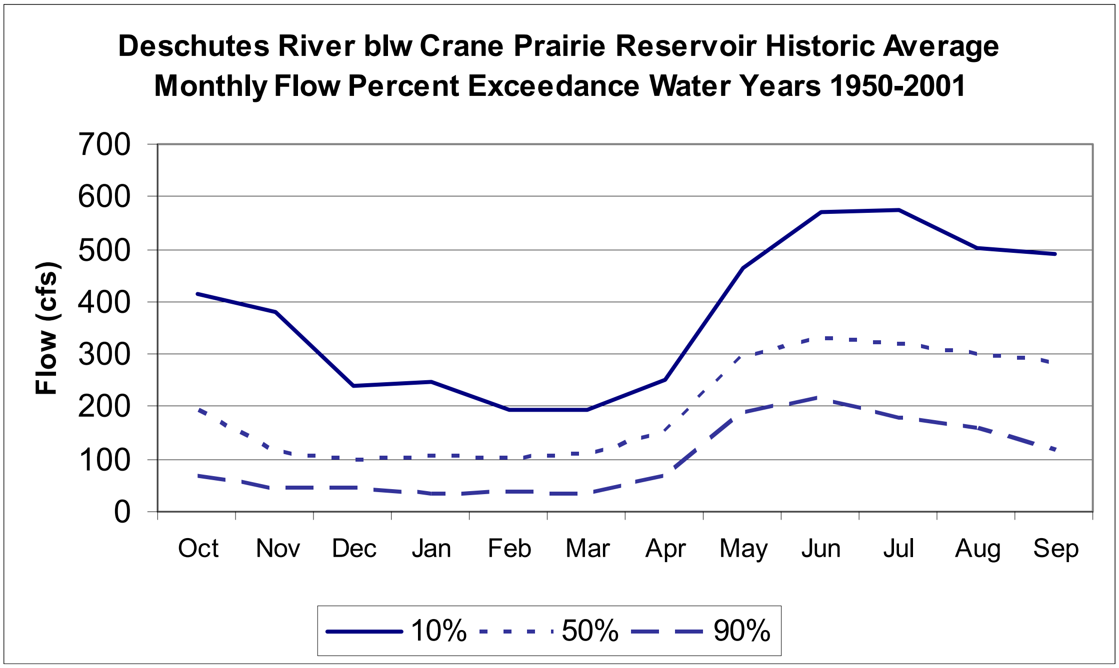


Figure 3-6. Deschutes River below Crane Prairie Dam, Average Monthly Flow Percent Exceedance After Construction of Wickiup Dam (Water Years 1950-2001)

Exceedance level values for flows or reservoir elevations are derived by sorting and ranking the data, usually by month. Flow values for October at the 10 percent exceedance level would occur when October flows are unusually high; 50 percent flows would occur in a median October; and 90 percent flows would occur when October flows are unusually low. For example, from Figure 3-5, the October 10 percent exceedance flow is 323 cfs, meaning 10 percent of the time average monthly October flows equal or exceed 323 cfs. Also, from Figure 3-5, the 90 percent exceedance flow for October is 52 cfs, meaning 90 percent of the time average monthly October flows equal or exceed 52 cfs.

Crane Prairie Dam was not rehabilitated by Reclamation until 1940, but there was a timber-crib structure at Crane Prairie that regulated the flow in the 1923 through 1938 period. From the discharge data and percent exceedance plots (Figure 3-5 and Figure 3-6), the flows were generally lower for the 90 percent exceedance during the winter months prior to construction of the reservoir (1923 through 1938) when compared to the after construction period. After Wickiup Dam was constructed in 1949, median flows downstream from Crane Prairie Dam were higher in April, May, and June due to irrigation releases and were lower in July and August due to irrigation flows being provided by Wickiup Reservoir downstream (water years 1950-2001). In the late 1930s and 1940s before Wickiup Dam was constructed, the winter minimum flows were well below 30 cfs and many times below 10 cfs. From the mid-1950s on, the minimum flows were generally in the 25 to 30 cfs range or more. During extremely dry years in the late 1970s and briefly in 1991, the flows dropped below 30 cfs, but since the mid-1950s there were fewer occurrences of very low flows. The infrequent occurrence of flows below 30 cfs since the mid-1950s, the presence of Wickiup Dam since 1949, and the management of the two reservoirs together explains the uniformity of Crane Prairie Reservoir elevation trends since the 1950s.

3.3.3 Wickiup Reservoir

Wickiup Dam was completed in 1949. Figure 3-7 displays the historic end-of-month elevations of Wickiup Reservoir for water years 1950 through 2001. During this 49-year period the reservoir filled approximately 70 percent of the time (elevation 4337.7 feet). In 1954 an official minimum winter discharge of 20 cfs was established. The elevation data show that the annual fluctuation of the reservoir elevation was greater prior to 1970. After 1970, the annual elevation ranges are more uniform and generally the reservoir is not drawn down as low as compared to pre-1970 data. There is no clear reason for this change in elevation trends. This may be due to more efficient use of the water or changes in land management and irrigation practices.

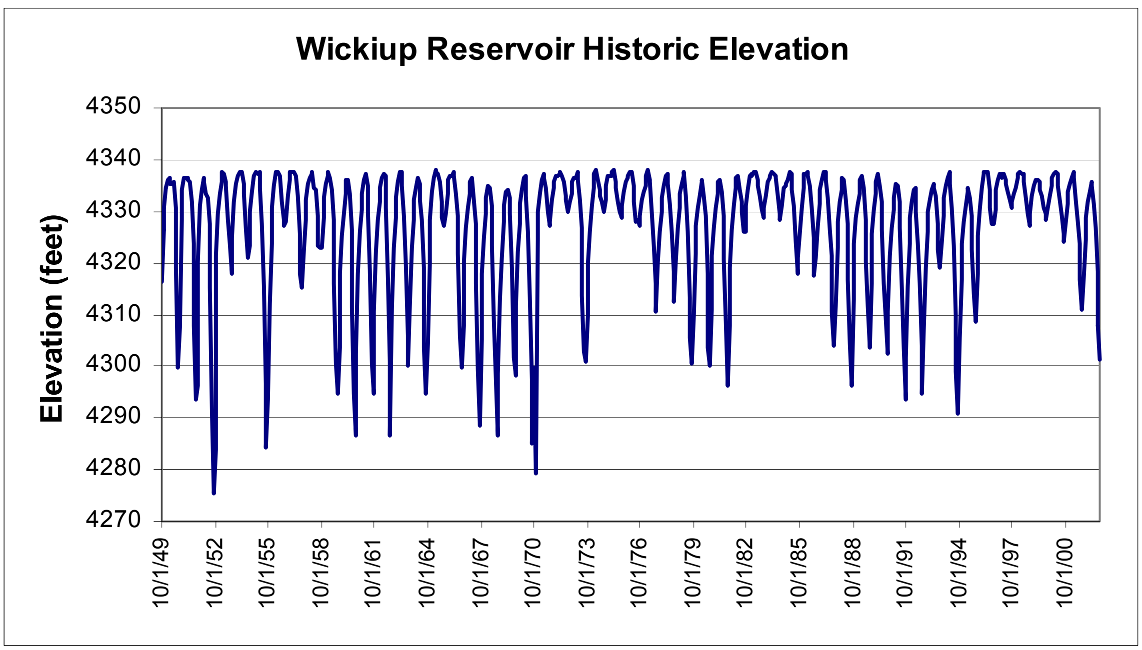


Figure 3-7. Wickiup Reservoir Historic End-of-Month Elevations (Water Years 1950-2001)

3.3.4 Deschutes River below Wickiup Dam

The average daily flows from water years 1939 to 2001 for the Deschutes River below Wickiup Dam are shown in Figure 3-8 and the average daily flows below 50 cfs are shown in Figure 3-9. The percent exceedance plot for the Deschutes River below Wickiup Reservoir for water years 1939 through 1949 is shown in Figure 3-10 and for water years 1950 through 2001 is shown in Figure 3-11.

In the period before Wickiup Dam was completed (1938 through 1948), the median (50 percent exceedance) flows are higher during the winter months and lower in the summer months when compared to the median flows after construction (1950 through 2001). The lower winter flows after construction reflect storage of water for refill and the higher summer flows are due to irrigation releases. Figure 3-8 shows a downward trend in summer discharges from 1950 on indicating more efficient irrigation practices and delivery systems in the basin, in addition to greater precipitation in later years requiring less storage water. From Figure 3-9 there is no obvious change to the frequency or level of minimum flows in the period after Crane Prairie and Wickiup Dams were constructed.

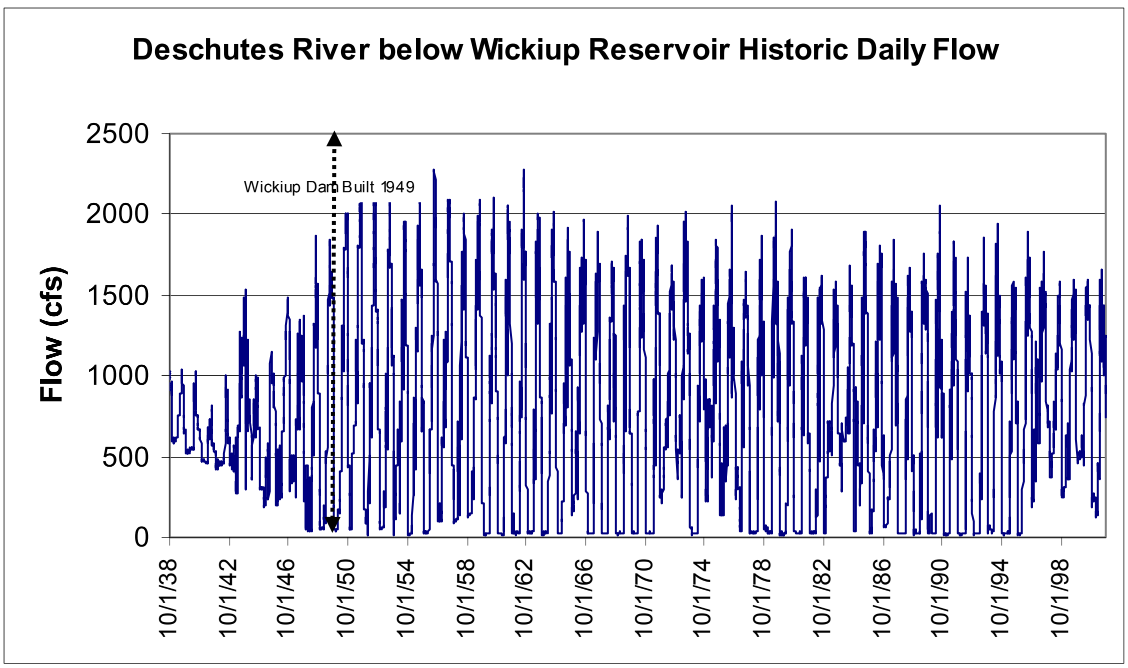


Figure 3-8. Deschutes River Below Wickiup Dam, Historic Average Daily Flow (Water Years 1939-2001)

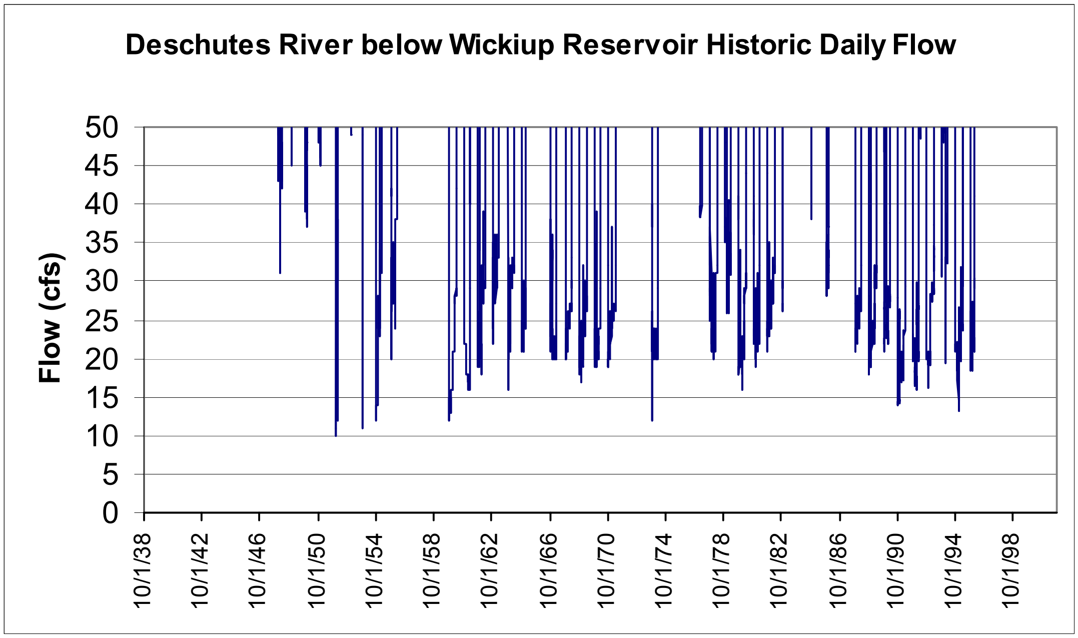


Figure 3-9. Deschutes River Below Wickiup Dam, Historic Average Daily Flows less than 50 cfs (Water Years 1939-2001)

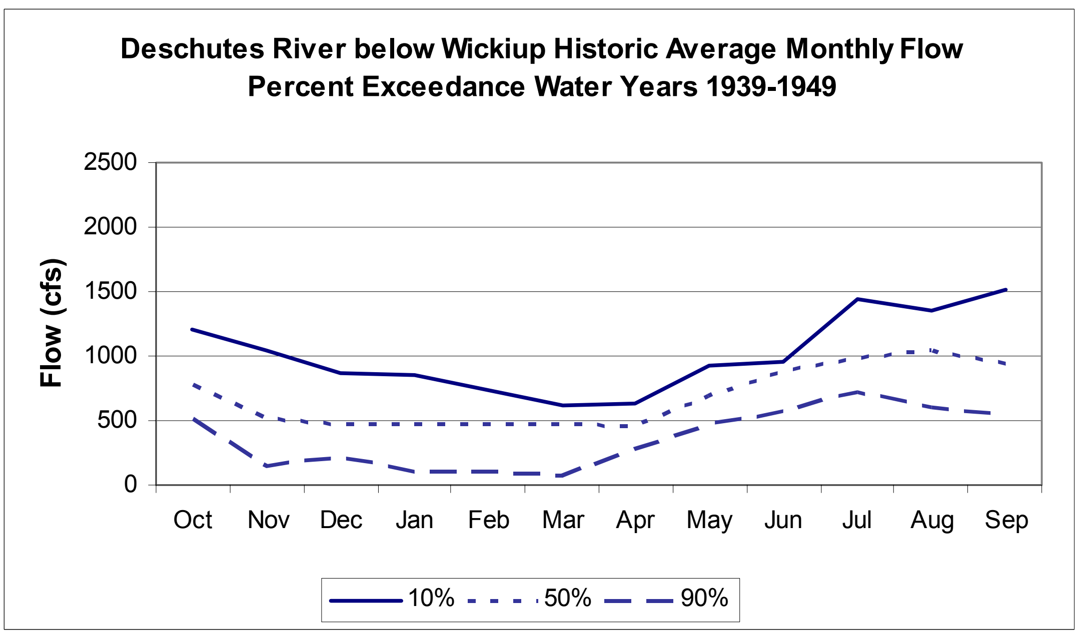


Figure 3-10. Deschutes River Below Wickiup Dam, Average Monthly Flow Percent Exeedance Before Construction of Wickiup Dam (Water Years 1939-1949)

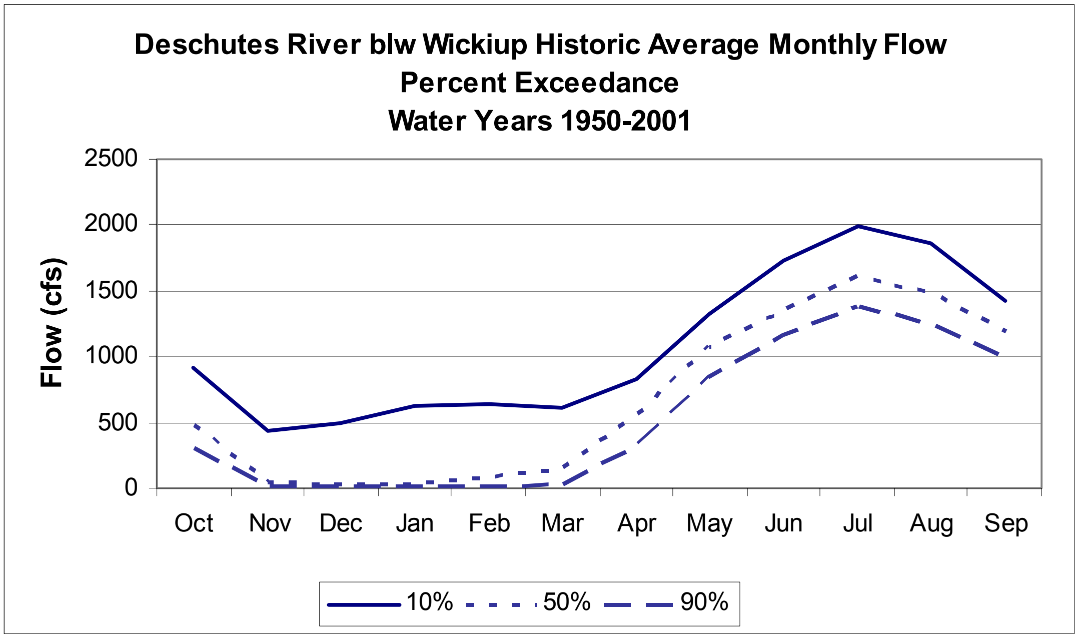


Figure 3-11. Deschutes River Below Wickiup Dam, Average Monthly Flow Percent Exceedance After Construction of Wickiup Dam (Water Years 1950-2001)

3.3.5 Deschutes River below Bend

The historic average daily flow for the Deschutes River below Bend for water years 1916 through 1990 is shown in Figure 3-12. The Deschutes River below Bend gage is located downstream of North Canal Dam near the town of Bend at RM 164.4. Two periods of record for the Deschutes River below Bend were examined: 1) water years 1916 through 1939 before Crane Prairie and Wickiup Dams were built, and 2) water years 1950 through 1990 after both Crane Prairie and Wickiup Dams were in place. The period of record from 1940 through 1949 are not included because Crane Prairie Dam was reconstructed and Wickiup Dam was constructed during these years.

The average monthly flow percent exceedance plot for water years 1916 through 1939 (before Crane Prairie and Wickiup Dams) is shown in Figure 3-13 and the exceedance plot for water years 1950 through 1990 is shown in Figure 3-14. The period before Crane Prairie and Wickiup Dams had higher flows during much of the water year. Flows were higher before the two projects due to less diversion and storage of water for irrigation.

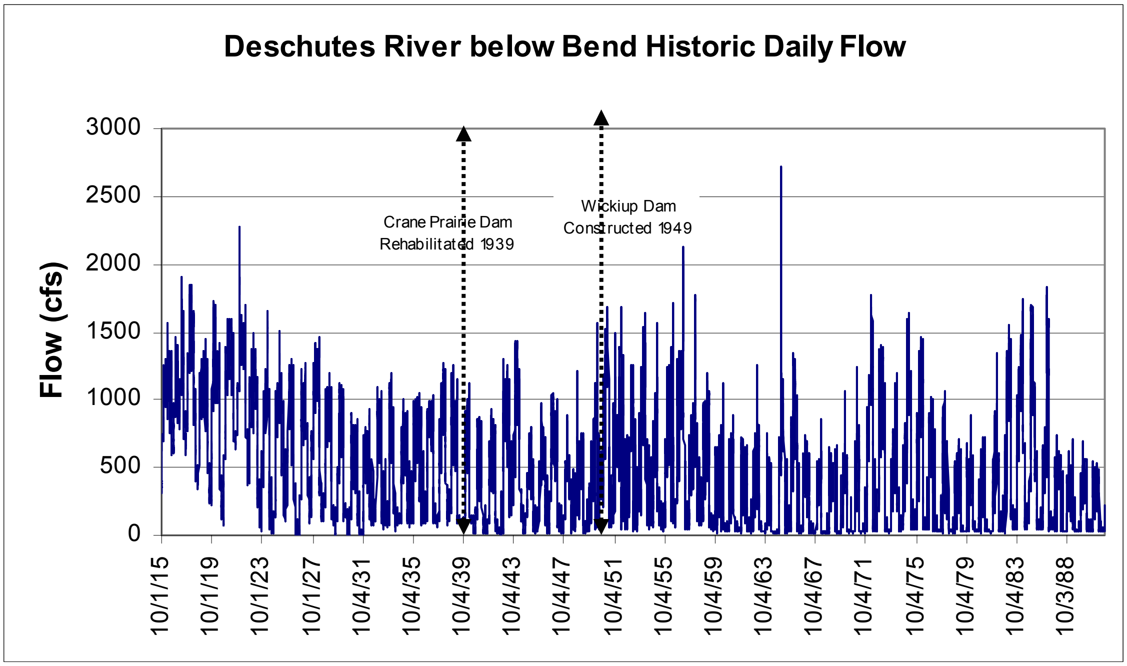


Figure 3-12. Deschutes River below Bend, Historic Daily Flow (Water Years 1916-1990)

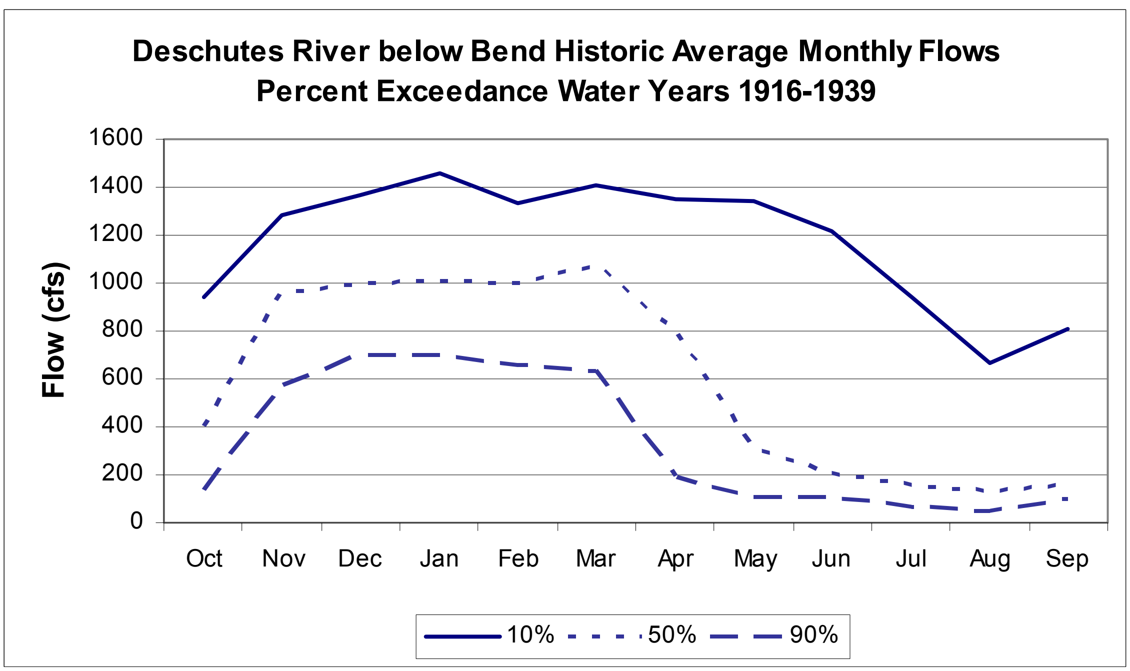


Figure 3-13. Deschutes River below Bend, Historic Average Monthly Flow Percent Exceedance (Water Years 1916-1939)

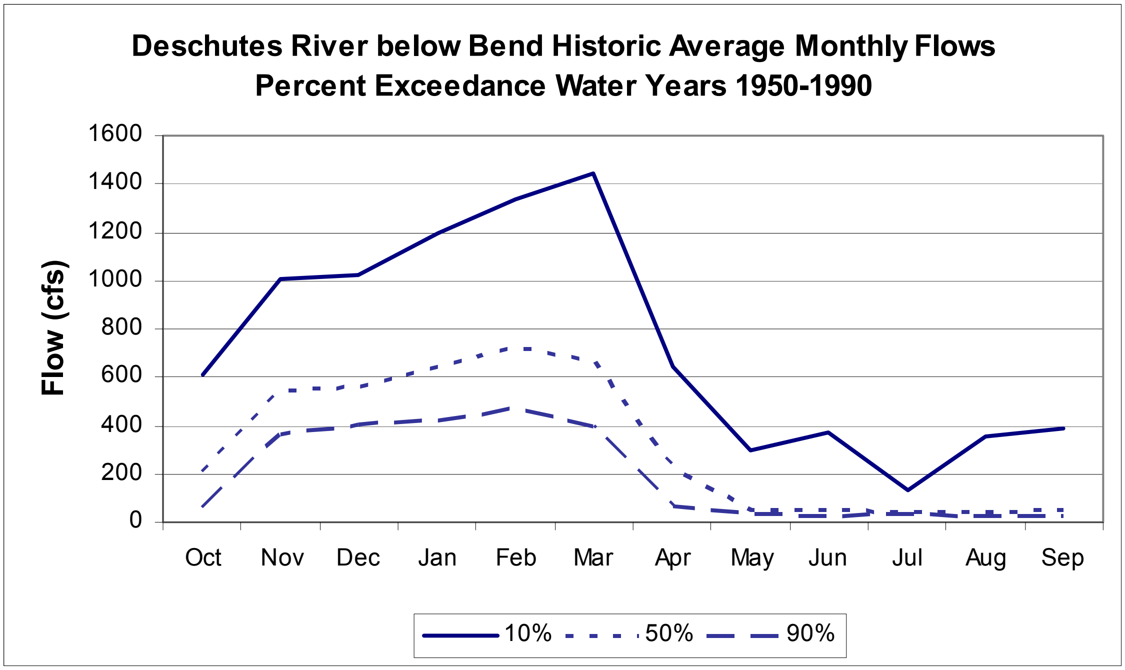


Figure 3-14. Deschutes River below Bend, Historic Average Monthly Flow Percent Exceedance (Water Years 1950-1990)

3.3.6 Deschutes River Near Culver

The historic average daily flow data for the Deschutes River near Culver for water years 1953 through 2001 are shown in Figure 3-15. The Deschutes River near Culver gage is located directly upstream from Lake Billy Chinook and downstream of Squaw Creek at RM 120.1. The flows range from a minimum of about 500 cfs to a maximum of nearly 5,000 cfs. The flows are lower during the late 1980s and early 1990s due to very dry conditions and low water supply.

The area upstream from this gage has significant groundwater discharge. Groundwater discharge was estimated from OWRD seepage runs. A seepage run consists of a series of discharge measurements made at sequentially downstream locations along a stream reach over a short period of time. The Deschutes River gained approximately 400 cfs along the 10-mile reach above the gaging station near Culver during seepage runs in May 1992 and May 1994 (Gannett et al. 2001). The consistency of the flows in both wet and dry years confirms the influence of considerable groundwater gains in this reach of the river. The exceedance plot for the Deschutes River near Culver is shown in Figure 3-16. Flows are higher during the winter when compared to the irrigation season due to significant groundwater discharge during the winter months

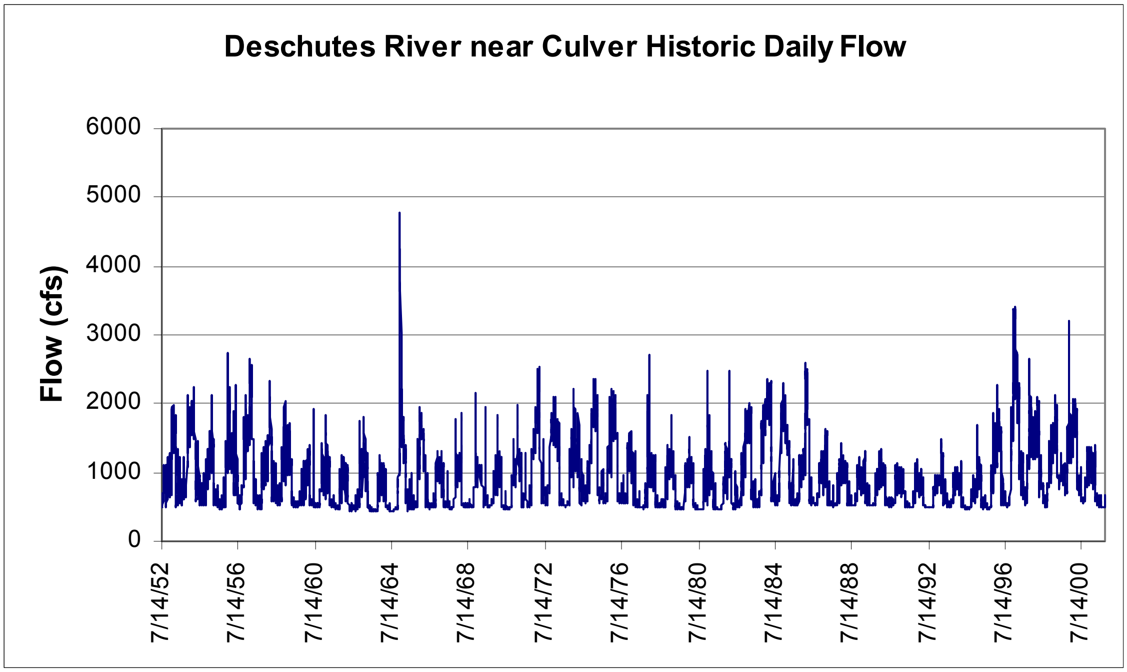


Figure 3-15. Deschutes River near Culver, Historic Average Daily Flow (Water Years 1953–2001)

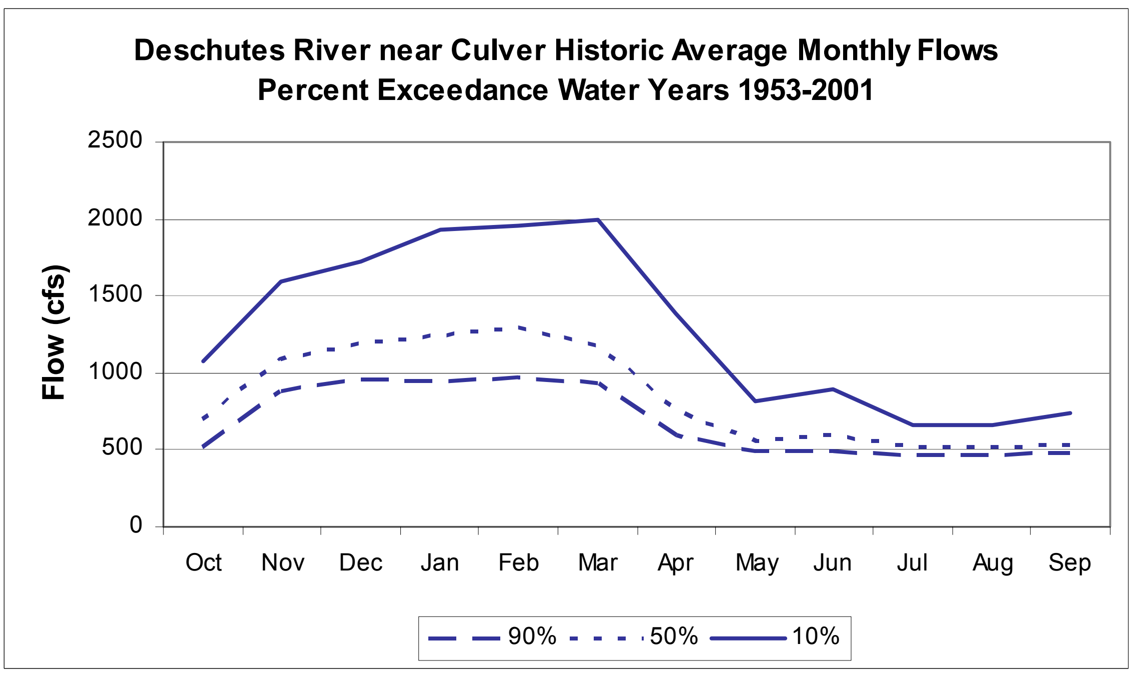


Figure 3-16. Deschutes River near Culver, Average Monthly Flow Percent Exceedance Plot (Water Years 1953-2001)

3.3.7 Deschutes River Near Madras

The Deschutes River near Madras gage is located directly downstream from Lakes Billy Chinook and Simtustus at RM 100.1. Flows at this location include contributions from the Metolius and Crooked Rivers. The average daily historic flows for water years 1925 through 2001 for the Deschutes River near Madras are shown in Figure 3-17. The daily flows ranged from 2,440 cfs to 17,800 cfs and minimum flows ranged from 2,000 to 3,000 cfs.

Two periods of record were examined for the Deschutes River near Madras: 1) water years 1925 through 1939, before any Reclamation reservoirs were in place, and 2) 1962 through 2001, when all Reclamation reservoirs were in place and operating (Crane Prairie, Wickiup, and Prineville Reservoirs). Additionally, the period after 1962 reflects operation effects from the private Pelton-Round Butte hydroelectric complex. Daily flows are less erratic post-1962.

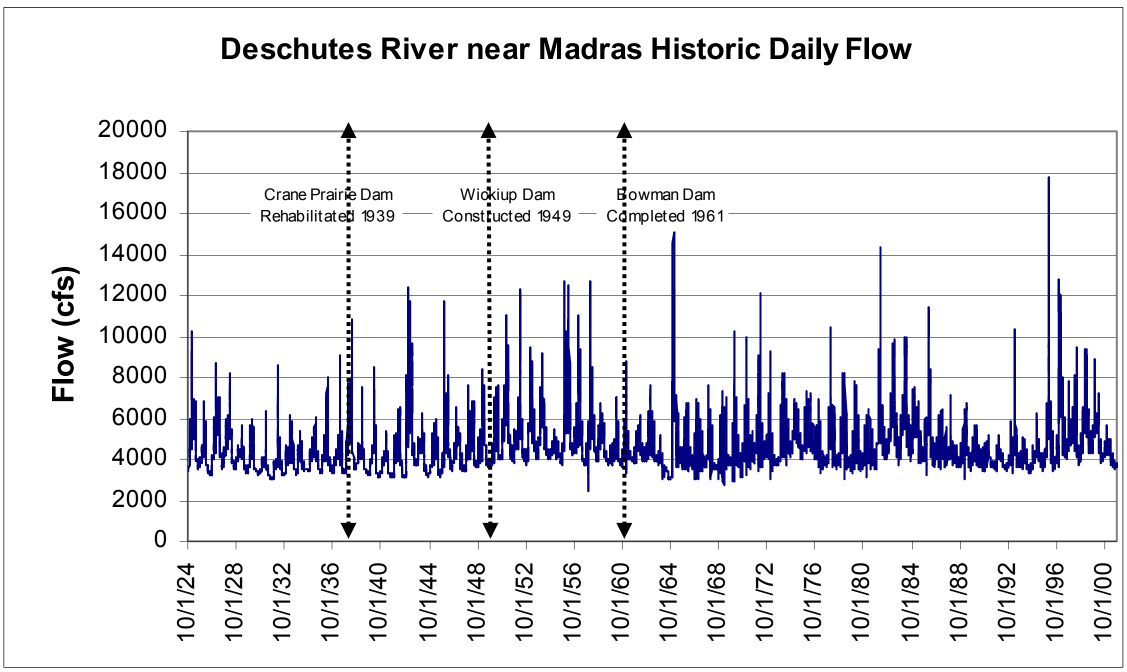


Figure 3-17. Deschutes River near Madras, Historic Average Daily Flow (Water Years 1925-2001).

The percent exceedance plot of the average monthly flows for the Deschutes River near Madras for the 1925 through 1939 period is shown in Figure **3-18** and for the 1962 through 2001 period in Figure 3-19. The exceedance plots have the same general shape with the highest flows in February and March and the lowest flows during July through November. Flows post-1962 are generally higher than prior to water development in the basin. The 50 percent exceedance is the most similar pre and post-water development with the 1962 through 2001 period having slightly higher flows during the winter which could be due to a greater amount of groundwater discharge from irrigation. The 10 percent exceedance on the 1925 through 1939 plot is much lower than the 10 percent exceedance on the 1962 through 2001 plot indicating a drier period during 1925 through 1939. With the exception of the January through March period, flows at the 90 and 50 percent exceedance are within 10 percent of each other.

Table 3-1 shows the average monthly flow exceedance for water years 1990 through 2001 for the Deschutes River near Madras gage.

Table 3-1. Average Monthly Flow (cfs) Exceedance for the Deschutes River near Madras

Gage Location (period of record)	Percent Exceedance	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Deschutes River													
Near:	90%	3708	4053	4023	4055	3952	3906	3739	3637	3643	3424	3586	3566
Madras	50%	3977	4305	4525	4591	4836	4775	4149	4081	3923	3777	3832	3773
(water years 1990-2001)	10%	5410	5714	7253	9600	8974	7732	7643	5807	5899	4863	4695	4911

* Information from: http://www.wrd.state.or.us

The Deschutes River flows near Madras reflect the influence of groundwater discharge. Gannett et al. (2001) estimated that the total groundwater discharge in the confluence area around Lake Billy Chinook was 2,300 cfs . They concluded that these groundwater discharges, along with the flow of the Metolius River (which is primarily groundwater discharge during the dry season), makes up almost all of the flows of the Deschutes River near Madras during the summer and early fall (Gannett et al. 2001).

Irrigation canal seepage is a significant source of groundwater recharge. It is estimated that 46 percent of the water diverted upstream from Lake Billy Chinook for irrigation is lost through canal leakage (Gannett et al. 2001). The average annual rate of leakage from irrigation canals to groundwater during 1994 (a year studied in detail by Gannett et al. 2001) was 356,600 acre-feet (490 cfs). Canal leakage peaked in the late 1950s when mean annual diversions were approximately 940,000 acre-feet (1,300 cfs) and nearly 435,000 acre-feet (600 cfs) was lost to groundwater recharge.

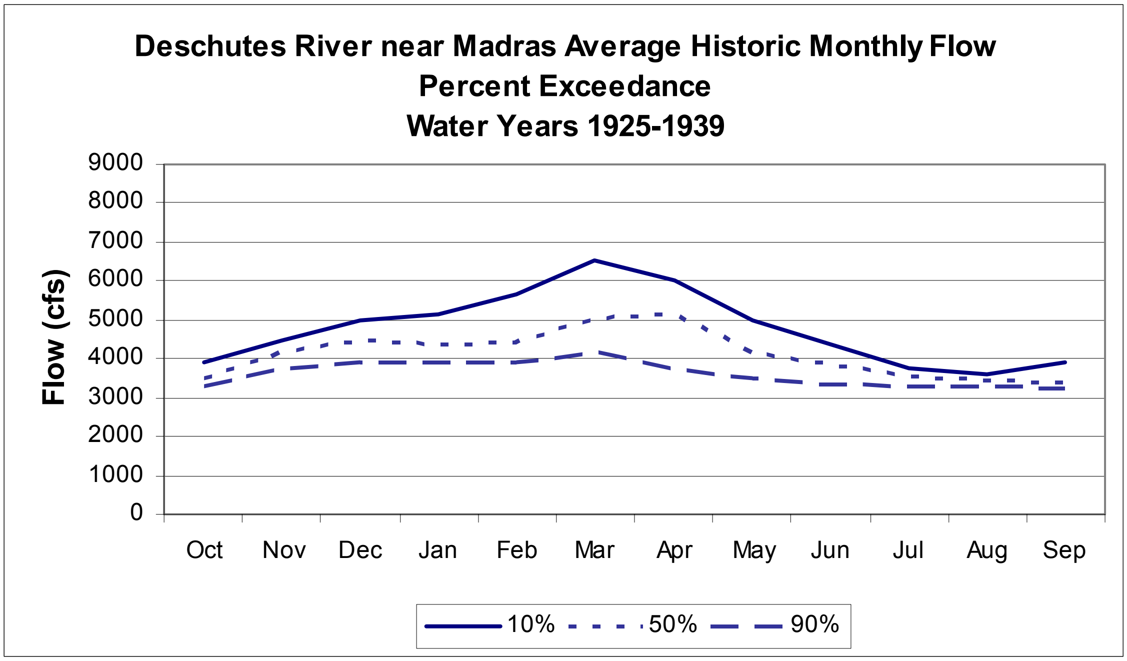


Figure 3-18. Deschutes River near Madras, Average Monthly Flow Percent Exceedance Plot (Water Years 1925-1939)

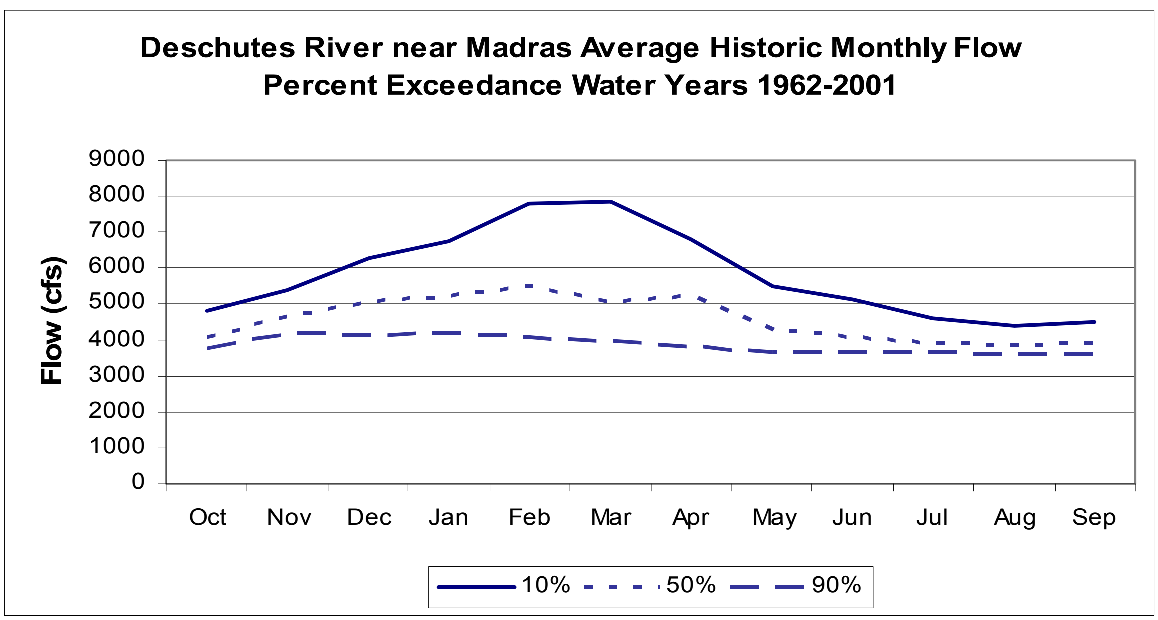


Figure 3-19. Deschutes River near Madras, Average Monthly Flow Percent Exceedance Plot (Water Years 1962-2001)

3.3.8 Deschutes River at Moody

The Deschutes River at Moody gage is located at RM 1.4 near the mouth of the Deschutes River where it enters the Columbia River. The historic average daily flow of the Deschutes River at Moody is shown in Figure 3-20. The minimum flows at Moody ranged from 2,880 to 5,000 cfs during the 1907 through 2001 water year period.

Two periods of record were examined for the Deschutes River at Moody: 1) water years 1907 through 1939, before any Reclamation projects were present in the basin, and 2) 1962 through 2001, the period when all the irrigation projects and Pelton-Round Butte hydropower complex were operating. The historic average monthly flow percent exceedance plot for water years 1907 through 1938 period is shown in Figure 3-21 and for water years 1962 through 2001 in Figure 3-22. Table 3-2 shows the average monthly flow exceedance for water years 1990 through 2001 for the Deschutes River at Moody.

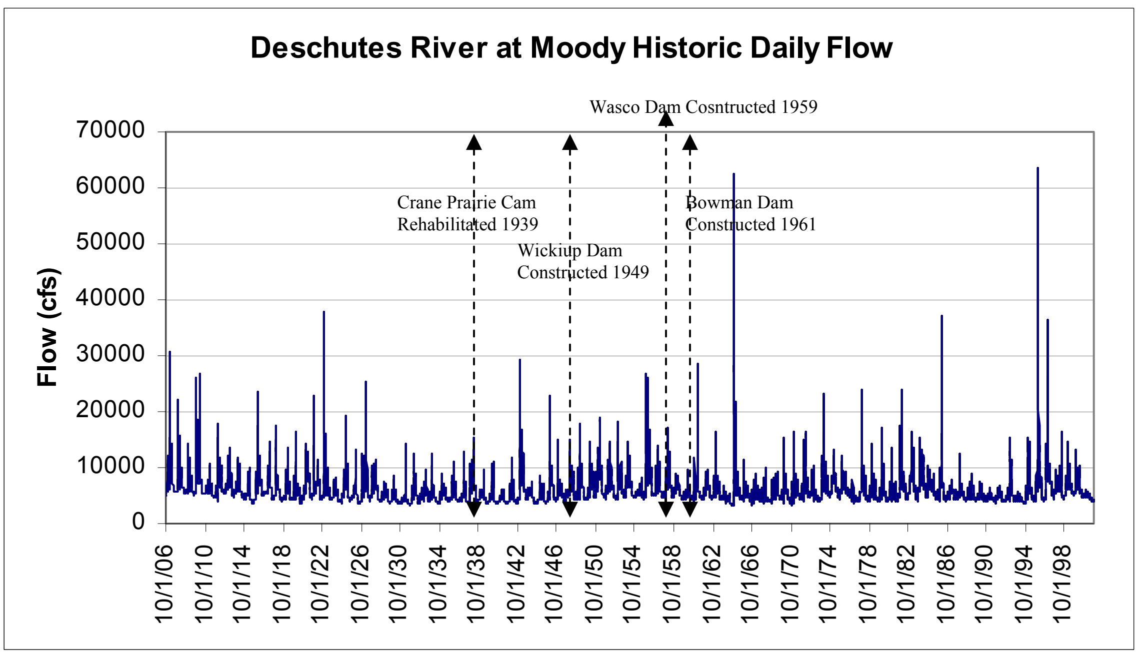


Figure 3-20. Deschutes River at Moody, Historic Average Daily Flow (Water Years 1907-2001)

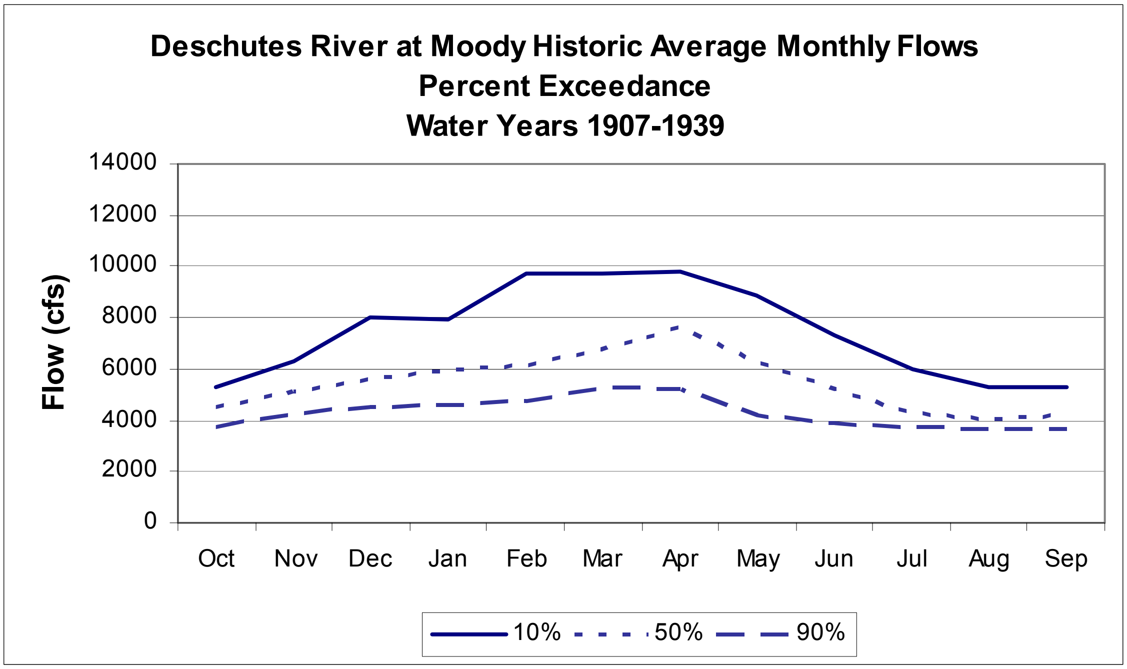


Figure 3-21. Deschutes River at Moody, Average Monthly Flow Percent Exceedance Plot (Water Years 1907-1939)

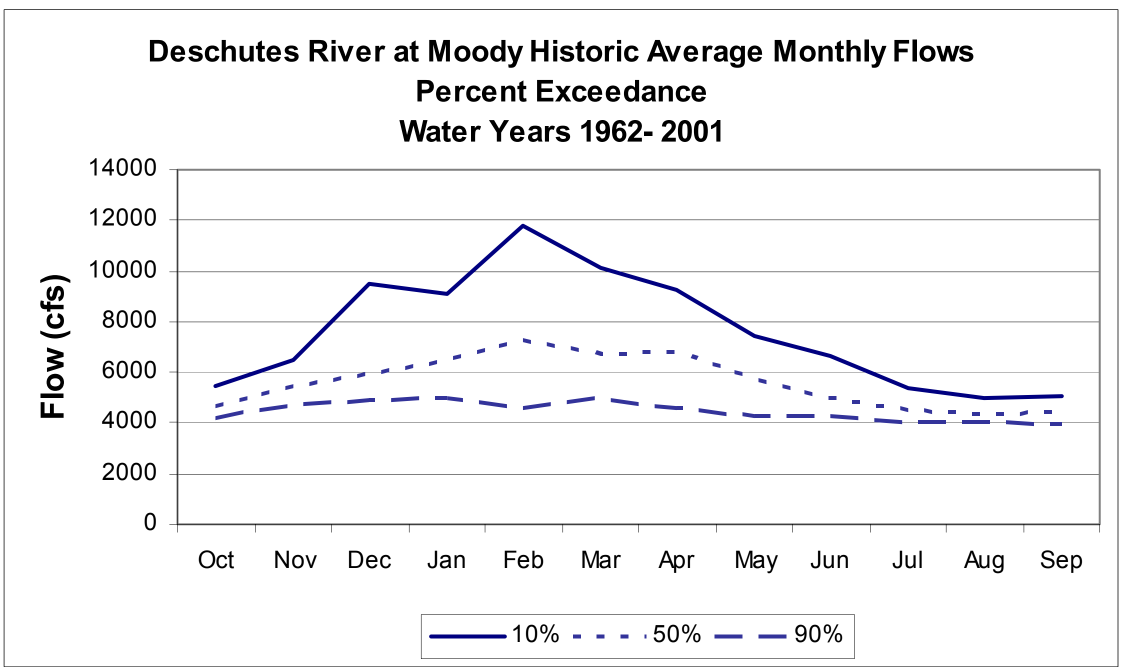


Figure 3-22. Deschutes River at Moody, Average Monthly Flow Percent Exceedance Plot (Water Years 1962-2001)

**Table 3-2. Average Monthly Flow (cfs)
Exceedance for the Deschutes River at Moody**

Gage Location (period of record)	Percent Exceedance	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Deschutes River													
At:	90%	4167	4652	4446	4873	4595	4418	4560	4166	3988	3606	3748	3809
Moody	50%	4410	5043	5389	5425	5503	6717	5494	5604	4731	4309	4302	4110
(water years 1990-2001)	10%	5860	6716	11,312	14,981	16,981	9512	9880	7717	7297	5715	5351	5285
* Information from: http://www.wrd.state.or.us													

The exceedance plots reflecting flows before and after construction of Reclamation projects and the Pelton-Round Butte hydropower complex are similar, with only subtle differences. Examination of average daily flows reveal that flows after construction of Pelton-Round Butte are more uniform.

3.4 Crooked River

3.4.1 Prineville Reservoir

Bowman Dam was completed in 1961. The historic end-of-month elevations for Prineville Reservoir are shown in Figure 3-23. The historic elevations reflect the normal operating practices as described in pages 66 through 73 in the Operations Report. The reservoir fills approximately 3 out of 4 years and the minimum elevations reflect the fluctuating water supply conditions over the 40-year period. The lowest minimum elevations occurred during the extreme drought years of 1977 and 1990 through 1992. Construction modifications on Ochoco Dam started in 1994 and completed in 1997 resulted in additional storage from Prineville Reservoir being used for that period. Other than this, there does not appear to be any significant changes in reservoir elevation trends over the period of record.

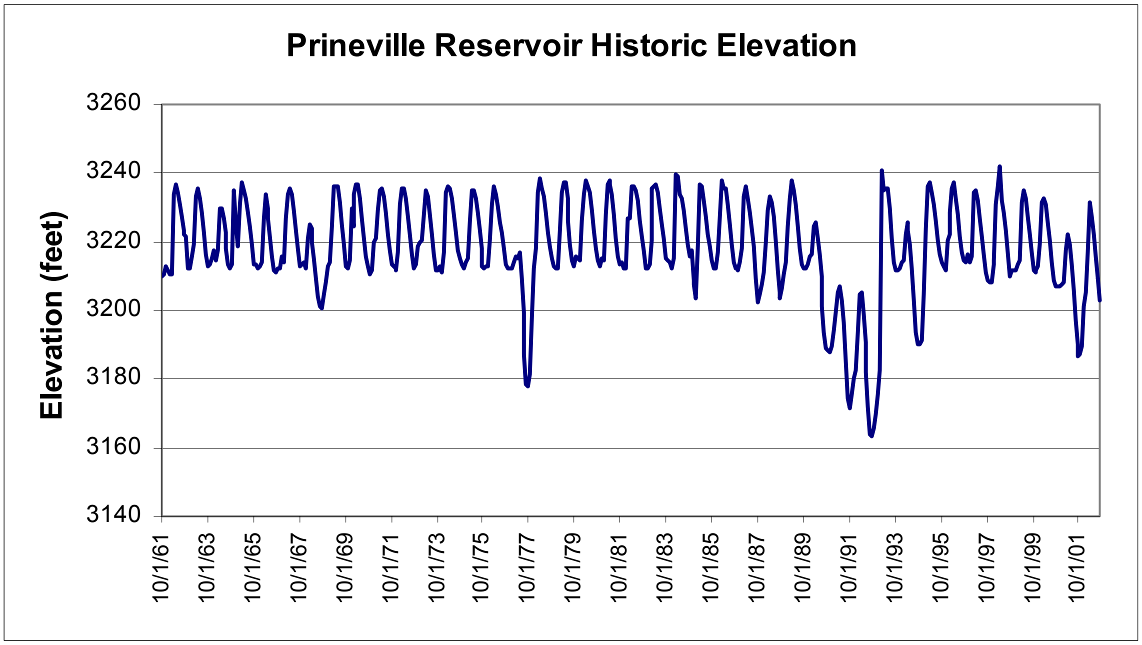


Figure 3-23. Prineville Reservoir Historic End-of-Month Elevations (Water Years 1962-2001)

3.4.2 Crooked River below Bowman Dam

The Crooked River below Bowman Dam historic average daily flows are shown in Figure 3-24. In the years before Bowman Dam was constructed there was a greater variability in the flows, with higher peak flows and lower minimum flows. The average monthly flow percent exceedance plots before construction of Bowman Dam are shown in Figure 3-25 and after construction (1961 through 2001) in Figure 3-26. In the period before Bowman Dam (1943 through 1960), the peak flows at all exceedance levels were higher and winter flows were lower than before construction of the dam. The timing of peak flows also changed after the construction of Bowman Dam. The seasonal peak flows pre-dam occurred in April at the 10, 50, and 90 percent exceedance. Post-dam peak flows occurred in March at the 10 percent exceedance, April at the 50 percent exceedance, and June or July at the 90 percent exceedance level.

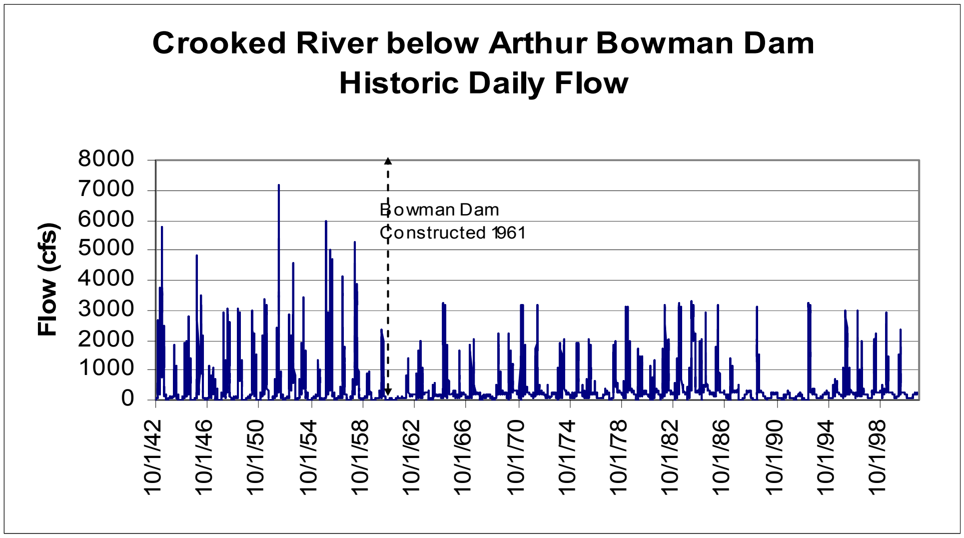


Figure 3-24. Crooked River below Bowman Dam, Historic Average Daily Flow (Water Years 1943-2001)

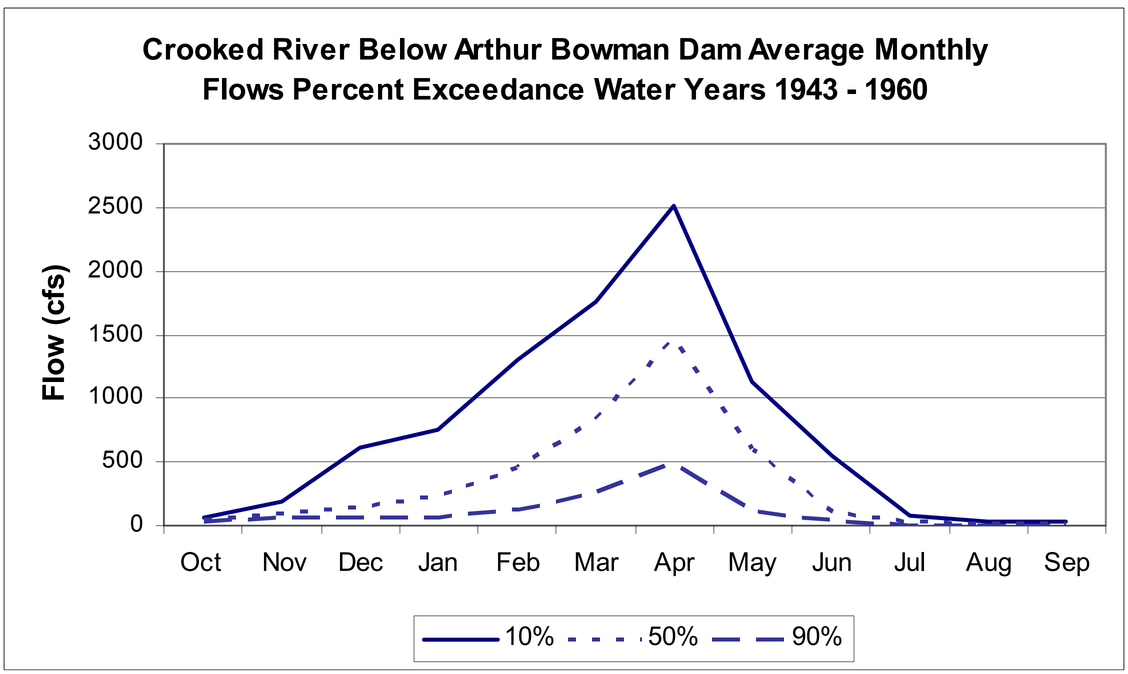


Figure 3-25. Crooked River below Bowman Dam, Average Monthly Flow Percent Exceedance Before Construction of Bowman Dam (Water Years 1943-1960)

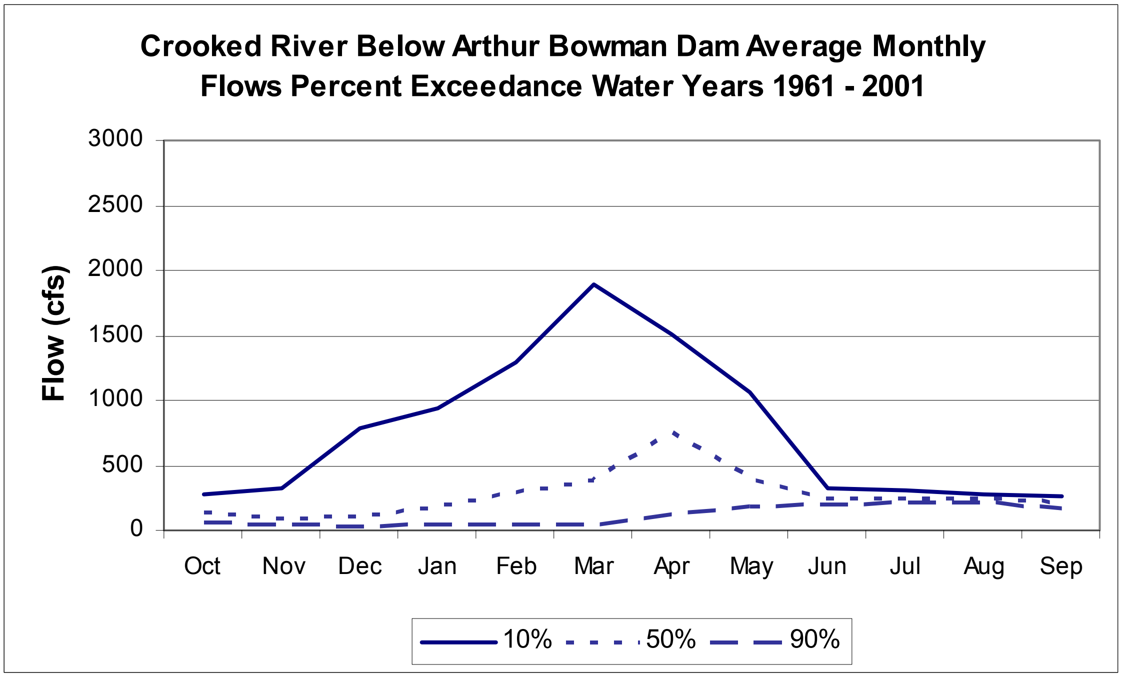


Figure 3-26. Crooked River below Bowman Dam, Average Monthly Flow Percent Exceedance After Construction of Bowman Dam (Water Years 1961-2001)

3.4.3 Crooked River Near Culver and Below Opal Springs

The Crooked River near Culver at RM 1.0 has a period of record from 1918 through 1961 (before construction of Bowman Dam), and the Crooked River below Opal Springs at RM 6.7 has a period of record from 1962 through 2001 (post-Bowman Dam). Although these gages are almost 6 miles apart, the records can be compared because nearly all of the diversions and seepage gains occur above RM 6.7. The historic average daily flows for these gages are shown in Figure 3-27 and Figure 3-28. Figure 3-29 and Figure 3-30 display the average monthly flow percent exceedance plots for these gages.

Figure 3-27 and Figure 3-28 show that the Crooked River flows were more variable before Bowman Dam was built. Maximum flows were as high as 8,000 cfs and minimums were near 1,000 cfs. After completion of the dam, flows on the Crooked River were more uniform with fewer extremes on the high and low ends of the hydrograph. The median average monthly flows ranged from 1,200 to 2,300 cfs in the years before Bowman Dam compared to median flows ranging from 1,200 to 2,000 cfs in the years after construction.

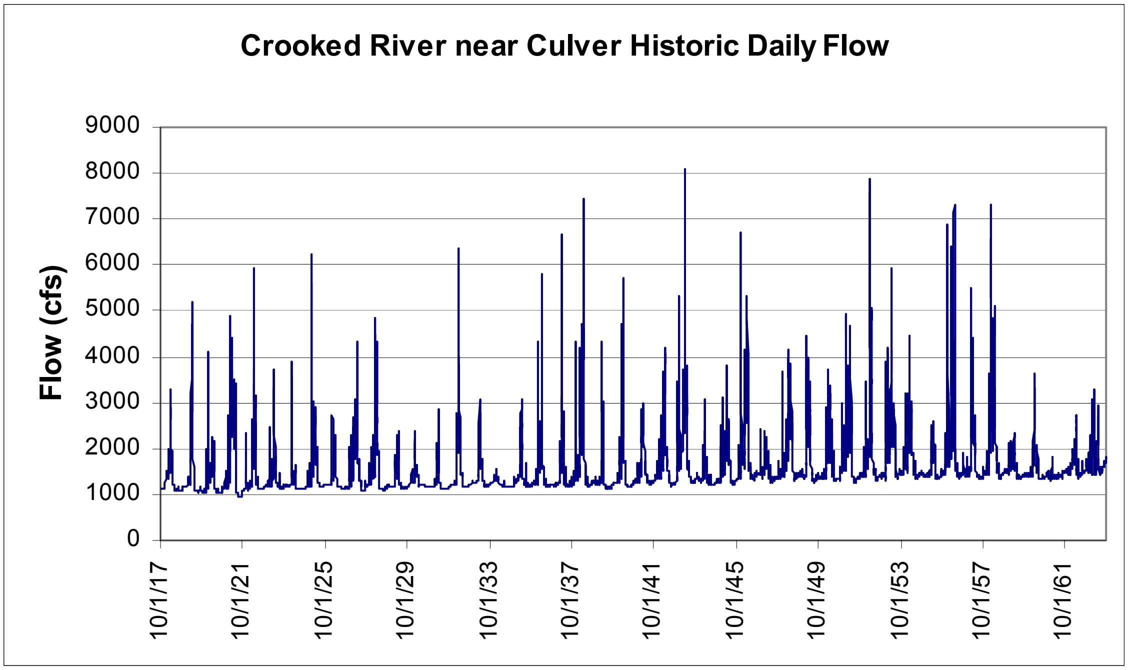


Figure 3-27. Crooked River near Culver, Historic Average Daily Flow Before Construction of Bowman Dam (Water Years 1918-1961)

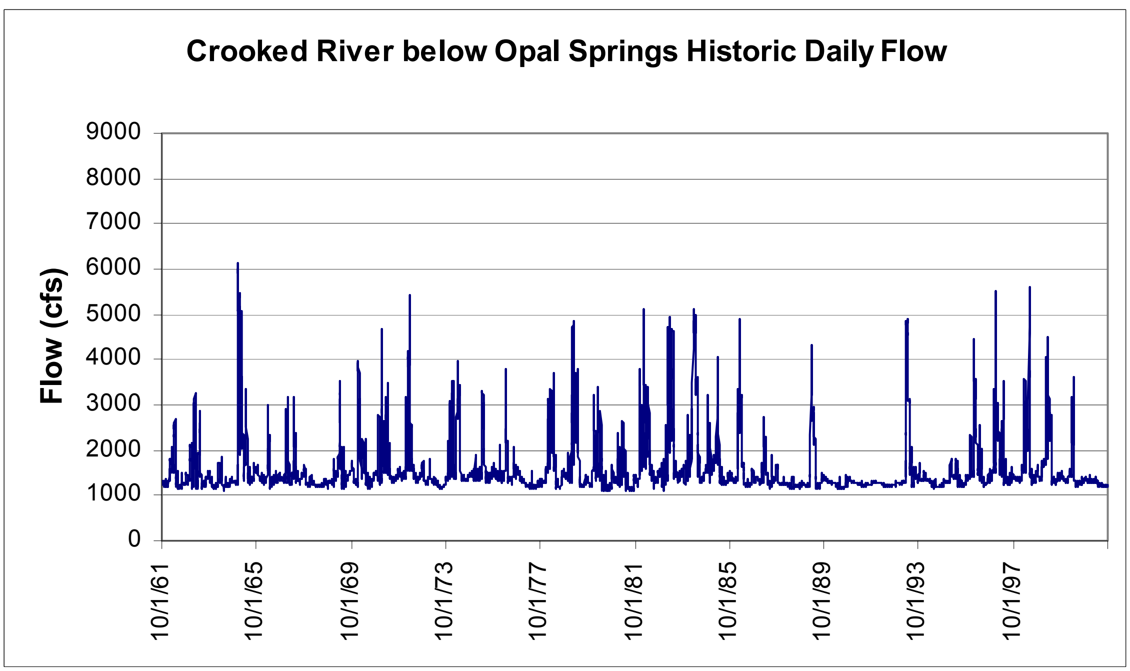


Figure 3-28. Crooked River below Opal Springs, Historic Average Daily Flow After Construction of Bowman Dam (Water Years 1962-1999)

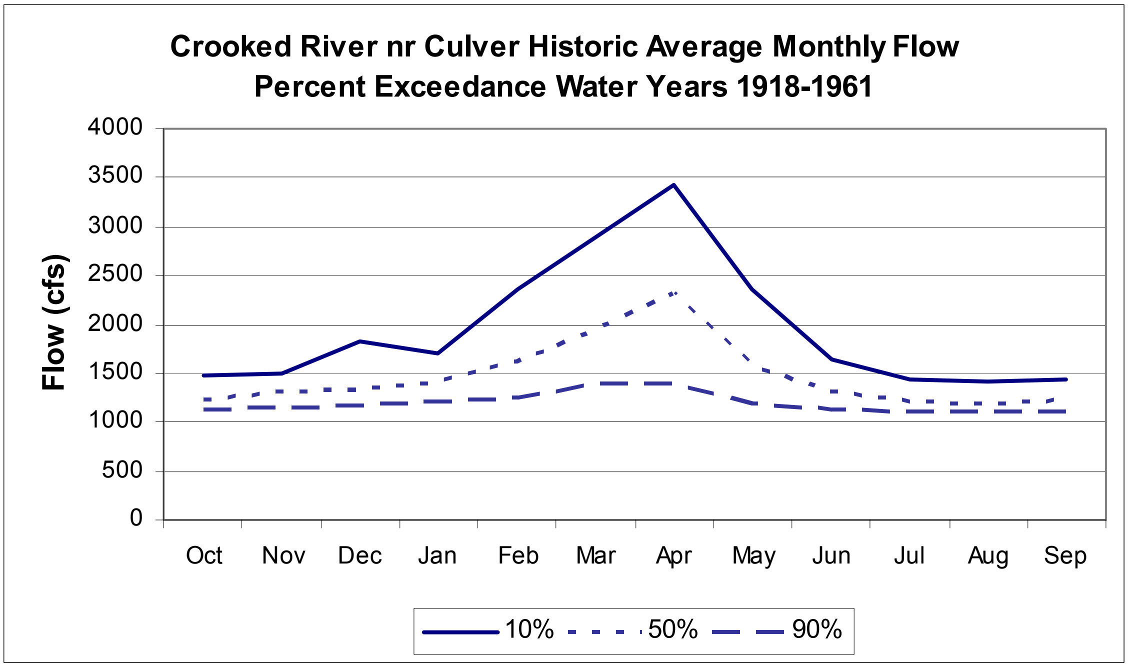


Figure 3-29. Crooked River near Culver, Historic Average Monthly Flow Percent Exceedance (Water Years 1918-1961)

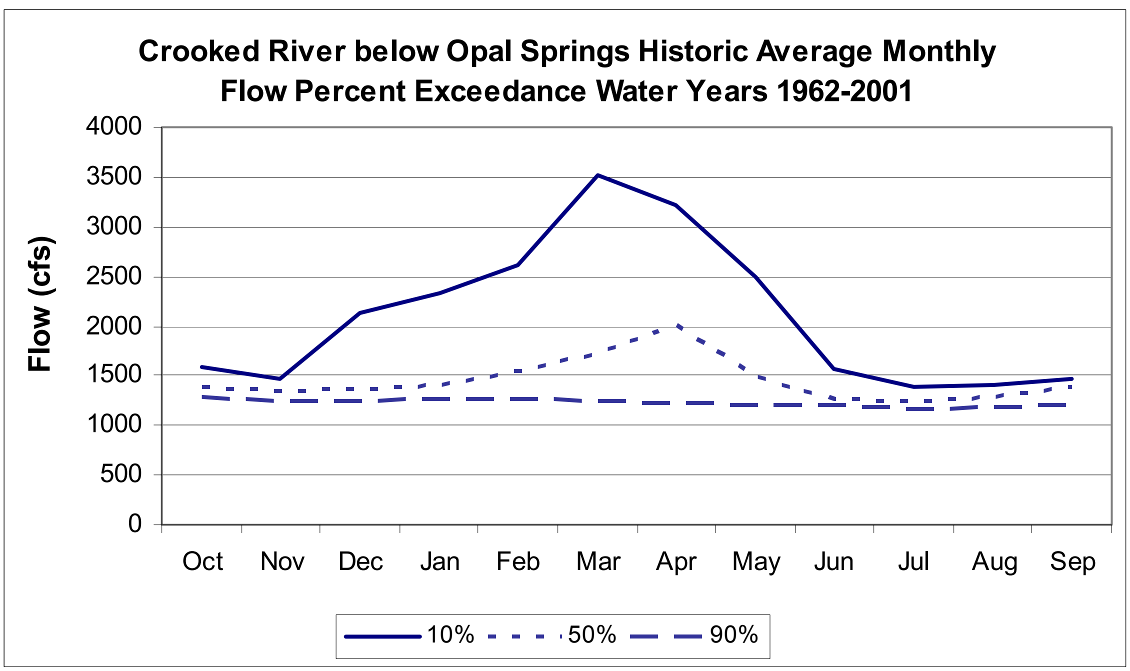


Figure 3-30. Crooked River below Opal Springs, Historic Average Monthly Flow Percent Exceedance After Bowman Dam (Water Years 1962-2001)

3.5 WHITE RIVER

3.5.1 Clear Lake

Wasco Dam (Clear Lake) was completed in 1959. The 1984 through 2001 historic end-of-month elevations for Clear Lake are shown in Figure 3-31. There are gaps in the historic elevation plot because measurements were not taken in some years and in other years some months had missing data. The available elevation data reflect the fluctuating water supply conditions during this 17-year period. Changes in elevation trends are due to changing water supply conditions, not due to changes in reservoir operations.

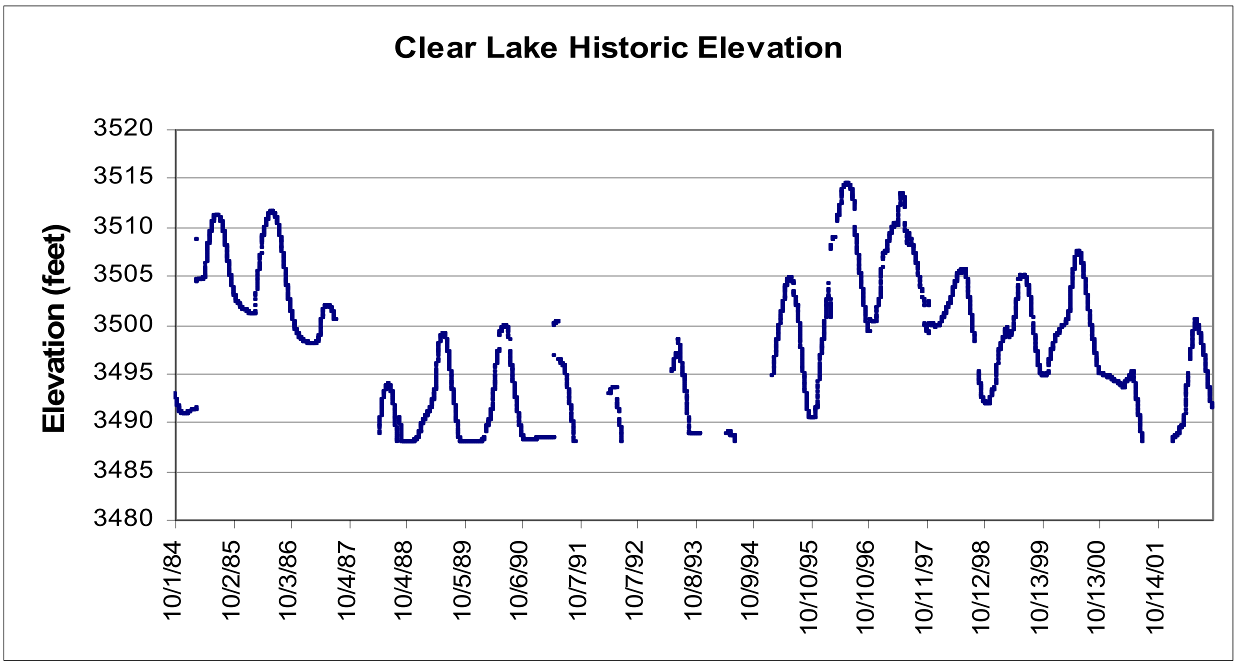


Figure 3-31. Clear Lake Historic End-of-Month Elevations (Water Years 1984-2001)

3.5.2 Clear Creek below Clear Lake

Figure 3-32 shows Clear Creek below Clear Lake historic daily flow for a period from 1968 through 1973. This figure shows the increase in outflows from Clear Lake during the irrigation season with very little outflow during the rest of the year. Exceedance plots for this site were not done because of the short period of record.

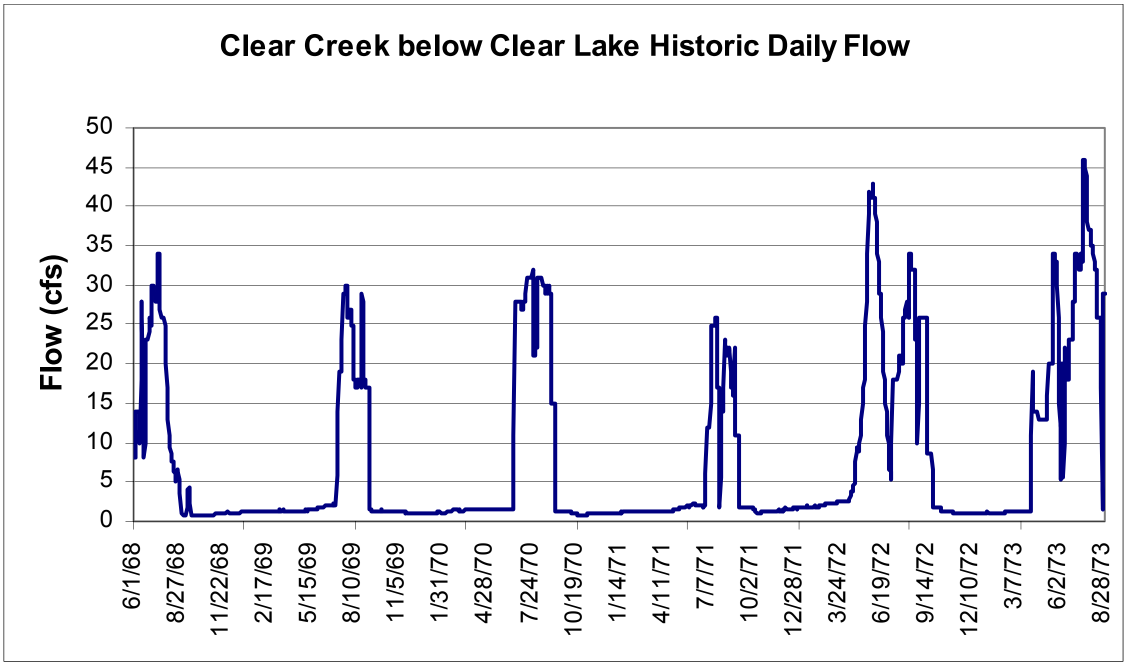


Figure 3-32. Clear Creek below Clear Lake, Historic Daily Flow (1968-1973)

3.5.3 White River below Tygh Valley

The Tygh Valley gage is located on the White River downstream of White River Falls, approximately 2 miles upstream from the confluence with the Deschutes River. The White River below Tygh Valley gage historic daily flow for water years 1918 through 1990 is plotted in Figure 3-33. (The data only goes through water year 1990 because the gage was discontinued after that year.) Figure 3-34 and Figure 3-35 show the average monthly flow percent exceedance plots for water years 1918 through 1959 before Wasco Dam, and for water years 1960 through 1990 after Wasco Dam was constructed, respectively. When comparing the two exceedance plots, they are very similar with no significant changes in flows in the periods before and after Wasco Dam. Both plots show a winter peak from rain-on-snow events and a spring snowmelt peak. Clear Lake was a natural lake before Wasco Dam was constructed and the effect of adding extra storage with the dam was to lower the spring snowmelt peak in May.

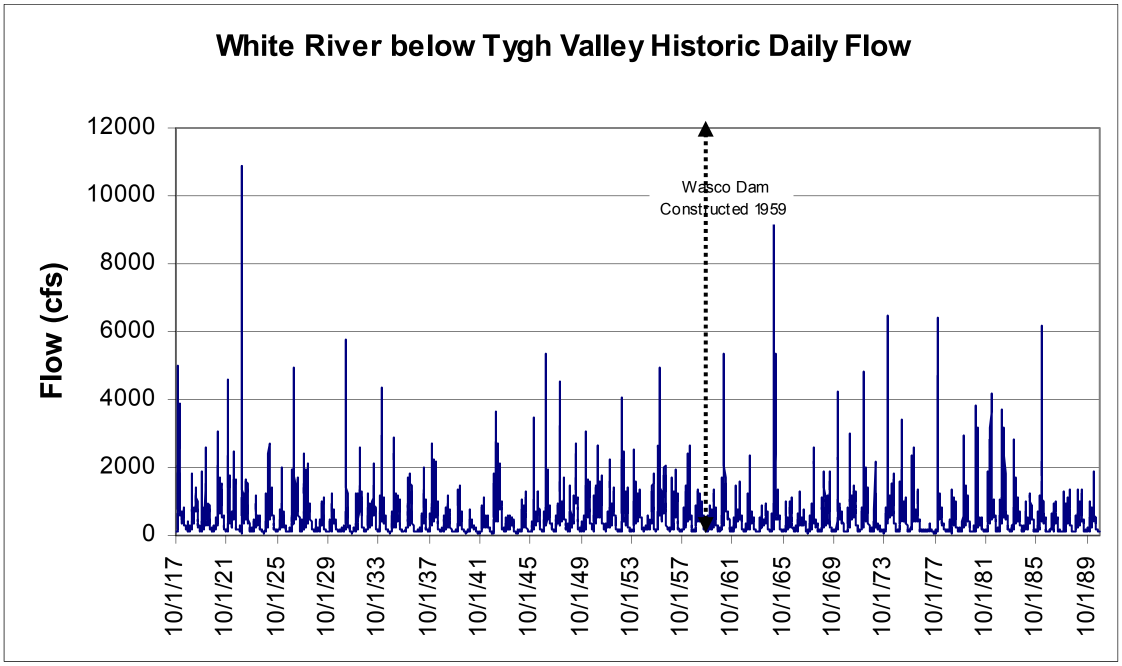


Figure 3-33. White River below Tygh Valley, Historic Average Daily Flow Percent Exceedance (Water Years 1918-1990)

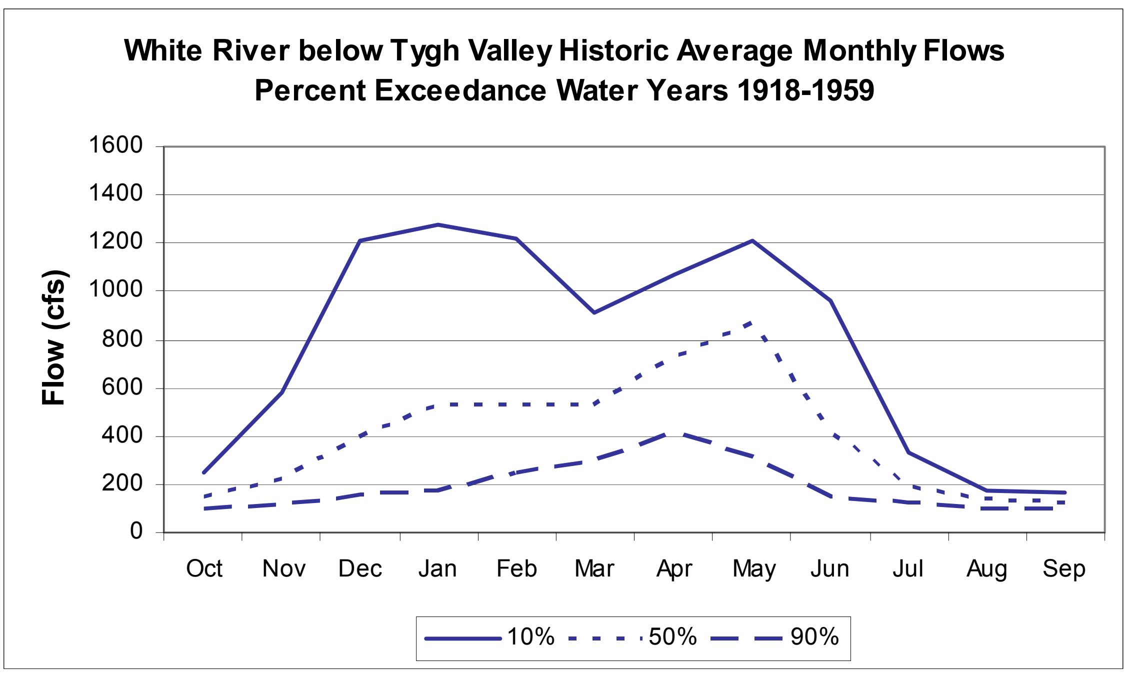


Figure 3-34. White River below Tygh Valley, Historic Average Monthly Flow Percent Exceedance Before Construction of Wasco Dam (Water Years 1918-1959)

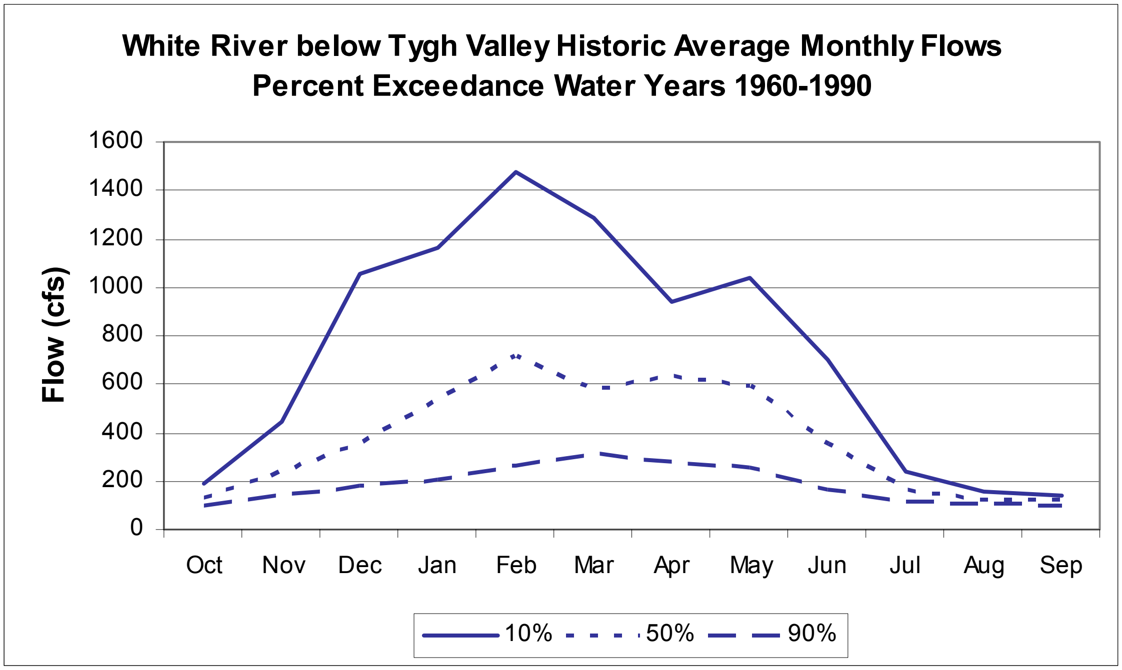


Figure 3-35. White River below Tygh Valley, Historic Average Monthly Flow Percent Exceedance After Construction of Wasco Dam (Water Years 1960-1990)

3.6 Summary Of Hydrologic Conditions

This hydrologic description examined the past and near present hydrologic conditions of reservoirs and river reaches in the Deschutes River basin. Water resources development in the Deschutes River basin, including Federal and private irrigation, groundwater development, and hydropower, has changed hydrologic conditions.

Comparisons of river flows before and after construction of Reclamation projects demonstrate that reservoir outflows change the shape of the natural hydrograph downstream due to storing and releasing water for irrigation and flood control. Winter flows are usually lower post-project when water is being stored. However, winter flows generally increased in the middle and lower reaches of the Deschutes River after construction of the Reclamation projects due to an increase in groundwater recharge from irrigation development and the resulting groundwater discharge into these areas. Irrigation releases in the summer generally have resulted in higher summer flows than occurred before these projects were constructed.

Hydrologic conditions have not changed substantially during the last 40 years since construction of irrigation and hydropower facilities in the basin. Reservoir elevation trends and river reach flows have remained relatively consistent over this period.

CHAPTER 4.0 LISTED SPECIES POTENTIALLY AFFECTED BY THE PROPOSED ACTION

4.1 INTRODUCTION

This chapter provides a brief description and ESA status of each listed species potentially affected by the proposed action.

On June 4, 2002, Reclamation sent letters to NMFS and USFWS requesting that they provide an updated listing of ESA listed threatened and endangered species that could potentially be present in the project area or affected by Reclamation O&M activities in the Deschutes River basin. By return letters dated July 3, 2002 and June 28, 2002, respectively, the two agencies provided lists of the ESA-listed species (Appendix A). Reclamation previously requested ESA-listed species in February 2000 and February 2001.

Table 4-1 tabulates all federally-listed ESA species that were initially identified and considered for this consultation. NMFS provided a comprehensive list of 14 anadromous fish ESUs that occur in Oregon. In conjunction with the NMFS, Reclamation determined that only one of the ESUs occurred in the action area (MCR steelhead). Accordingly, analysis was not conducted for 13 of the ESUs as indicated in Table 4-1.

ESA species considered in this consultation include bald eagle, bull trout, MCR steelhead, Canada lynx, and northern spotted owl. The ESA status, distribution, life history, and habitat requirements for these species are presented in this chapter. The environmental baseline for the listed species is stated in Chapter 5, and the effects of the proposed action are described in Chapter 6.

Table 4-1. ESA Federally-Listed Species Initially Considered for Consultation on the Deschutes River Basin Projects O&M

Common Name/ESU	Scientific Name	Occurs in Action Area
Snake River sockeye salmon	*Oncorhynchus nerka*	No
Upper Columbia River spring Chinook salmon	*Oncorhynchus tshawytscha*	No
Upper Columbia River steelhead	*Oncorhynchus mykiss*	No
Middle Columbia River steelhead	*Oncorhynchus mykiss*	Yes

Common Name/ESU	Scientific Name	Occurs in Action Area
Snake River spring/summer Chinook salmon	*Oncorhynchus tshawytscha*	No
Snake River fall Chinook salmon	*Oncorhynchus tshawytscha*	No
S. Oregon/N. California coasts coho salmon	*Oncorhynchus kisutch*	No
Oregon coast coho salmon	*Oncorhynchus kisutch*	No
Upper Willamette River Chinook salmon	*Oncorhynchus tshawytscha*	No
Upper Willamette River steelhead	*Oncorhynchus mykiss*	No
Lower Columbia River Chinook salmon	*Oncorhynchus tshawytscha*	No
Snake River steelhead	*Oncorhynchus mykiss*	No
Lower Columbia River steelhead	*Oncorhynchus mykiss*	No
Columbia River chum salmon	*Oncorhynchus keta*	No
Bald eagle	*Haliaeetus leucocephalus*	Yes
Bull trout	*Salvelinus confluentus*	Yes
Northern spotted owl[1]	*Strix occidentalis caurina*	(occurs in Deschutes and Wapinitia projects only)
Canada lynx[1]	*Lynx canadensis*	(occurs in Deschutes and Wapinitia projects only)

[1] During preliminary analysis, it was determined that routine project operation and maintenance will not affect the Northern spotted owl, Canada lynx, nor their forest habitats.

4.2 BALD EAGLE

4.2.1 Status

The bald eagle (*Haliaeetus leucocephalus)* is currently listed as threatened in all lower 48 contiguous states. Historically, the bald eagle could be found nesting throughout most of the continent. However, reproduction in North America declined dramatically between 1947 and 1970 largely due to intake of organo-chloride pesticides (USFWS 1986). Habitat degradation, illegal harassment and disturbance, poisoning, and a reduced food base helped contribute to the decline. By 1978 the bald eagle was federally listed as a threatened species in 5 of the lower 48 states and as an endangered species in the remaining lower 43 states.

The USFWS initiated a recovery program for the species in the mid-1970s and divided the 48 states into five bald eagle recovery regions. The Deschutes River basin lies within the Pacific Recovery Region that includes the states of Idaho, Oregon, Washington, Montana, Wyoming, California, and Nevada. The bald eagle recovery plan for the Pacific Region was approved in 1986.

Bald eagle populations have increased steadily since ESA listing. The improvement is a direct result of:

- bans on DDT and other persistent organochloride pesticides
- habitat protection
- a growing public awareness of the bald eagles' plight

Due to the overall population increase, the bald eagle was reclassified in 1995 from endangered to threatened in all 48 lower states (Federal Register 60:36000). The number of bald eagles in the Pacific Recovery Region is five times what it was when the recovery plan was written (Federal Register 64:36454).

4.2.2 Distribution

In 1990, bald eagles nested in all but 5 of the 50 states. However, most bald eagle nesting is limited to the Pacific Northwest, Alaska, Canada, the Great Lake states, Chesapeake Bay, Arizona, and Florida. Oregon and Washington have been strongholds for bald eagles, with more than two-thirds of the nesting population and one-half of the wintering population of the Pacific recovery area occurring in these two states (USFWS 1994). Occupied breeding territories surveyed in Oregon have increased from 20 in 1971 to 401 in 2002 (Isaacs and Anthony 2002). Figure 4-1 shows the distribution of bald eagle nesting sites in the Deschutes River basin.

Delisting requirements under the Pacific Bald Eagle Recovery Plan include: 1) a minimum of 800 nesting pairs; 2) an average reproductive rate of 1.0 fledged young per pair, with an average success rate per occupied site of not less than 65 percent; 3) breeding population goals met in at least 80 percent of the management zones; and 4) stable or increasing wintering populations. The numeric delisting goals have been met since 1995 (Federal Register 64:36454).

Productivity has averaged about 1.0 young per occupied breeding area since 1990. The average success rate for occupied breeding areas exceeded 65 percent for the 5-year period ending in 1999. For 1998, six of the seven Pacific region states reported an average success rate of 75 percent. However, the plan goal for distribution among management zones is not yet fully achieved for all areas. The number of occupied breeding areas exceeded 800 in 1990 and has continued to increase. In 1998, 1,480 occupied breeding areas were estimated. As of 1999 (Federal Register 64:36454), 28 of 37 (76 percent) management zone targets had been met. Of the 28 zones where target levels have been met, at least 11 have more than doubled the established goal. Wintering populations have been tracked in the Pacific and many other states using the mid-winter bald eagle surveys. However, wintering populations are difficult to assess because concentrations are dependent on weather and food supply and thus can be quite variable from year to year.

4.2.3 Life History

The bald eagle, like most birds of prey, exhibits sexual dimorphism, with the females weighing more than the males. Males and females are thought to mate for life, returning to the same nesting territory year after year. A clutch of one to three eggs is laid and incubated mostly by the female for about 35 days. The young fledge in 72-75 days. Often the younger, weaker bird is killed by its sibling in the competition for food. Bald eagles require 4-5 years to reach sexual maturity and attain full adult plumage. Prior to that time, immature bald eagles are often confused with immature golden eagles.

4.2.4 Habitat Requirements

4.2.4.1 Nesting Habitat

In the Pacific Northwest, bald eagles typically nest in multi-layered coniferous stands with old growth trees within 1 mile of large bodies of water (lakes, reservoirs, large rivers, and coastal estuaries). Availability of suitable trees for nesting and perching is critical. Nest trees in the Pacific Northwest are found primarily in ponderosa pine, mixed conifer, Douglas fir, and Sitka spruce/western hemlock forests (USFWS 1986). Species of trees used for nesting, however, vary among areas. In Oregon, nests are typically found in large conifers or cottonwoods (USFWS 1986). Nests are generally not constructed in areas with nearby human activity. The nesting season for bald eagles in the Pacific Northwest generally extends from January 1 to mid-August (USFWS 1994). Young are usually produced in March and fledged in July; however, they may stay near the nest for several weeks after fledging.

4.2.4.2 Wintering Habitat

More than 25 percent of the wintering bald eagles in the lower 48 states are present in the Pacific Northwest (USFWS 1986). Bald eagles winter in the Northwest from approximately November through March and are primarily associated with open water near concentrated food sources. An important habitat feature is perch trees which provide an unobstructed view of the surrounding area near foraging sites (USFWS 1986). Ponderosa pine and cottonwood snags are preferred perches in some areas, probably due to their open structure and height. Bald eagles may also use communal night roost sites in winter for protection from inclement weather. Characteristics of communal winter roost sites differ considerably from those of diurnal perch sites (USFWS 1986), although both are invariably located near concentrated food sources, such as anadromous fish runs or high concentrations of waterfowl. Roost sites tend to provide more protection from weather than diurnal perch sites. Communal roosts in the Pacific Northwest tend to be located in uneven-aged forest stands with some degree of old-growth forest structure. Conifers might provide a more thermally favorable microenvironment than dead or deciduous trees, which might explain their high use by wintering eagles. In eastern Washington, bald eagles have been observed roosting in mixed stands of Douglas fir and ponderosa pine and in stands of black locust and black cottonwood.

Deschutes River Basin

Bald Eagle

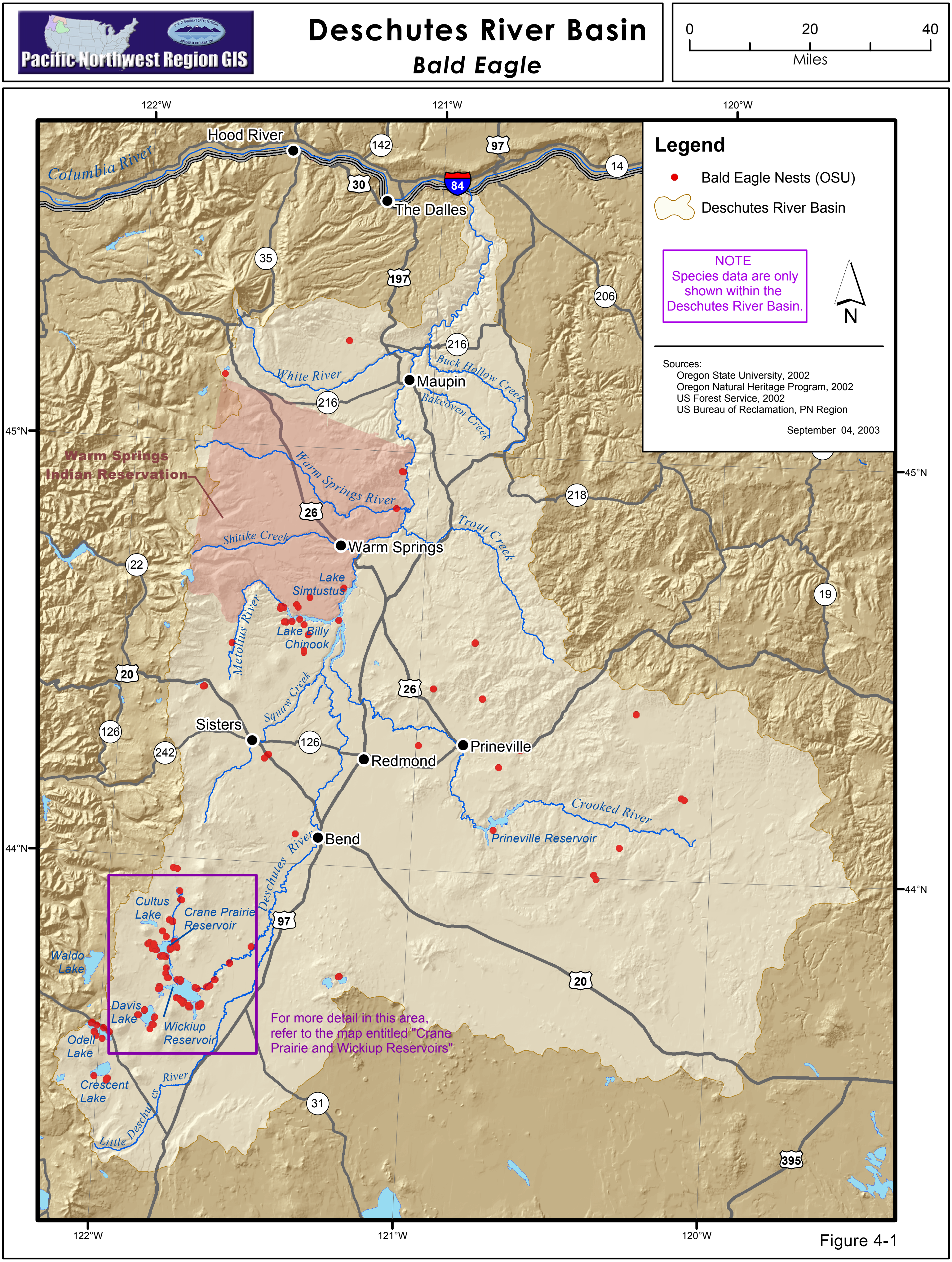


Figure 4-1

4.2.4.3 Foraging Habitat

Bald eagles are opportunistic foragers throughout their range. In the Pacific Northwest, bald eagles consume a range of food including a variety of fish, waterfowl, jackrabbits, and mammalian carrion (USFWS 1994). Game and nongame fish species tend to be the preferred food, but diet is dependent on prey availability. Winter killed mammals can be important on big game winter ranges, while waterfowl are important where concentrations are significant. Fish are also taken as carrion, especially spawned out kokanee (USFWS 1986).

4.3 BULL TROUT

4.3.1 Status

The USFWS issued a final rule listing the Columbia River and Klamath River populations of bull trout (*Salvelinus confluentus)* as a threatened species under the ESA on June 10, 1998 (USFWS 1998). The Columbia River Distinct Population Segment is threatened by habitat degradation and fragmentation, blockage of migratory corridors, poor water quality, and past fisheries management practices such as the introduction of non-native species.

In the final listing rule, the USFWS (1998) identified three subpopulations of bull trout in the Deschutes River basin: 1) Odell Lake in the upper Deschutes River basin, 2) Metolious River-Lake Billy Chinook complex, and 3) lower Deschutes River. Historically bull trout were distributed throughout the Deschutes River basin from the headwaters and headwater lakes to the Columbia River, allowing access to the Columbia River for juvenile rearing and adult foraging (Buchanan et al. 1997). The subpopulations are isolated by the Pelton-Round Butte Project dams on the Deschutes River between RM 100 and 110, and Big Falls, a natural barrier at about RM 132. Bull trout are thought to be extirpated in up to seven reaches or tributaries within the Deschutes River basin (Buchanan et al. 1997).

At the time of listing, bull trout had been extirpated from their historic habitats in the upper and middle Deschutes above Big Falls. Five populations of bull trout currently exist in the basin. These are located in Shitike Creek, Warm Springs River, Whitewater River, Jefferson/Candle/Abbot complex, and the Canyon/Jack/Heising/mainstem Metolious complex.

In November 2002, a proposed rule for bull trout critical habitat in the Columbia and Klamath River basins was published in the Federal Register by the USFWS. This proposal includes bull trout critical habitat for the Deschutes River basin. Originally, a final decision was expected in October 2003; however, USFWS is proposing deferring work to develop a final rule until fiscal year 2004 because of lack of funding (http://endangeredfish.gov/criticalhabitat/chactions.pdf.) Critical habitat refers to specific geographic areas that are essential for the conservation of a threatened or endangered species and which may require special management considerations. Reclamation will not be consulting on critical habitat in this BA.

The USFWS prepared a draft recovery plan for bull trout in November 2002. The USFWS is anticipating completion of final bull trout recovery plans in 2004. Recovery plans are a much larger blueprint for the recovery and eventual delisting of a species, as it provides recommendations concerning habitat and various other factors that need to be addressed to achieve recovery.

4.3.2 Historical Distribution

Historical distribution of bull trout in the Deschutes River basin is summarized herein from Buchanan, et al. (1997). Bull trout were historically found throughout much of the Deschutes River basin (Figure 4-2). Bull trout populations upstream from Big Falls (RM 132) were apparently reproductively isolated from populations in the lower river. Historically, adfluvial populations of bull trout were also present in the Blue/Suttle Lake complex, in the upper Metolius River basin, and in Crescent and Davis Lakes of the upper Deschutes basin.

Isolation of upper Deschutes River basin bull trout populations occurred upon completion of upper basin irrigation storage dams. The completion of Crane Prairie Dam in 1922, Crescent Lake in 1928, and Wickiup Dam in 1949, all without fish passage facilities, blocked access for adult bull trout migrating to upper Deschutes River spawning areas. Increased water temperatures, altered streamflow regimes, inundation of some juvenile rearing areas and adult spawning areas, barriers to spawning areas, competition with non-native fish species, and over-harvest eliminated remnant bull trout populations in the Deschutes River above Big Falls during the 1950s.

The last bull trout observed in Crane Prairie Reservoir was in 1955, in Wickiup Reservoir in 1957, and in Crescent Lake in 1959. The last bull trout observed in the Deschutes River above Bend was in 1954. Ratliff and Howell (1992) listed two bull trout populations, upper Deschutes River and Crescent Lake, as “probably extinct.” There may have been separate populations in the Fall River and Tumalo Creek, but spawning was not documented in these systems and bull trout are no longer found there.

Construction of Round Butte Dam in 1964 and the subsequent abandonment of passage facilities in 1968 isolated the Metolius River bull trout populations from those found downstream in Shitike Creek and the Warm Springs River. Bull trout are no longer found in Trout Creek, although they were reported there in 1960. Fluvial subpopulations in Shitike Creek and Warm Springs River contributed and still contribute bull trout into the lower Deschutes River.

The Blue Lake-Link Creek-Suttle Lake bull trout group in the Metolius subbasin has been extirpated, possibly due to overharvest and/or creation of passage barriers on Lake and Link Creeks (Marx 2000).

Deschutes River Basin
Bull Trout

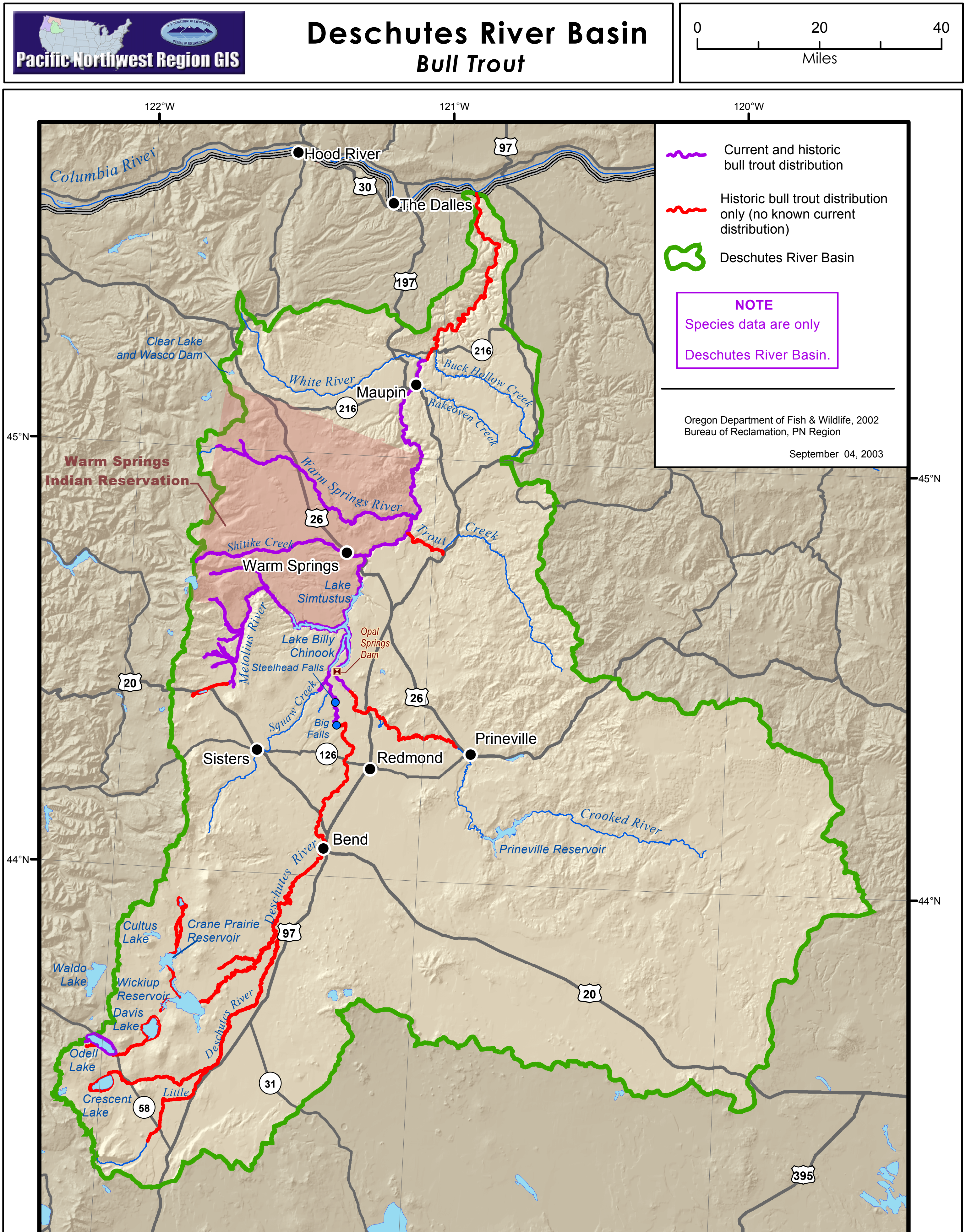


Figure 4-2

The first extensive fish surveys in the Crooked River subbasin were conducted in the 1950s. By this time, the basin had experienced years of water withdrawal that radically altered riparian areas. Wandering subadult and adult bull trout, likely from the Metolius system, were occasionally caught in the Crooked River as far upstream as the city of Prineville through the early 1980s. However, the 1983 enlargement of the Opal Springs Diversion Dam, owned by the Deschutes Valley Water District, on the lower Crooked River created an upstream barrier to bull trout and other fish.

4.3.3 Present Distribution

Information about the current distribution of bull trout in the Deschutes River basin is summarized from Buchanan et al. 1997. Current and historic distribution of bull trout in the basin based on documented reports is portrayed in Figure 4-2. Of the historical adfluvial bull trout population in Oregon, only the Odell Lake population continues to produce bull trout. The abundance of the Odell Lake population remains unknown. However, angler observations of bull trout incidentally caught in the kokanee fishery have been increasing since the harvest of bull trout was prohibited after 1990.

Bull trout currently inhabit most riverine habitats of the Metolius subbasin except Lake Creek, Link Creek, and Suttle and Blue Lakes. The Metolius River, Lake Billy Chinook Reservoir, the Deschutes River above Lake Billy Chinook upstream to Big Falls, and the lower part of Crooked River up to the Opal Springs Dam also support bull trout. Bull trout also use lower Squaw Creek, a tributary to the Deschutes River above Lake Billy Chinook. Bull trout found in the Deschutes River between Lake Billy Chinook and Big Falls, as well as the lower Crooked River and Squaw Creek, appear to originate from the Metolius River and its tributaries, as these are the only sites for which there is evidence of bull trout reproduction above Round Butte Dam (Ratliff et al. 1996, Thiesfield et al. 1996). Extensive surveys of the Deschutes arm of Lake Billy Chinook have not captured significant numbers of juveniles or the stratified age structure typical of a reproductive population of bull trout (as is seen in surveys near the mouth of the Metolius River), but instead reflects a population of foraging migratory or adfluvial fish originating from the Metolius River (Thiesfield et al. 1996).

Bull trout are found in the lower Deschutes River upstream from Sherars Falls, Shitike Creek, and Warm Springs River. Anglers, as recently as 2002, have reported higher incidental hooking of bull trout in the Deschutes River, which may indicate that the population is increasing. One or two adult bull trout are caught in the Pelton Dam trap each year.

4.3.4 General Life History

Bull trout generally exhibit two distinct life history forms–migrant and resident. Migrant fish emigrate from the small streams where the juveniles rear to larger rivers (fluvial) or lakes (adfluvial). Resident fish remain in the rearing streams and mature there. Table 4-2 (Knowles and Gumtow 1996) summarizes the general life history of bull trout.

Table 4-2. Bull Trout Life History Summary

Life Conditions	Criteria/Facts
Age at first reproduction	4-5 years
Number of eggs produced	1,300 to 9,000
Maximum size	Greater than 30 pounds and 36 inches
Life span	Up to 10 years
Food habits	Juveniles are insectivorous. Adults are piscivorus.
Incubation success	Water temperature critical: 32-36 °F = 80-95 percent 43 °F = 60-90 percent 46-48 °F = 0-20 percent Sediment size: 20 percent fines = 40 percent 30 percent fines = 20 percent 40 percent fines = 1 percent
Migration strategies	Resident, adfluvial, fluvial, and anadromous
Closely related species	Dolly Varden, lake trout, and brook trout
Optimal and maximum water temperature	Juveniles = 39-48 °F and 59 °F Adults = 39-48 °F and 64 °F
Spawning season	September through November
Source: Knowles and Gumtow 1996	

Bull trout can live up to 10 years and are sexually mature after 4 or 5 years. They spawn during September through November, in cold, flowing groundwater-fed streams that are clean and free of sediment. The incubation period for bull trout is extremely long, and young fry may take up to 225 days to emerge from the gravel. Juvenile bull trout mature slowly, often spawning for the first time in their fourth or fifth year.

Migrant bull trout usually emigrate from their rearing streams at 2-3 years of age when they are 6-8 inches long; however, younger fish may occasionally outmigrate earlier (Elle et al. 1994). They move downstream to a river or lake and find feeding sites. After entering the river or lake, juvenile bull trout grow rapidly, often reaching over 20 inches long and 2 pounds by the time they are 5-6 years old. The Oregon bull trout record is 23 pounds, 2 ounces, taken from Lake Billy Chinook in 1985 (Buchanan et al. 1997).

Migratory bull trout live several years in larger rivers or lakes, where they grow to a much larger size than resident forms before returning to tributaries to spawn. Growth differs little between forms during their first years of life in headwater streams, but diverges as migratory fish move into larger and more productive waters (Rieman and McIntyre 1993). Resident and migratory forms may live together, but it is unknown if they represent a single population or separate populations (Rieman and McIntyre 1993). Migratory forms of bull trout appear to use much of the river basin that they are located in through their life cycle (Batt 1996). Adfluvial mature bull trout appear to reside in reservoirs for about 6 months from November to June.

It appears that most bull trout, even those not ready to spawn, migrate upstream beginning in May-June and return to mainstem rivers or lakes in November-December. This migration may be in part to avoid high summertime water temperatures in some areas or insufficient flows or water levels. Rieman and McIntyre (1993) indicate that diverse life-history strategies are important to the stability and persistence of populations of any species. Such diversity is thought to stabilize populations in highly variable environments or to refound segments of populations that have disappeared.

Variation in the timing of outmigration and in the timing and frequency of spawning also represents diversity in life history. Bull trout may spawn each year or in alternate years (see Block 1955 in Batt 1996). It is possible that four or more year classes could compose any spawning population, with each year class including up to three outmigration strategies. This theory supports the idea that the multiple life-history strategies found in bull trout populations represent important diversity (both spatial and genetic) within populations.

4.3.5 Habitat Requirements

Bull trout have some of the most demanding habitat requirements of any native trout species, mainly because they require water that is especially cold and clean. Eggs are extremely vulnerable to siltation problems and bed load movement during the long incubation period. Any activity that causes erosion, increased siltation, removal of stream cover, or changes in waterflow or temperature affects the number of bull trout that hatch and their ability to survive to maturity (Knowles and Gumtow 1996).

In general, bull trout appear to have more specific habitat requirements than other salmonids. Outside of the reservoirs, channel stability, winter high flows, summer low flows, substrate, cover, temperature, and the presence of migration corridors consistently appear to influence bull trout distribution and abundance (see Allen 1980 in Batt 1996).

Water temperature is a critical habitat characteristic for bull trout. Temperatures above 59°F are thought to limit bull trout distribution (Allen 1980 in Batt 1996). Optimum water temperatures for rearing are thought to be 45-46°F (Allan et al. in Batt 1996). Researchers recognized water temperature more consistently than any other factor influencing bull trout distribution. However, it is poorly understood whether the influence of temperature is consistent throughout life or whether a particular stage is especially sensitive.

Bull trout have voracious appetites and take full advantage of any and all food sources available to them. Fish are considered to be the major item in the diet of large bull trout. They feed primarily along the bottom and up to mid-water levels, consuming insects and other fish species such as suckers, sculpins, minnows, and trout. Mountain whitefish are one of the bull trout's preferred prey (Knowles and Gumtow 1996).

Adult adfluvial bull trout generally spend about one half of every year associated with a natural or man-made lake (generally November-May). These fish most likely forage in shallow areas where the majority of prey exists. Depending on water conditions, bull trout will occupy deeper areas of the reservoir where water temperatures are cooler (45-54°F) and move to the surface when surface water temperatures drop to or below 54°F.

4.4 MIDDLE COLUMBIA RIVER STEELHEAD

4.4.1 Status

Steelhead (*Oncorhynchus mykiss),* that occupy the lower Deschutes River are part of the Middle Columbia River ESU that is currently listed as threatened by the NMFS (Federal Register 64:4517) under the ESA. Critical habitat designated February 16, 2000 for this ESU (Federal Register 65:7764) has been withdrawn effective May 30, 2002 (Stone 2002). The MCR steelhead ESU includes native wild steelhead populations occurring in the Columbia River east of the Cascades, excluding the Hood River in Oregon, and Wind River in Washington, up to and including the Yakima River, but not including the Snake River populations, which constitute a separate ESU. Hatchery steelhead in this MCR ESU are not listed.

According to NMFS (2000a) and Busby et al. (1996), current population sizes in this ESU are substantially lower than historic levels, especially in the rivers with the largest MCR steelhead runs in the ESU: the John Day, Deschutes, and Yakima Rivers. The John Day may be the most robust of these three populations (NMFS 2000a). Busby et al. (1996) indicated that the run size to the MCR steelhead ESU could have been in excess of 300,000 fish. At least two extinctions of native wild steelhead runs in the ESU have occurred, the Crooked and Metolius Rivers, both in the Deschutes River basin (Federal Register 65:7764). The loss of these runs is due primarily to blockage of the migration corridor by the Pelton-Round Butte Project (Federal Register 65:7764).

4.4.2 Distribution

Nehlsen (1995) provided a fairly comprehensive review of historical steelhead runs and their environment in the Deschutes River basin upstream from the Pelton-Round Butte Hydroelectric Project. Steelhead spawned in major tributaries of the upper Deschutes River above Pelton-Round Butte Project (Squaw Creek and the Crooked River); historic occurrence of steelhead in the Metolius River is uncertain and equivocal (NPPC 1990; Lichatowich et al. 1998). Steelhead were documented up to 120 miles from the mouth of the Crooked River (Nehlsen 1995). Historic and current distribution of Deschutes River steelhead is shown in Figure 4-3.

Deschutes River Basin

Middle Columbia River Steelhead

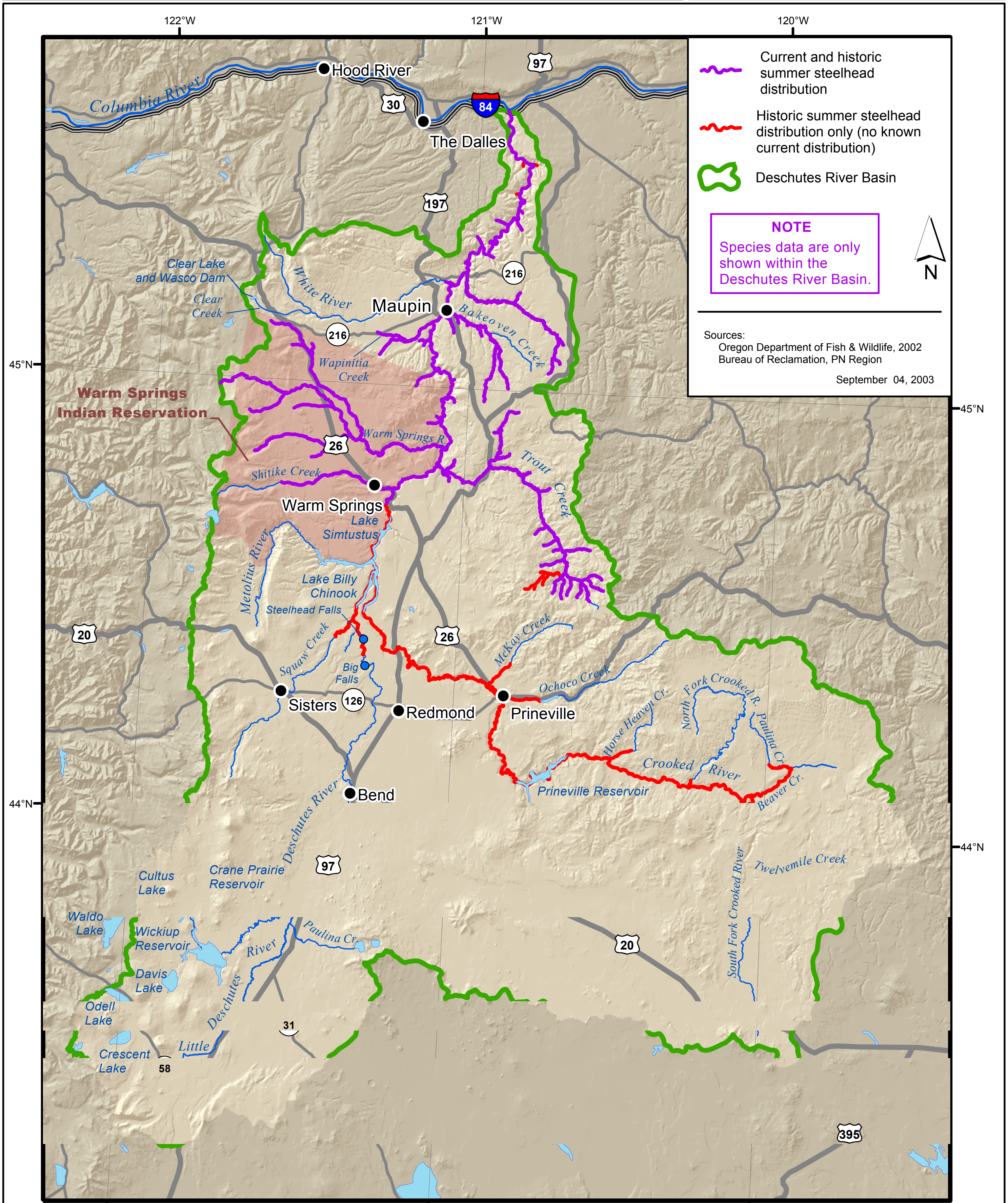


Figure 4-3

In the early part of the past decade, naturally produced steelhead in the Deschutes River declined; however, ODFW (2002) reported that escapement in the Deschutes River during the years 1998, 1999, 2000, 2001, and 2002 show an increasing trend that may be due in part to improved environmental conditions.

Where resident and anadromous forms of *O. mykiss* co-occur, the relationship between these two forms has been questioned as to whether resident *O. mykiss* contribute to the population dynamics and abundance of anadromous *O. mykiss* and provide a buffer against steelhead extinction. The two forms represent genetically distinct populations or two “ecophenotypes” within a single gene pool (Zimmerman and Reeves 1998). Zimmerman and Reeves (2000) reported that in the Deschutes River, based on microprobe analysis of Sr/Ca (strontium/calcium) ratio in otoliths, steelhead and rainbow trout are reproductively isolated. That is to say, adult steelhead from the Deschutes River that they tested were progeny of steelhead females and resident rainbow trout were progeny of resident rainbow trout. There was also spatial and temporal separation of spawning in these two forms (Zimmerman and Reeves 1998).

Fish passage for Chinook salmon and steelhead was attempted at the Pelton-Round Butte Project soon after its construction, with limited success. Passage of adults upstream was relatively successful, but from their upstream rearing habitats, downstream migrating smolts apparently became disoriented once they entered Lake Billy Chinook and did not move directly through the reservoir to an outlet. It became apparent in the late 1960s that upriver salmonid runs could not be sustained naturally with these facilities. Therefore, the efforts to maintain naturally spawning salmonid populations upstream from Pelton-Round Butte were abandoned and hatchery compensation was initiated in 1968 (Nehlsen 1995). In 1970, Portland General Electric agreed to finance the operation of an anadromous fish hatchery at the base of Pelton-Round Butte Dam. The hatchery began operation in 1972 (NPPC 1990).

NMFS (2000a) believes that one of the most significant sources of risk to steelhead in the MCR ESU is the recent and dramatic increase in the percentage of hatchery fish escapement in the Deschutes River basin. ODFW (2002) has estimated from capture of adult steelhead at Sherars Falls (RM 42) that in recent years, the percentage of hatchery steelhead strays in the Deschutes River has exceeded 70 percent, and many of these are believed to be long-distance strays from outside the ESU, based on differential marking. Coincident with this increase in the percentage of strays was a corresponding decline in the abundance of native wild steelhead in the Deschutes River. NMFS (2000a) stated that in combination with the increasing trend in hatchery fish in the Deschutes River, estimates of increased proportions of hatchery fish in the John Day and Umatilla River basins pose a risk to native wild steelhead due to negative effects of genetic and ecological interactions with hatchery fish. The downriver transportation of juvenile hatchery steelhead from upriver locations may contribute to increasing numbers of strays in the Deschutes River (NPPC 1990).

4.4.3 Life History

Biologists classify steelhead into two reproductive ecotypes according to their level of sexual maturity when they enter freshwater and the duration of their spawning migration. Stream maturing or summer steelhead enter freshwater in the spring and summer in a sexually immature condition. They require several months in freshwater to mature prior to spawning. Ocean maturing or winter steelhead enter freshwater in the fall and winter in a sexually mature condition ready to spawn (NMFS 1996). Most Deschutes River steelhead outmigrate at age 2 and spend 1 to 2 years in salt water before returning to spawn; these returning adults are referred to as 1-ocean and 2-ocean fish, respectively.

Adult inland steelhead, the anadromous form of resident redband trout, are found in Columbia River tributaries east of the Cascade Mountains, including the Deschutes River. Winter steelhead occur in Mosier, Chenowith, Mill, and Fifteenmile Creeks, Oregon; and in the Klickitat and White Salmon Rivers in Washington, all of which are downstream from The Dalles Dam, although east of the Cascade Mountains (NMFS 2000a).

All steelhead upstream from The Dalles Dam are summer-run fish. Summer-run steelhead are further divided into A-run and B-run fish. A-run adult summer steelhead are those inland Columbia River steelhead that pass Bonneville Dam up to 25 August, they are predominantly age-1-ocean, and are less than 77.5 cm in length (Schriever 2002). B-run summer steelhead pass Bonneville Dam after 25 August, are predominantly age-2-ocean, and are larger than 77.5 cm. Deschutes River steelhead are typical of A-run fish. B-run steelhead have a limited distribution in some Snake River tributaries, and are differentiated by size but not date of passage at Lower Granite Dam.

4.4.4 Habitat Requirements

In general, summer-run fish enter freshwater 9 to 10 months prior to spawning and ascend the Columbia River from June through October. They spawn from late winter through spring. Deschutes River wild steelhead spawn from about the middle of March to the end of May (Zimmerman and Reeves 1998). Spawning habitat requirements would typically include water depths of 9 inches to 5 feet, water velocity from 1 to 3 feet per second, and a largely sediment-free substrate with gravel to cobble sized from 0.5 to 4 inches in diameter. Spawning females construct several nests in each redd. They usually pair with a dominant male, but sometimes they spawn with different males for each nest. The number of eggs varies between 200 and 9,000, depending on fish size and stock. Adult steelhead, unlike salmon, do not necessarily die after spawning, but may return to the ocean to grow for another year and return to freshwater to spawn again. However, iteroparity (capability of spawning more than once) is not common among steelhead migrating more than several hundred miles upstream from the ocean; the number of repeat spawners in the Deschutes River is very low (NPPC 1990).

Fecundity of wild summer steelhead in the Deschutes River ranged from 3,093 to 10,480 eggs per female, with a mean of 5,341 eggs (NPPC 1990). Average fecundity was higher for age-2-ocean fish.

Eggs hatch in 35 to 50 days, depending on water temperature (about 50 days at 50 °F [10 °C]). Following hatching, alevins remain in the gravel 2 to 3 weeks until the yolk sac is absorbed. About 65-85 percent of the fertilized eggs survive to emerge as fry, while egg to smolt survival is estimated to be 0.75 percent. Steelhead fry emerge from redds in the middle to late summer. Following emergence, fry usually move into shallow and slow-moving margins of stream channels. As they grow, they move to areas with deeper water, a wider range of velocities, and larger substrate, sometimes emigrating from tributaries to the mainstem for a period of time prior to smolting (NPPC 1990). During winter, fry select areas with relatively low velocity and conceal themselves among cobble or rubble substrate.

Information on habitat carrying capacity for summer steelhead in the lower Deschutes River subbasin is not available, although the NPPC (1990) Subbasin Plan stated that the standard estimate of potential smolt production is 513,636 smolts. ODFW (1987, cited in NPPC 1990) estimated maximum steelhead production capacity at 147,659 smolts.

Juvenile steelhead (parr) rear in freshwater for 1 to 4 years, depending on water temperature and growth rates. Downstream migration and smoltification typically occurs from April to mid-June when parr reach a size of 6-8 inches (15-20 cm). Life history information for MCR steelhead indicates that most of these steelhead smolt at 2 years and spend 1 to 2 years in salt water (1-ocean and 2-ocean fish, respectively) prior to re-entering fresh water, where they may remain for up to a year prior to spawning. Pribyl (2002) noted that juvenile Deschutes River steelhead generally spend 2 years in freshwater. Returning adults are about equally divided between 1-ocean and 2-ocean fish.

Diet of steelhead varies considerably according to life history stage and fish size as well as the food items that are available. Juvenile steelhead feed primarily on benthic macroinvertebrates associated with the stream substrate such as immature aquatic insects (e.g., mayfly and stonefly nymphs and caddisfly, dipteran, and beetle larvae), amphipods, snails, aquatic worms, fish eggs, and occasionally small fish. Diets of juveniles can fluctuate seasonally, depending on food availability. At times the diet may include terrestrial insects and emerging adult aquatic insects drifting in the current. In estuaries, steelhead smolts initially feed on invertebrates, but as they grow they begin to feed on larger prey more typical of their diet at sea, which may include crustaceans, and eventually squid, herring, and other fish species.

At any time of the year in the lower Deschutes River and its major tributaries, some life stage of steelhead are present, either migrating, rearing, or spawning adult fish; incubating eggs or developing fry; or rearing or migrating juvenile fish (NPPC 1990). Steelhead may be seasonally absent from smaller tributaries where environmental conditions become unfavorable, such as eastside tributaries that warm up or have reduced flow during the summer.

4.5 CANADA LYNX

4.5.1 Status

In April 2000, the USFWS listed the Canada lynx (*Lynx canadensis)* as threatened under the ESA across the contiguous United States. The United States listing provides protection for lynx within 13 states, including Oregon. The USFWS will develop a proposal to be used for the designation of critical habitat in the future. A recovery plan has not yet been developed; however, in February 2000, the USFS and the USFWS signed a Lynx Conservation Agreement and Strategy which will promote the conservation of lynx and lynx habitat on Federal land managed by the Forest Service (Federal Register 65:16052).

4.5.2 Distribution, Life History, and Habitat Requirements

The Canada lynx is a medium-sized cat with long legs; large, well-furred paws; long tufts on the ears; and a short, black-tipped tail. On average, males weigh 22 pounds and are 33.5 inches in length (head to tail); females weigh 19 pounds and are 32 inches in length (Federal Register 65:16052).

In the contiguous United States, the historic range of the Canada lynx includes forests of the Cascade Range in Washington and Oregon (Figure 4-4). In particular, within the West, lynx primarily inhabit subalpine coniferous forests that receive deep snow, for which they are highly adapted. Snowshoe hare (*Lepus americanus),* also specialized to survive in areas that receive deep snow, are the primary prey of the lynx. Lynx and snowshoe hare are considered to have a classic predator-prey relationship, with lynx populations fluctuating on an approximate 10-year cycle following the hare population cycle. Red squirrels (*Tamiasciurus hudsonicus*) are an important alternate prey when snowshoe hare populations are low (Federal Register 65:16052). Further study into the dynamics of lynx-hare interaction is critical; rather than analyzing only the relationship between lynx and snowshoe hare, research into the hare cycle which is produced by an interaction between predation and food supplies is necessary (Krebs 2001). The USFWS states, "It is imperative that snowshoe hare and alternate prey populations be supported by appropriate habitat management on Federal lands into the future to ensure the conservation of lynx in the contiguous United States" (Federal Register 65:16052).

The USFWS determined that lynx in the lower 48 states emanated from a larger metapopulation whose core is located in the northern boreal forest of central Canada. This boreal forest naturally becomes fragmented at its southern margins where it transitions into other vegetation types. Lower snowshoe hare densities are a result of this patchy, transitional habitat, as well as the presence of more predators and competitors of hares at southern latitudes. It is unknown as to the extent to which the northern lynx populations influence lynx occurrence in the contiguous United States. But because of the naturally fragmented habitat and lower hare densities, it is expected that lynx in the southern boreal forest naturally occur at lower numbers than in the north (Federal Register 65:16052).

In the Cascades region, including Washington and Oregon, most lynx occurrences are found within conifer forests consisting of Douglas fir and western spruce/fir and at elevations between 3,200 and 6,100 feet. Older, mature forests contain large woody debris such as downed logs and windfall that provide habitat for denning sites, escape cover, and protection from severe weather. It appears that for den sites, the age of the forest stand is not nearly as important as the amount of downed woody debris available. Snowshoe hare use these areas and earlier successional forests with dense understories that provide forage, cover, escape routes, and protection from severe weather. Forest structure that provides food and cover for snowshoe hare and cover for lynx dens is determined to be more important than specific vegetation found within the forest type (BLM and USFS 2001; Federal Register 65:16052).

4.6 NORTHERN SPOTTED OWL

4.6.1 Status

In July 1990, the USFWS listed the northern spotted owl (*Strix occidentalis caurina)* as threatened under the ESA throughout its entire range, including western Oregon. Designated CHU on Federal lands became effective February 1992, providing additional protection to the spotted owl with regard to Federal activities (Federal Register 57:1796). In 1994, the U.S. Department of Agriculture (USDA) published the Northwest Forest Plan. In theory, the plan would aid in the conservation of the spotted owl by allowing currently non-suitable, but potential, habitat to regenerate within Late-Successional Reserves, which in turn would allow the population to eventually stabilize across its range. Many CHUs overlap with Late-Successional Reserves within the known spotted owl range in western Oregon (Tuchmann 1996, BLM and USFS 2001). In 1992, the USFWS developed a draft recovery plan for the northern spotted owl, but at this time a final recovery plan has not been published.

4.6.2 Distribution, Life History, and Habitat Requirements

The northern spotted owl is a medium-sized owl with dark eyes, chocolate brown coloring with round to elliptical white spots on the body, and white bars on the tail. The adult female is slightly larger than the male (Federal Register 55:26114).

The current range of the northern spotted owl is southwestern British Columbia, western Washington, western Oregon, and the coast range area of northwestern California south to San Francisco Bay (Figure 4-5). The majority of spotted owls are found in the Cascades of Oregon and the Klamath Mountains in southwestern Oregon and northwestern California (Federal Register 55:26114).

Northern spotted owls are long-lived and monogamous, mating for life. These pairs usually do not nest every year, nor are nesting pairs successful every year. It has been suggested that fluctuations in reproductive activity may be related to fluctuations in prey availability. Nesting activity begins between February and March, with one to four eggs laid soon after. Fledging occurs between mid-May and June, with parental care continuing into September. At that time, the juvenile owls are on their own. It has been estimated that only 18 percent of sub-adult spotted owls survive their first year, with predation by great horned owls and starvation the two main causes of mortality (Federal Register 55:26114).

Adult northern spotted owls maintain a territory year-round, with home ranges varying in size depending on the time of year (breeding and nonbreeding season), the amount of old-growth and mature forest available, and prey base. Within Oregon, median annual pair home ranges were estimated to be 2,955 acres for the Cascades and 4,766 acres for the coast (Federal Register 55:26114).

Northern spotted owls primarily occur in old-growth and mature forest habitats, but may also be found in younger forests that contain the necessary structures, vegetation, and prey. Suitable spotted owl habitat has 60-80 percent canopy closure; a multi-layered, multi-species canopy dominated by large (>30 inches diameter at breast height) overstory trees; an abundance of large trees with various deformities (i.e. cavities, snags); large accumulations of fallen trees and other woody debris; and adequate open space below the canopy for flight. These necessary components are most often associated with stands aged 200+ years. However, spotted owls have been observed using relatively young forests (60+ years) that contain key components of suitable owl habitat, particularly those with significant remains of earlier stands that were affected by fire, wind storms, and inefficient logging. Northern spotted owls are primarily nocturnal predators of small mammals such as flying squirrels (*Glaucomys sabrinus)*, red tree voles (*Arborimus longicaudus)*, and dusky-footed woodrats (*Neotoma fuscipes)* (Federal Register 55:26114).

Deschutes River Basin
Canada lynx

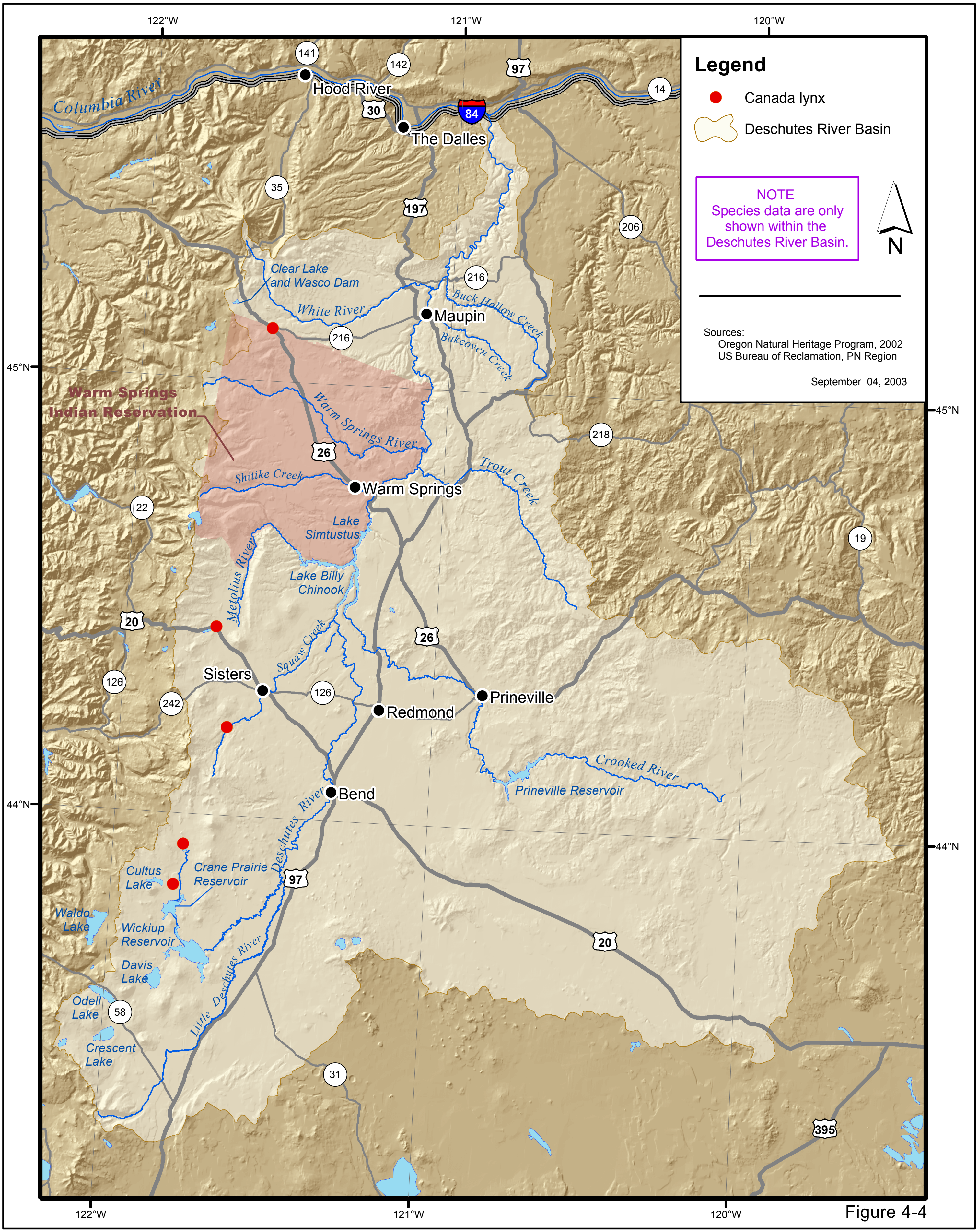


Figure 4-4

Deschutes River Basin
Northern Spotted Owl

Pacific Northwest Region GIS

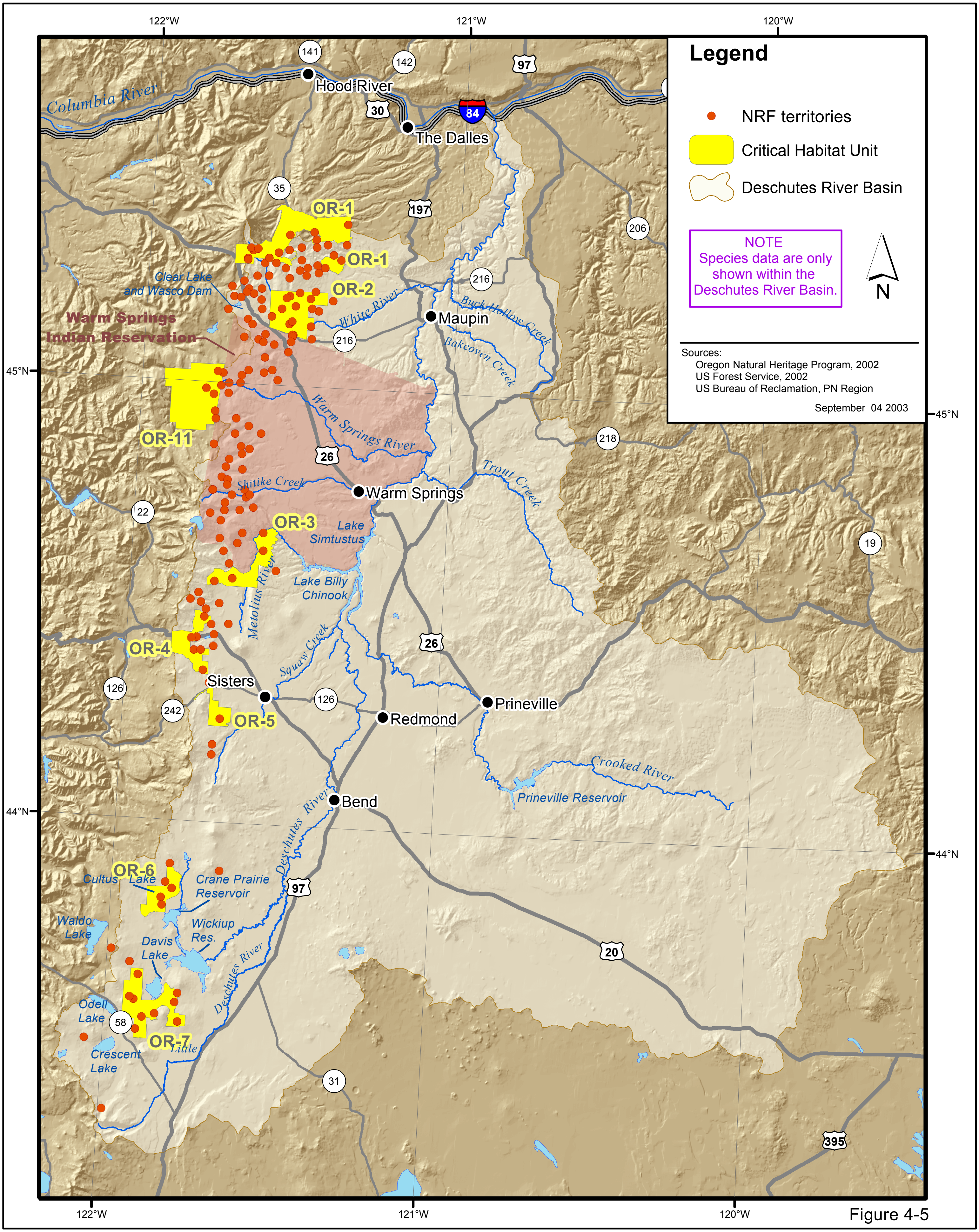


Figure 4-5

CHAPTER 5.0 ENVIRONMENTAL BASELINE

5.1 INTRODUCTION

The environmental baseline describes the impacts of past and ongoing human and natural factors leading to the present status of the species and its habitat within the action area. The environmental baseline provides a "snapshot" of the relevant species' health at a specified point in time (i.e., the present). The environmental baseline includes past and present impacts of all Federal, state, or private actions and other human activities in the action area (50 CFR § 402.2). Therefore, all existing facilities and all previous and current effects of the construction, operation, and maintenance of the Deschutes, Crooked River, and Wapinitia Projects are part of the environmental baseline. The environmental baseline also includes state, tribal, local, and private actions already affecting the species or habitat in the action area or actions that will occur contemporaneously with the consultation in progress. The environmental baseline assists both the action agency and the USFWS and NMFS in determining the effects of the proposed action on the listed species. The following section describes the effects of past and current activities as they relate to the current status of bald eagle, bull trout, MCR steelhead, Canada lynx, and northern spotted owl.

5.2 BALD EAGLE

5.2.1 Factors Contributing to Species Decline

Habitat loss and increasing human population will continue to be the greatest long-term threats to recovery of the bald eagle. Breeding, wintering, and foraging areas continue to be degraded by urban and recreational development and resource extraction activities. Shootings continue to be a problem for bald eagles. Electrocution is also an ongoing problem where powerlines do not conform to raptor protection standards. Nesting habitat quality downstream of dams may decline over the long term if flow releases do not permit perpetuation of forest riparian stands or if fisheries are negatively affected.

Contamination of waterways from point and nonpoint sources of pollution is also a potential problem. Contaminants may affect the survival as well as the reproductive success and health of bald eagles. The abundance and quality of prey may be seriously affected by environmental contamination. Although many compounds implicated in reduced reproductive rates and direct mortality are no longer used, contaminants continue to be a major problem in some areas. Pesticides in recent times have not affected the bald eagle on a population level; however, individual poisonings still occur.

Reservoir drawdowns, low winter flows, or high ramping rates that reduce fish populations impact bald eagle food supplies. Low winter flows reduce habitat availability by reducing spatial rearing area and restrict fish populations to a few residual pools, increasing their vulnerability to predation. Low winter flows that result in increased ice cover can affect the availability of fish and may be a factor in heavily used areas. Reservoir open water areas may not be available to bald eagles during the late winter because of ice conditions.

5.2.2 Environmental Baseline Conditions in Project Area

The Deschutes River basin supports a significant population of nesting and wintering bald eagles. The bald eagle population in the Deschutes basin (including Deschutes, Crook, Jefferson, and Wasco Counties as well as the very northwest tip of Klamath County) is in the High Cascades Recovery Zone (Isaacs and Anthony 2002). The Pacific Bald Eagle Recovery Plan identified recreation disturbance, logging, shooting, and trapping as the main threats for this zone. Since the plan’s approval, new habitat issues have evolved including: insect, disease, blowdown, wildfire, and timber harvest effects on large potential nesting or roosting trees (BLM and USFS 2001). BLM and the USFS (2001) have consulted on programmatic activities on their respective administered lands in the upper Deschutes River subbasin.

Nesting activity in the High Cascades Recovery Zone has increased from 52 occupied breeding territories to 60 in the 5-year period from 1998 through 2002 (Isaacs and Anthony 2002). The number of young produced each year increased from 57 to 62 during the same time period. The habitat management goal for this recovery zone has been 47 occupied nesting territories and the recovery population goal has been 33 (Isaacs and Anthony 1999).

The 5-year (1998 through 2002) nesting success average was about 65 percent in the High Cascades Recovery Zone, and the 5-year average of young produced per occupied breeding territory was 1.00. These results are equal to those identified in the Pacific Bald Eagle Recovery Plan and similar to state of Oregon results of 64 percent success and 1.01 young per occupied territory.

5.2.2.1 Upper Deschutes River Subbasin

Nesting Bald Eagles

The upper Deschutes River subbasin above Bend contains the greater part of the bald eagle nesting population in the Deschutes basin (Figure 5-1). According to Isaacs and Anthony (2002) there are approximately 35 identified breeding (nesting) territories in this geographic area (Deschutes County and northern Klamath County), and they are mostly associated with the headwater lakes and reservoirs. For example: there is one breeding territory associated with Crescent Lake; about seven associated with Odell and Davis Lakes; two in the Lava Lake/Elk Lake area; about 17 associated with Crane Prairie and Wickiup Reservoirs and their tributaries; three along the Deschutes River below Wickiup Dam; one at East Lake on the Paulina Creek drainage; and two in the area north and west of Bend. Most nests are in the tops of large conifers, primarily ponderosa pine. A large blow-down of timber at Wickiup Reservoir has limited the availability of suitably sized nesting trees at the location (Morehead 1999).

There are approximately 20 bald eagle breeding territories that are influenced by the operation of Crane Prairie and Wickiup Reservoirs (Figure 5-1 and Table 5-1). For the 1972 through 2002 period of record, the number of occupied breeding territories in the vicinity of these two reservoirs has increased from 6 to 20 (Table 5-1). This increase is largely due to an expanding bald eagle population region-wide. The last 5-year average (1998 to 2002) has been between 18 and 20 occupied territories. The number of young produced over the period of record has varied from three in 1982 to 20 in 1999 and has generally been in an upward trend, similar to the number of occupied territories (Figure 5-2). The last 5-year (1998 through 2002) average was between 17 and 18 young fledged. The last 5-year average success rate per occupied territory was about 60 percent and the 5-year average of young produced per occupied breeding territory was 0.91 – both being near, but slightly below, the recovery goals of 65 percent and 1.0 young per occupied territory. The average success rate and average young fledged has varied considerably over the period of record, but appears to have been on a slight decline overall (Figure 5-3). This may be due to the increased competition for space and prey as breeding pairs have begun to saturate the available habitat and/or to other annual environmental variables such as climate or prey availability.

Eagles nesting in close association with project reservoirs and natural lakes in the upper Deschutes River subbasin are subject to a variety of disturbances, mostly associated with recreational uses of these resources. Some nesting pairs at project reservoirs appear to have grown somewhat tolerant of continued recreational activities such as fishing, boating, camping, vehicle traffic, etc., while other pairs have remained disturbed by such activities. Recreational issues of primary concern (i.e., have the most potential for disturbing nesting activities) are water surface activities. USFWS has suggested that restricting access to some bays during the eagle nesting period would help reduce disturbance impacts on nesting eagles (Dillon 2002).

The Deschutes National Forest administers the lands where the bald eagle nests are located. For most of the nesting territories, the USFS (2002) has established Bald Eagle Management Plans as indicated in Table 5-1. The Bald Eagle Management Plans include restrictions on recreational activities that may adversely affect breeding, nesting, and rearing activities; although these restrictions may be occasionally abused by undisciplined individuals.

Wintering Bald Eagles

Winter use by bald eagles of suitable habitats in the upper Deschutes River subbasin is dependent on winter conditions. When reservoirs, lakes, and streams remain ice-free, some eagles may remain at the higher elevation lakes and streams to prey on the resident fish populations (i.e., bald eagles both nest and winter at Wickiup Reservoir). The greatest winter use is in the Davis Lake arm of Wickiup Reservoir and in the Deschutes River arm below Crane Prairie Reservoir. These areas are most likely to remain ice-free. In extreme winter conditions when ice cover precludes prey availability in high elevation lakes and streams, most bald eagles move to lower elevations or migrate to lower basins to forage for food. A few bald eagles (possibly 10-12) forage along the upper Deschutes River during the winter season preying on fish and waterfowl which are in adequate supply (Morehead 1999). However, lower winter flows make this reach of river more susceptible to ice-cover and may, in some years, limit the availability of fish prey.

Crane Prairie and Wickiup Reservoirs
Bald Eagle

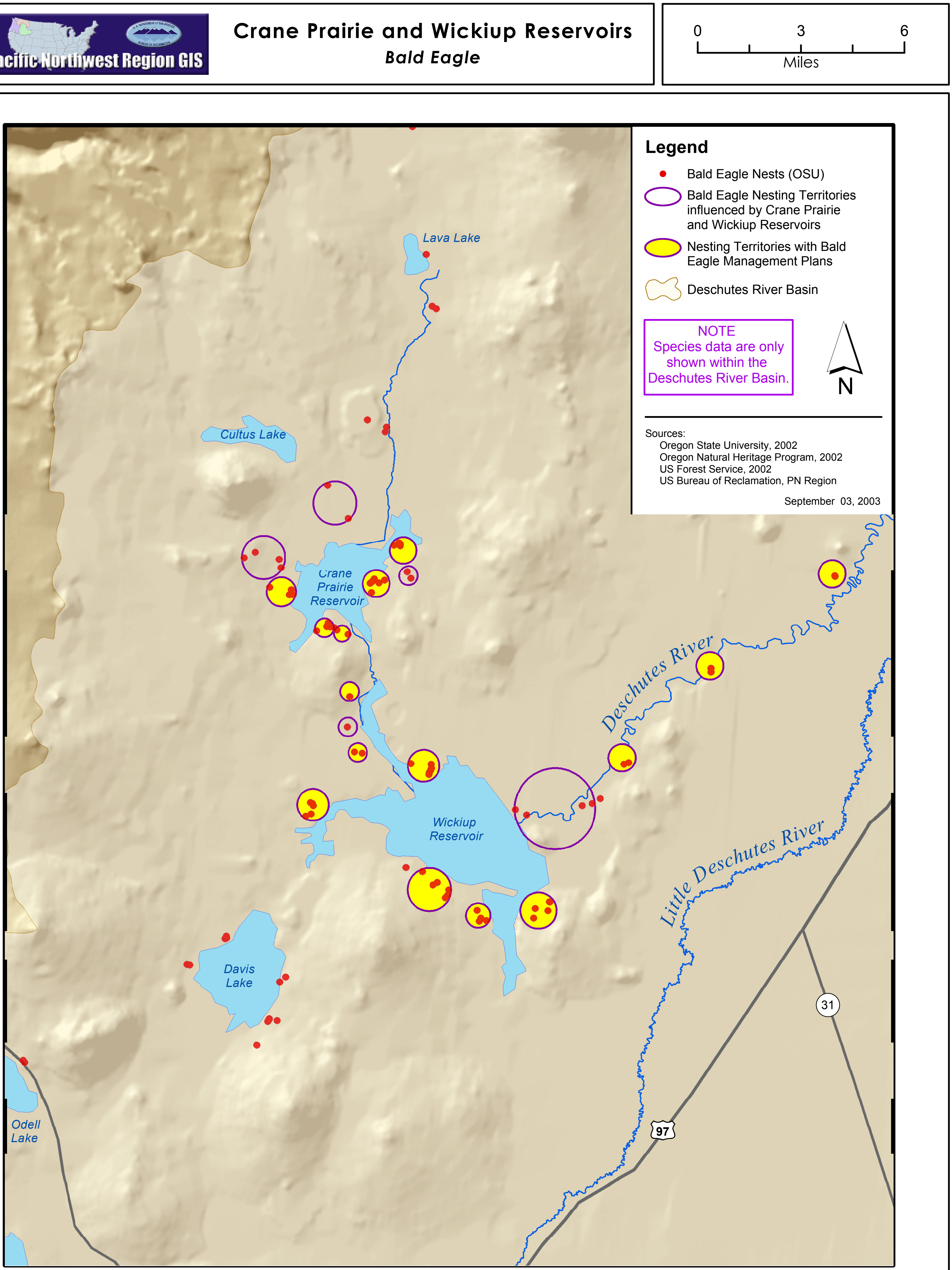


Figure 5-1

Table 5.1 [1]Bald Eagle Nest Production - Vicinity of Crane Prairie and Wickiup Reservoirs

Bald Eagle Nesting Territories	Number of Young Observed per Occupied Breeding Area 1972 - 2002																													
	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02
Associated with Crane Prairie Reservor:																															
1. ✰Crane Prairie North East		2		1	2	0	1	2	0	0	0	0		0	1	0	0	0	1	2	2	0	1	0	0	0	0	0	0	0	0
2. ✰Crane Prairie East					0	0				0	0	0	0	0	0	0	0	0	1	2	2	1	2	0	0	0	2	2	0	2	1
3. ✰Crane Prairie West			0	0	0	0	2	0	1	2	0	0	1	2	2	2	0	2	2	2	2	2	2	2	2	2	1	0	0	0	1
4. ✰Crane Prairie South West																							0	0	1	1	2	1	0	2	0
5. ✰Crane Prairie South East	1	1		2	2		2	0	0	2	0	0	2	0	0	0	2	1	1	2	2		0	0	2	1	0	2	0	0	1
6. Cultus River																														1	2
7. Quinn/Lemish Butte	0	0	1							0		0		0		0	0	0	0	1	0	2	0	1	1	1	2	0	0	2	0
8. □ Wuksi Butte																								1	1	1	1	1	2	2	2
Associated with Wickiup Reservoir:																															
9. ✰Brown's Mountain				1		2	0		2	1	0		0	2	1	2	1	2	2	0	1	2	2	2	1	2	1	2	0	0	0
10. ✰Brown's Creek	2	2	2		3	1	2	2		0	0	1	2	0	2	1	2	0	2	1	0	0	0	2	1	2	0	2	2	2	2
11. ✰Brown's Crossing																															0
12. ✰Wickiup Reservoir North	2	1	1	0			0	1	1	0	1	1	0	0	1	0	0	0	0	0	0	2	0	1	0	1	0	1	2	0	2
13. ✰Wickiup Dam/Wickiup Res. East									2	2	0	0	2	0	0	1	0	0	2	0	1	1	0	2	2	2	2	1	2	1	0
14. ✰Eaton Butte										0	0			0			0	0	0		0	0	0	0	0	0	1	1	2	2	2
15. ✰Davis Creek	1	1			1	0	2	2	1	2	2	1	1	0	0	0	0	2	1	2	1	1	2	2	0	0	1	2	1	0	1
16. ✰Round Swamp		1							0	0	0	1	1	0	1	0	1	1	0	0	2	0	0	0	0	0	1	2	0	0	2
17. ✰Wickiup Reservoir South								0	1	2	0	0	2	1	0	1	0	2	1	1	0	0	0	0	0	1	2	0	0	0	0
Associated with Deschutes River (Downstream of Wickiup Dam)																															
18. ✰Tetherow Meadow																		0	1	1	1	1	1	2	0	0	1	1	1	1	0
19. ✰Deschutes River Oxbow																						1	0	0	1	1	0	1	2	0	1
20. ✰Bates Butte	2	1	2			2	2	1	1	2	0	1	2	2	0	1	2	2	0	2	2	0	2	1	2	3	0	1	2	2	1
ANNUAL TOTAL - # OF YOUNG	8	9	6	4	8	5	11	8	9	13	3	5	13	7	8	8	8	12	15	16	17	15	13	16	14	18	17	20	16	17	18
Annual Total - # of Occupied Breeding Areas	6	8	5	5	6	6	8	8	10	14	13	12	11	14	12	13	15	15	16	14	16	16	18	18	18	18	18	18	19	20	20
Avg # Young /Occupied Breeding Area	1.3	1.1	1.2	0.8	1.3	0.8	1.4	1.0	0.9	0.9	0.2	0.4	0.8	0.5	0.7	0.6	0.5	0.8	0.9	1.1	1.1	0.9	0.7	0.9	0.8	1.0	0.9	1.1	0.8	0.9	0.9
Avg Success Rate/Occupied Breeding Area (%)	83	88	80	60	67	50	75	63	70	50	15	42	73	29	50	46	33	47	69	71	69	63	44	56	56	67	67	78	47	50	60

✰ Bald Eagle Management Plans have been completed for these sites (Bend/Ft. Rock Ranger District, Deschutes Natl. Forest, Bend OR).

□ An essential habitat evaluation has been conducted for this site (Bend/Ft. Rock Ranger District, Deschutes Natl. Forest, Bend OR).

0 Indicates an occupied breeding area, but no young raised or no young observed.

2

[1]Nest occupancy and number of young observed is taken from: Isaacs, F.B. and R.G. Anthony. 2002. Bald eagle nest locations and history of use in Oregon and the Washington portion of the Columbia River Recovery Zone, 1972 through 2002. Oregon Cooperative Fish and Wildlife Research Unit, Oregon State University, Corvallis.

Information on Bald Eagle Management Plans furnished by: Burchert, S. Feb. 4, 2001. Written Communication. Bend/Ft. Rock Ranger District, Deschutes Natl. Forest, Bend OR.

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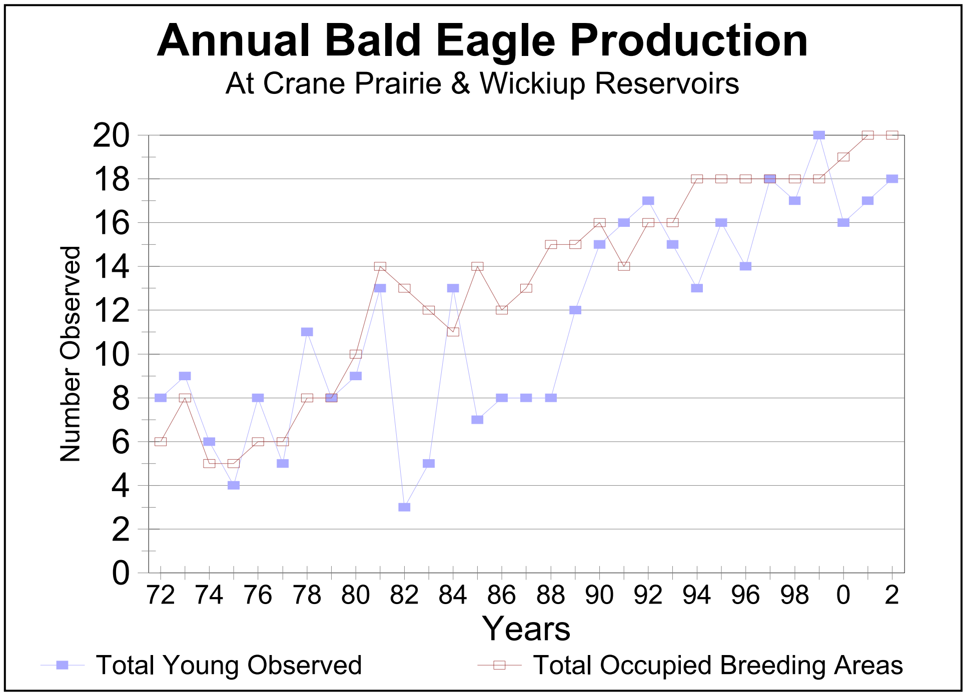

Figure 5-2. Bald Eagle Production Success

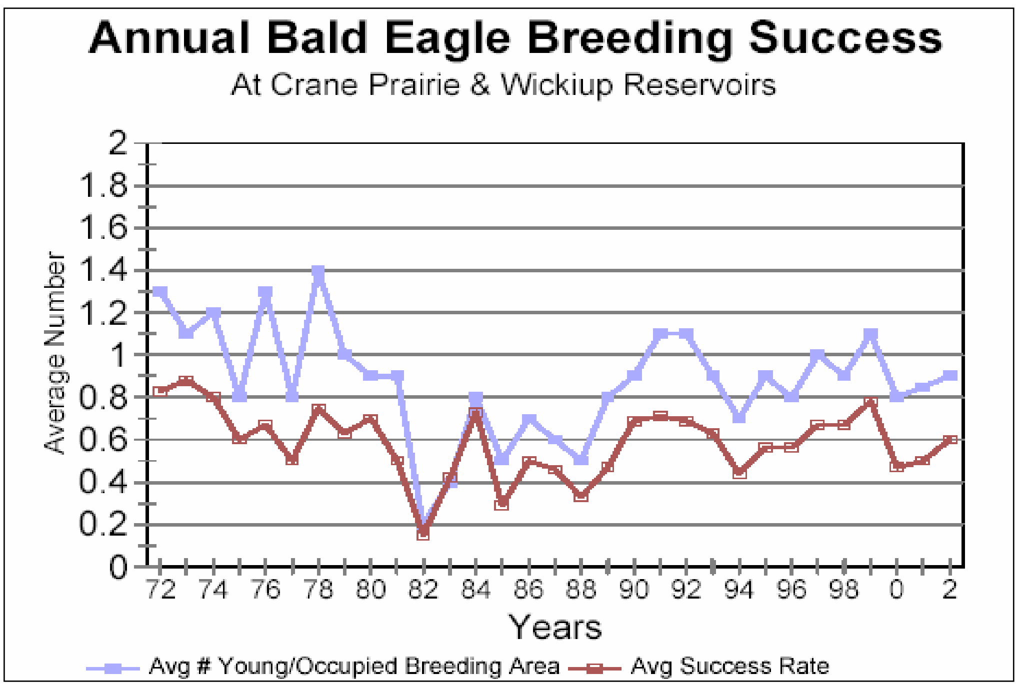

Figure 5-3. Bald Eagle Breeding Success

5.2.2.2 Middle Deschutes River Subbasin

Nesting Bald Eagles

The middle Deschutes River provides only limited habitat for bald eagle nesting because there is a paucity of suitable large conifers for nesting. Many of the nests in this area are associated with the Metolius River and its tributaries (Figure 4-1) as well as the other streams tributary to the west side of Lake Billy Chinook. Two nesting areas are on the upper Metolius, and eight are on the lower drainages immediately west of the Pelton-Round Butte Project reservoirs. The latter are all nest sites located in the upper branches of large ponderosa pine trees. Most of the nest trees are located in canyons or side slopes. There are concerns over human disturbance at nest sites in the vicinity of recreational activities (CTWSRO 1999).

Breeding success and the production of young for nesting territories associated with the Pelton-Round Butte Project are available in Isaacs and Anthony (2002). Although these breeding territories have no direct link to Reclamation projects, a brief summary of nesting and production data is presented here for purposes of the environmental baseline discussion.

The known number of occupied breeding territories in the Pelton-Round Butte Project area increased from 3 in 1989 to 8 in 2000 and remained at 8 during the 2001 and 2002 breeding seasons (CTWSRO and PGE 2002). The recent 5-year (1998 through 2002) average is 7.6 occupied breeding territories and 5.0 successful territories. The number of young produced annually from 1989 through 2002 varied from 3 to 12 and the recent 5-year average is 7.4. The 5-year ratio of success versus occupied territories is 66 percent and the number of young/per occupied territories is 1.02–these are both slightly higher than the Oregon (1998 through 2002) averages of 64 percent and 1.01 (Isaacs and Anthony 2002).

Nesting pairs directly associated with Lake Billy Chinook have generally had good breeding success over the period of record. Other sites removed from Lake Billy Chinook have had mixed success (CTWSRO and PGE 2002). The reasons for unsuccessful nests are only partly known. In some years, breeding pairs have occupied their nesting territory, but for unknown reasons appear to have chosen not to nest. In a few instances, nests have blown out of the nest trees, resulting in nesting failure. Eggs and/or young have been observed early in the nesting season, but have been destroyed or disappeared altogether for unknown reasons prior to hatching or fledging.

A devastating, lightning-caused wildfire in mid-July 2002 severely impacted the bald eagle habitat associated with Lake Billy Chinook (CTWSRO and PGE 2002). The Eyerly Fire, which started initially on the Warm Springs Indian Reservation near the upper end of the Metolius Arm of Lake Billy Chinook, spread south across the reservoir to Federal and private forest lands burning more than 18,000 acres and destroying the Eyerly, Spring

Creek, and Fly Creek nest sites. A fourth nest site in Big Canyon may have also been damaged or destroyed.

Fish comprise the greater part of the diet for the nesting eagles in the middle Deschutes River subbasin. There is a strong dependence on kokanee from Lake Billy Chinook (CTWSRO 1999). Suckers, bass, mountain whitefish, and other fish species are also utilized along with bird species and small mammals.

Wintering Bald Eagles

The majority of bald eagle sightings in this area occur during the fall, winter, and spring months when eagles are wintering or migrating through the area. A migrant population of bald eagles has been frequenting the Metolius Arm of Lake Billy Chinook for many years to feed on kokanee, a reliable and predictable food source. Counts exceeding 200 birds have been recorded in this area (CTWSRO 1999).

All of the resident bald eagles in this area roost in their territories and in nest trees during the fall and late winter. Two winter communal roosts are found along the Metolius River arm of Lake Billy Chinook, near Spring Creek. These roosts are in a coniferous old-growth stand, with an abundance of snags, in close proximity to foraging areas with some thermal cover from the surrounding topography. A separate fall communal roost used by migrating eagles is located near the confluence of the Metolius River with Lake Billy Chinook. The two bald eagle winter roost sites near Perry South Campground and Spring Creek burned in the July 2002 fire discussed above (CTWSRO and PGE 2002).

5.2.2.3 Crooked River Subbasin

Nesting Bald Eagles

Isaacs and Anthony (2002) list 12 known nesting territories in Crook County, most of which are in the Crooked River subbasin (Figure 4-1). Seven of the territories are located at higher elevations upstream of project lands and reservoirs. One of these nests is located on Ochoco Creek, a few miles above Ochoco Reservoir. Three additional nests are located to the north of Prineville, a considerable distance from Crooked River Project lands. The only nesting territory in the vicinity of Reclamation project lands or facilities is at Prineville Reservoir, consisting of two nest sites. The traditional nest is located on north Alkali Flat, within ½-mile of the south side of Prineville Reservoir. While bald eagles had occasionally been observed at Prineville Reservoir during the summer months, the Alkali Flat nest, first reported in 1996 (Table 5-2), was the only nest documented in the area until the 2002 nesting season (Isaac and Anthony 2002; Soules 1999).

Table 5-2. Bald Eagle Nest Production - Vicinity of Prineville Reservoir

North Alkali Flat Bald Eagle Nesting Territory	Number of Young Observed 1996 – 2002						
Year	96	97	98	99	00	01	02
# of Young	1	0	1	1	0	2	0
# of Occupied Breeding Areas	1	1	1	1	1	1	1

The nest site on Alkali Flat is not directly influenced by recreational activities on the reservoir and is on BLM-administered lands. The nest is in a dead snag and is in poor physical condition. It may not provide a good nesting site for much longer (Zakrajsek 2002, Clowers 2002). BLM has not prepared a formal Bald Eagle Management Plan for this nest site, but roads are closed and access in the vicinity of the nesting site is restricted during the breeding season (Dean 2002).

Suitable nesting trees are scarce near the reservoir. Bald and golden eagles have been observed using a tree located on the south side of the reservoir at Sanford Creek. This tree has potential to become a nest tree, but would be very close to recreational boating activities on the reservoir.

Zakrajsek (2002) and Clowers (2002) have suggested that the Alkali Flat nesting pair appears to be defending the entire reservoir against other potential new pairs. The female is showing signs of age and it is expected that there will be a change in the composition of the nesting pair in the near future.

In 2002, the Alkali Flat resident pair of bald eagles established an alternate nest at Owl Creek, on the north side of the reservoir, also on BLM-administered lands. The nesting attempt was unsuccessful. The tree selected is not well suited to breeding and nesting; it is too small for breeding activity and is beginning to fail structurally. It is also within line of sight of and less than ¼-mile from an established recreation access road. It has been speculated that the nest may have been built by the Alkali Flat pair as a defensive act and is probably used by the birds to help discourage other potential bald eagles from using this area (Zakrajsek 2002). Reclamation cooperated with the BLM, ODFW, and Oregon State Parks to close access roads in the immediate vicinity of the new nest during the nesting season.

Reclamation recently completed a resource management planning process for lands surrounding Prineville Reservoir (Reclamation 2003b). As part of that planning process, Reclamation assessed the effects of land management practices on the bald eagles at the reservoir. Reclamation concluded that implementation of the resource management plan may affect, but is not likely to adversely affect bald eagles. USFWS concurred (2003) with Reclamation's assessment based on the following measures which Reclamation is committed to implement to reduce potential human conflicts with bald eagles in the Prineville Reservoir area:

1. Vehicle access around the reservoir will be controlled by seasonal road closures, barrier, signs, and increased enforcement. In addition, an annual review of current eagle activities at known nests will be used to determine the opening dates for some winter road closures.
2. A bald eagle management plan will be developed in cooperation with ODFW, BLM, and USFWS.
3. A comprehensive monitoring plan will be developed for bald eagle nest and roost sites.
4. Dispersed camping at most of the popular camping areas around the reservoir will be limited to defined, designated campsites.

Wintering Bald Eagles

Bald eagles are mostly winter visitors to the Prineville and Ochoco Reservoir areas from December through April (Reclamation 1992). Weekly eagle counts between January and April have regularly observed bald eagles throughout the upper Crooked River drainage as well as the upper Prineville Reservoir area. Three winter communal roost sites have been identified on the steep slopes along the south side of Ochoco Reservoir, well upstream of the dam (Reclamation 1993). Waterfowl and fish, both available at Ochoco Reservoir, are important prey for wintering bald eagles.

A study conducted by Isaacs et al. (1993) on eagles wintering along the upper Crooked River upstream of Prineville Reservoir in 1986 and 1987 found wintering/migrating bald eagles to be most abundant during the first 2 weeks of March, peaking at 115 birds. Eleven communal night roosts were identified in large conifers with one in a cottonwood. Deer and cattle carcasses were the primary food source for these eagles during January and February, while ground squirrels provided an important source of food during March and April.

Bald eagles winter in the downstream Crooked River corridor below Bowman Dam (Prineville Reservoir). Historical reports indicate that the corridor supported their nesting in the past (BLM 1992). Observations of wintering eagles in the canyon have shown a steady increase. In recent years, counts have ranged between 8 to 10 birds, with the majority of them being bald eagles. Resident fish species (i.e., redband trout, hatchery rainbow, mountain whitefish, brown trout, bass, brown bullhead, sucker, and northern pikeminnow) in Prineville Reservoir and in the lower Crooked River, along with small mammal prey and carrion, provide winter forage for these eagles.

5.2.3 Bald Eagle Foraging Habitat and Prey Base

5.2.3.1 Upper Deschutes River Subbasin

Nesting bald eagles in the upper Deschutes ecosystem rely heavily on the abundant prey base of resident fish populations in the streams, lakes, and reservoirs. Common species of prey include rainbow trout, brown trout, coho salmon, kokanee, and whitefish (USFS 1996). Waterfowl and other birds and small mammals are incidental to fish prey.

The availability of prey varies according to habitat conditions, production success, and annual stocking rates. Of the foregoing, habitat conditions in the project reservoirs are closely associated with reservoir operations. Dry year cycles, in particular, reduce the quality and quantity of available aquatic habitat, which may adversely affect fish production and/or longevity. Low reservoir levels and streamflows concentrate fish and make them more susceptible to predation. While this may be initially advantageous for bald eagles, it may lead to reduced fish populations in following years.

Crane Prairie Reservoir

Foraging habitat for nesting bald eagles at Crane Prairie Reservoir consists primarily of the open water area of the reservoir surface and several small tributary streams. The reservoir has a maximum capacity of about 55,300 acre-feet covering about 4,900 surfaces acres. At full pool, the average depth is 11 feet with a maximum of 20 feet. The shoreline has a length of about 22.3 miles. It is 4.9-miles-long and 2.2-miles-wide. The reservoir has no minimum pool restrictions, but the outlet structure is screened to prevent fish losses.

The reservoir storage content has varied considerably from year to year and season to season depending on the water year and on withdrawals for irrigation (Figure 3-2). The reservoir storage at the end of October (going into the winter season) is critical for sustaining a productive reservoir fishery. The average end-of-October carryover has been about 23,000 acre-feet (about 42 percent full).

Fish prey are the most sought after prey for nesting eagles at Crane Prairie Reservoir. The eight bald eagle nesting pairs associated with Crane Prairie Reservoir must compete, not only among themselves, for the available fish prey, but also with high numbers of other piscivorous birds and anglers.

Fies et al. (1996a) reported that bull trout, redband trout, and mountain whitefish were the indigenous fish species present in the Deschutes River when Crane Prairie Reservoir was first created in 1922. Bull trout are no longer found in this upper reach of the river. Crane Prairie Reservoir presently contains hatchery rainbow trout, brook trout, kokanee, mountain whitefish, largemouth bass, tui chub, and three-spined stickleback. Rainbow trout and kokanee are stocked in the reservoir on an annual basis. The other fish species are self-sustaining from previous stocking or illegal introductions.

Crane Prairie Reservoir has long been recognized by ODFW (Fies et al. 1996a) and anglers as one of Oregon's premier trout producing waters. The fishery has been managed as "basic yield" (using natural productivity with or without addition of hatchery stocks) for hatchery and naturally produced trout, whitefish, and largemouth bass. It is especially well known for producing large rainbow trout. Rainbow trout up to 13 pounds have been taken and 3-5 pound fish are common.

Fies, et al. (1996a) stated that the "fish production potential in Crane Prairie Reservoir for all species is, apparently, limited primarily by reservoir pool level." Current population levels of tui chubs and largemouth bass may also be a factor in limiting trout production. There is no minimum pool level for fish life; however, the reservoir typically stays above 10,000 acre-feet. A minimum of 9,470 acre-feet was recorded in 1980 (Reclamation 2003a). Another factor influencing reservoir pool levels is excessive water loss from the reservoir by leakage through broken lava flows along the shoreline (particularly at high storage levels). In fact, seepage can actually exceed annual irrigation releases (Reclamation 2003a).

Reduced reservoir levels during poor water years results in loss of (1) aquatic food production, (2) cover for juvenile fish rearing, and (3) access to spawning areas (Fies et al. 1996a). The annual loss of trees in the reservoir has also resulted in the loss of fish and wildlife habitat. Standing dead timber in the reservoir is lost at an accelerated rate during low water years. Exposure to the air accelerates wood decay and trees are subsequently sheared at water level by a combination of ice and wind.

An additional concern raised by anglers (Fies et al. 1996a) is predation on trout by a variety of fish-eating bird species. The primary species of concern have been cormorants and osprey. Other fish-eating birds present, in addition to bald eagles, include great blue herons, mergansers, kingfishers, gulls, grebes, and goldeneyes. Biologist have learned that water levels appeared to be the key factor in determining numbers of cormorants at Crane Prairie Reservoir. When the reservoir was low, more cormorants came to the reservoir to take advantage of the concentrated food supply. For example, a high count of 730 cormorants was reached in 1981, a poor water year (11,260 acre-feet at end of September). In 1982, a good water year (33,160 acre-feet at end of September), the high count was 295 cormorants.

The tributaries of Crane Prairie Reservoir provide varying amounts of trout spawning and rearing habitat for both reservoir and resident fish populations (Fies et al. 1996a). Of the approximately 13.5 total miles of tributary habitat available in Cultus and Deer Creeks and in Cultus, Quinn, and Deschutes Rivers, over three quarters of it is in the Deschutes River. Consequently, the small amount of habitat available in each stream, except the Deschutes River, may in itself limit the amount of potential fish production.

Wickiup Reservoir

Foraging habitat for nesting bald eagles at Wickiup Reservoir consists primarily of the open water area of the reservoir surface, the Deschutes River (above and below the reservoir), and several small tributary streams. The reservoir has a maximum capacity of about 200,000 acre-feet covering about 11,200 surfaces acres. At full pool, the average depth is about 20 feet with a maximum of 70 feet in the original Deschutes River channel. The shoreline has a length of about 50.5 miles. It is over 6.5-miles-long and 4.5-miles-wide, not including the Deschutes River or Davis Creek arms of the reservoir. The reservoir has no minimum pool restrictions. The outlet structure is unscreened and allows fish to escape when water levels are drawn down. The outlet's depth is approximately 70 feet which rules out the use of conventional fish screening. Fies et al. (1996a) stated that "It does not appear to be technically feasible to screen such an outlet at this time."

As stated above for Crane Prairie Reservoir, Wickiup Reservoir storage content has also varied considerably from year to year and season to season depending on the water year and on withdrawals for irrigation (Figure 3-7). When the reservoir level drops below 40,000 acre-feet of storage (20 percent full), fish become concentrated in the Deschutes River channel of the reservoir and the loss of fish through the outlet increases (Fies et al. 1996a). The average end-of-October carryover has been between 50,000 and 60,000 acre-feet, 25 to 35 percent full.

Fish prey are also the most sought after prey for nesting eagles at Wickiup Reservoir. The nine bald eagle nesting pairs associated with Wickiup Reservoir compete among themselves for the available fish prey and with other piscivorous birds (especially ospreys) and anglers.

Fies et al. (1996a) reported that bull trout, redband trout, and mountain whitefish were the indigenous fish species present in the Deschutes River before the construction of Wickiup Reservoir in 1949. Bull trout are no longer found in this upper reach of the river. In addition to the indigenous mountain whitefish and a small population of redband trout, the reservoir and its tributaries currently contain introduced brown trout, kokanee, coho salmon, brook trout, largemouth bass, and tui chub. Brown trout and coho salmon (as available) are still stocked in the reservoir on an annual basis. The other fish species are self-sustaining from previous stocking or illegal introductions.

Wickiup Reservoir and its tributaries are heavily used by anglers throughout the season (Fies et al. 1996a). Both the reservoir and its tributaries have been managed as "basic yield" fisheries for indigenous whitefish, introduced hatchery and naturally-producing populations of brown, rainbow, and brook trout; kokanee; and coho salmon. The reservoir has a reputation for producing large brown trout; however, the primary angling is for kokanee and coho.

Fies et al. (1996a) stated that, for Wickiup Reservoir, "the fish production potential is limited by reservoir pool level." More recent evidence suggests that illegally introduced populations of bass and tui chubs may also be limiting trout production. There is no designated minimum pool level for fish life. Reservoir storage records (Reclamation 2003a) show that the reservoir typically stays above 25,000 acre-feet. A recent recorded minimum of 15,600 acre-feet occurred in 1994. Average end-of-September carryover is 61,000 acre-feet.

As previously discussed above, "When the reservoir drops below 40,000 acre-feet of storage, the loss of fish through the unscreened outlet increases...These are primarily kokanee and coho, fish with strong migrational tendencies (Fies et al. 1996a)." Thousands of kokanee and coho salmon and lesser numbers of brown trout can be lost from the reservoir annually.

"During a period of high water years, natural production of kokanee results in too many fish for the available food supply and the size of the fish declines rapidly. Conversely, in the low water cycles, fish losses through the outlet increase and remaining fish have an abundant food supply resulting in larger fish (Fies et al. 1996a)."

As at Crane Prairie Reservoir, Wickiup Reservoir also experiences an annual loss of tree stumps resulting in lost aquatic food production and fish cover. This problem is especially severe in low water years. Projects to replace structural habitat (i.e., rocks, whole trees, root wads) have been undertaken, but are relatively small in scope compared to the amount of habitat lost. With continued loss of stump habitat, the overall fish production capability of the reservoir may decline in the future (Fies et al. 1996a).

Browns Creek, Davis Creek, Sheep Springs, and the Deschutes River (between Crane Prairie Dam and Wickiup Reservoir) provide spawning habitat for brown and rainbow trout, kokanee, whitefish, and brook trout. Coho salmon, although present at Wickiup Reservoir, have never been observed spawning in the tributaries--possibly because water temperatures are too cold for coho production (Fies et al. 1996a). Stream habitat in the Deschutes River varies in length due to fluctuations in Wickiup Reservoir pool, but averages about 2.5 miles. It may be up to 6 miles in late summer when the Wickiup

Reservoir pool level is down. While this reach of the Deschutes River is characterized by generally good water quality (Fies et al. 1996a), it can be adversely affected in mid-summer because of warm water releases, accompanied by extensive amounts of algae, from Crane Prairie Reservoir. Flow fluctuations can also significantly alter the amount of useable spawning gravel and trout rearing cover in this reach of river.

Deschutes River (Downstream of Wickiup Reservoir)

The Deschutes River and tributaries below Wickiup Reservoir provide foraging habitat for three bald eagle pairs which nest along the river and possibly other pairs with overlapping territories (i.e., the Wickiup Dam nesting territory). Flows in this reach of river are characterized by large, demand-based seasonal fluctuations as a result of reservoir operations and irrigation diversions (Figure 3-8). During irrigation season, when releases from upstream reservoirs increase to meet downstream irrigation demands, Deschutes River flows greatly exceed historic "natural" flows. During the fall and winter, flows are reduced below historic "natural" flows as the reservoirs are refilled (see Chapter 3).

During the nonirrigation season, a minimum of 20 cfs is normally maintained at the gaging station about 1,000 feet downstream from the dam (Reclamation 2003a). This minimum was set by the Oregon State Engineer as a result of a hearing held in September 1954 on the amended application to increase the storage in Wickiup Reservoir. Flows higher than 20 cfs can usually be supplied in a series of wet years without risk to refill, as was the case from 1997 to 2001.

This combination of wide seasonal fluctuations, sustained high summer flows, sustained low winter flows, and the rapid transition from each to accommodate seasonal irrigation needs is the current primary source of aquatic and riparian habitat degradation (i.e., bankline erosion, sediment load, high turbidity levels, loss of spawning habitat, loss of riparian vegetation) and limitations on overall productivity of fish prey in the Deschutes River from Wickiup Dam to Bend.

During the eagle nesting season, flows in this reach of river are generally high from spring runoff and from irrigation releases. The prey base in this reach of the Deschutes River consists, primarily, of the same fish species which exist in Wickiup Reservoir. Resident fish and fish flushed through the dam (as described earlier) provide needed forage for the nesting eagles which forage along the river. Although, higher than natural flows may restrict foraging success. Low water in the winter period (dry and average years) does not directly influence foraging of nesting eagles, but it does limit habitat available to resident fish, resulting in reduced fish populations.

5.2.3.2 Crooked River Subbasin

Prineville Reservoir

The nesting pair of bald eagles at Prineville Reservoir rely primarily on the abundant prey base of resident fish populations in the reservoir. Common species of prey may include rainbow trout, smallmouth and largemouth bass, brown bullhead, largescale and bridgelip suckers, and black crappie. Waterfowl and other birds and small mammals are incidental to fish prey.

The availability of prey varies according to habitat conditions, production success, and annual stocking rates. Of the foregoing, habitat conditions in Prineville Reservoir are closely associated with reservoir operations. Dry year cycles, in particular, reduce the quality and quantity of available aquatic habitat, which, in turn, may adversely affect fish production and/or longevity. However, dry cycle effects at Prineville Reservoir are rare.

Foraging habitat for nesting bald eagles at Prineville Reservoir consists primarily of the open water area of the reservoir surface and the Crooked River above and below the reservoir. The reservoir has an active capacity of about 148,640 acre-feet covering about 3,070 surfaces acres. Maximum depth is about 230 feet, with an average annual drawdown of 25 to 30 feet. The shoreline has a length of about 43 miles. The reservoir is over 12 miles in total length but varies from less than ¼-mile-wide to about ¾-mile-wide. The reservoir has no minimum pool restrictions, but the uncontracted space (83,000 acre-feet) serves to maintain a minimum pool in most years. The recent recorded minimum pool was 22,450 acre-feet in 1993 (Reclamation 2003a). The reservoir storage content is fairly predictable for most years (Figure 3-23). The average end-of-October carryover storage is about 83,000 acre-feet (about 56 percent of full).

Prior to inundation in the winter of 1960-61, the Crooked River at the site of Prineville Reservoir supported a very low abundance of native redband trout and MCR steelhead, brown bullhead, and assorted nongame species. The riverine ecosystem was extremely degraded by land and water management practices at the time (Stuart et al. 1996).

Stuart et al. (1996) reported that "Prineville Reservoir is probably moderately nutrient rich, but unproductive due to the high turbidity which limits sunlight penetration." The reservoir is impacted by high quantities of suspended sediments resulting from erosion occurring on the mainstem Crooked River and tributaries above the reservoir as well as shoreline erosion of the reservoir caused by the wave action from wind and boats.

Nongame species presently dominate the fish population in Prineville Reservoir. Suckers and chiselmouth are the most abundant. Stuart et al. (1996) reported that hatchery rainbow trout are stocked in the reservoir in early to mid-May and are the primary game fish in the reservoir.

Largemouth and smallmouth bass are sustained by natural reproduction. Largemouth are generally found in the upper half of the reservoir while smallmouth bass are common throughout the reservoir. The generally poor condition of bass species in the reservoir indicate an insufficient prey base (Stuart et al. 1996). Production may also be limited by reservoir drawdowns in the early spring. ODFW and Reclamation have cooperated on projects to improve bass habitat in the reservoir, including the placement of juniper trees for fish cover (Reclamation 2003a).

Crooked River Below Bowman Dam

Cold water releases (Figure 3-24) from Prineville Reservoir have created a tailrace fishery through the Chimney Rock section (about 12 miles) of the lower Crooked River. This reach of river supports a mix of native redband trout, hatchery rainbow trout, and mountain whitefish. Hatchery fish stocked in Prineville Reservoir sometimes pass through the dam to the Crooked River below. High entrainment rates appear to correspond with severe drawdown of the reservoir or when the reservoir is high enough that water flows over the spillway (Stuart et al. 1996). Small amounts of smallmouth and largemoth bass, brown bullhead, and nongame fish also occur in the river below the dam.

Informal minimum releases up to 75 cfs (usually 30-35 cfs during extreme drought conditions) from the uncontracted storage space have helped sustain the downstream fishery during the nonirrigation season.

Ochoco Reservoir

Ochoco Reservoir is a privately-owned facility that is operated in coordination with Reclamation’s Bowman Dam operations.

Wintering bald eagles at Ochoco Reservoir utilize the prey base of resident fish populations in the reservoir to supplement their diet of big game and livestock carrion. Common species of fish prey may include rainbow trout, brown bullhead, and bridgelip suckers. Waterfowl, other birds, and small mammals are incidental to fish prey and upland carrion in the eagles winter diet.

The availability of prey varies according to habitat conditions, production success, and annual stocking rates. Of the foregoing, aquatic habitat conditions in Ochoco Reservoir are closely associated with reservoir operations. Dry year cycles, in particular, severely reduce the quality and quantity of available overwintering aquatic habitat, which, in turn, may adversely affect fish numbers during the winter period.

Foraging habitat for wintering bald eagles at Ochoco Reservoir consists primarily of the open water area of the reservoir surface and Ochoco Creek above the reservoir. The reservoir has a capacity of about 44,266 acre-feet covering about 1,060 surfaces acres. Maximum depth is about 100 feet with an average annual drawdown of 25 to 50 feet. The reservoir is about 3.5 miles in total length with a maximum width of 0.5 miles. The reservoir has no minimum pool restrictions; the entire useable pool is used to irrigate OID lands.

The reservoir storage content is fairly predictable for most years (Figure 5-4). The average end-of-October carryover storage has been about 14,750 acre-feet or about 33 percent full (Reclamation 2003a).

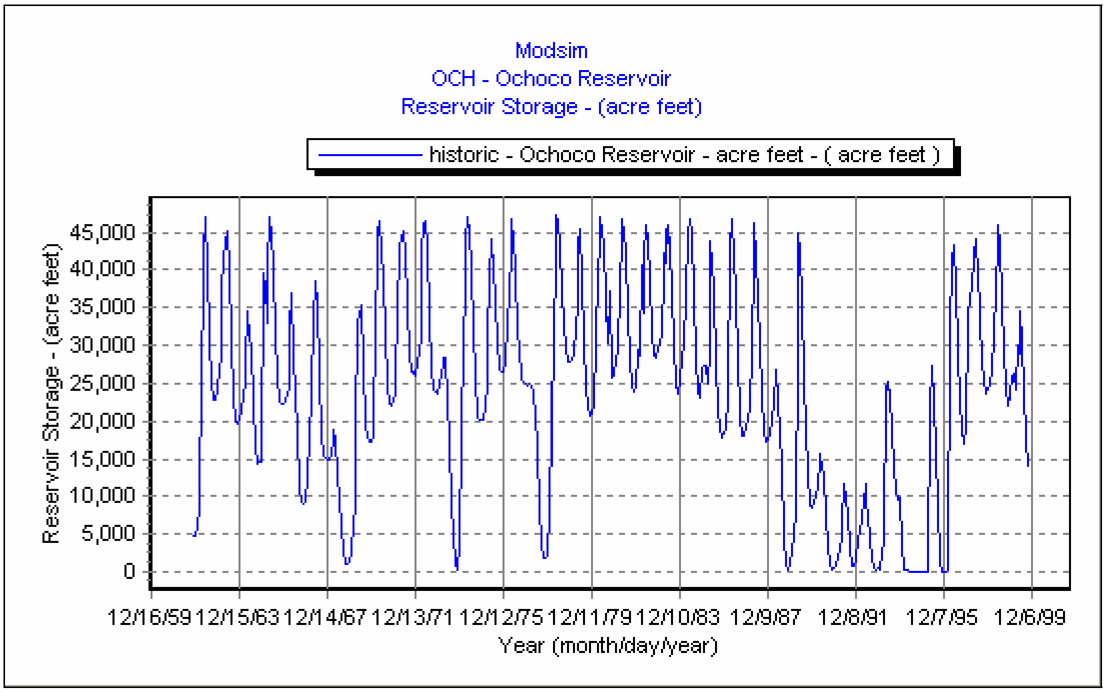

Figure 5-4. Ochoco Reservoir – Historic End-of-Month Elevations

Ochoco Reservoir habitat is characterized by a lack of shoreline vegetation, an expansive mud flat substrate in the upper end, and a boulder and cobble-strewn substrate in the lower end. Additional habitat limitations for fish include only moderate concentrations of nutrients in the water, very low abundance of aquatic vegetation, a lack of structural complexity, and water that is too cold for optimal warmwater fish production and perhaps too warm for optimal trout production (Stuart et al. 1996).

Ochoco Reservoir currently supports populations of rainbow trout, brown bullhead, and bridgelip suckers. Ochoco Creek upstream of the reservoir supports redband trout, bridgelip sucker, sculpins, and dace. Hatchery rainbow trout grow well in the reservoir and have supported the bulk of angler effort since 1958 (Stuart et al. 1996). The reservoir is managed for intensive use and basic yield, with the fishery sustained by a hatchery fingerling rainbow trout program. Since 1980, approximately 100,000 rainbow trout have been stocked in the reservoir, annually; although these numbers have been adjusted downwards in years with anticipated low water conditions.

Ochoco Dam has an unscreened outlet that allows hatchery fish to be entrained into the stilling basin and creek below. When water is shut off following the irrigation season, these fish die unless a salvage is conducted. Some hatchery rainbow pass downstream, rear, and may reproduce in Ochoco Creek. Hatchery fish may also move upstream from the reservoir, rear, and reproduce in Ochoco and Mill Creeks (Stuart et al. 1996).

5.2.3.3 Lower Deschutes River Subbasin

The nesting pair of bald eagles at Clear Lake rely primarily on the fish prey base in Clear Lake and in adjacent streams and lakes. Common species of prey are rainbow trout and kokanee. Waterfowl and other birds and small mammals would be incidental to fish prey.

The availability of prey varies according to habitat conditions, production success, and annual stocking rates. Of the foregoing, habitat conditions in Clear Lake are closely associated with reservoir operations. Dry year cycles, in particular, reduce the quality and quantity of available aquatic habitat, which, in turn, may adversely affect fish production and/or longevity.

Foraging habitat at Clear Lake consists of the open water area of the reservoir surface. The reservoir has an active capacity of about 11,900 acre-feet covering about 557 surfaces acres. The water depth at the dam is about 40 feet at full pool. The shoreline has a length of 5 to 6 miles. It is about 2 miles in total length but varies from less than ¼-mile wide to about 1-mile across its two arms. The reservoir has no minimum pool restrictions, but when the reservoir is drawn down to dead pool, the original natural lake remains (storage content unknown).

The historic record of reservoir storage at Clear Lake is not complete; therefore, only a partial hydrograph can be constructed (Figure 3-31). It is estimated that the average end-of-October carryover storage is about 2,540 acre-feet over and above the natural lake level (Reclamation 2003a). The reservoir is essentially emptied on most drought years, but still leaving the natural lake.

Bald eagles have been commonly seen in the area for years foraging in the Clear Lake, Frog Lake, and Timothy Lake areas (Morehead 1999). A kokanee run above Timothy Lake provides seasonal prey for eagles. Fish as a prey base at Clear Lake itself may be limited, because of annual reservoir drawdowns. Even so, Clear Lake is regularly stocked with legal size rainbow trout and regular stocking is expected to continue into the foreseeable future. Clear Creek below the dam typically has insufficient year-round flows to support a fishery.

Wintering Bald Eagles

The lower Deschutes subbasin value to bald eagles is primarily as wintering habitat. As described for the Crooked River and middle Deschutes River subbasins, bald eagle numbers increase dramatically during the fall, winter, and spring during migrations and wintering periods. Numerous communal roosts are utilized along the river corridor. Prey species include fish which are abundant in the lower river and tributaries, as well as waterfowl, small mammals, and big game and livestock carrion.

Clear Lake freezes over in the winter, so there is no foraging habitat at the lake for eagles or ospreys during that season (Reclamation 1999).

5.3 BULL TROUT

5.3.1 Factors Contributing to Species Decline

Bull trout were formerly viewed as a "trash fish" by anglers because they consume juvenile salmon and other game fish and were considered undesirable predators. Many fish and wildlife agencies mounted active campaigns to eliminate bull trout. Even after active efforts to eliminate bull trout ceased, populations continued to decline due to impacts from other human activities. The causes of this decline are many and varied and have worked in concert to cumulatively impact this and other native salmonid species. Impacts on bull trout generally occur from three areas of resource management: 1) land management practices, 2) water management practices, and 3) fisheries management practices. Current recognized threats to bull trout are discussed in the following sections.

5.3.1.1 Habitat Degradation

Loss of riparian vegetation through human activity leads to increased water temperature and siltation. Instream cover is lost due to a reduction in woody debris recruitment and unstable banks that do not allow the formation of undercut banks. Most bull trout spawning strongholds are associated with unmanaged watersheds with near pristine streams.

5.3.1.2 Passage Barriers and Stream Diversions

Dams, irrigation diversions, and other alterations of waterways have interrupted the migration of bull trout. Numerous dams without adequate fish passage have caused some populations with migratory life histories to switch to resident life histories. Where once the migratory bull trout linked resident bull trout to much of the species' gene pool, today, the resident populations are isolated, vulnerable to habitat degradation and may suffer a loss of genetic diversity. If a barrier is high in a drainage, the isolated population may be too small to sustain itself.

On bull trout streams where there are irrigation diversions, at least four potential problems may affect bull trout production. Irrigation diversions reduce instream flows; the water returned to streams tends to be warmer than the water diverted; sediment is added to streams; and unscreened diversions entrain migrating juvenile bull trout to conveyance systems and fields where they die.

Construction of water storage structures appears to have been a significant factor in the reduction of bull trout range and distribution. Construction and operation of these facilities have modified streamflows, changed stream temperature regimen, blocked migration routes, entrained bull trout, and affected bull trout forage bases.

Reservoirs experience substantial drawdowns during drought years. Reduced reservoir volume directly impacts the amount of aquatic environment for all organisms in the food web. Production of phytoplankton, zooplankton, and aquatic insects are all reduced when drawdowns are extreme. Reduction in the food base may reduce the prey available for predator species like bull trout; although, in some cases, forage fish populations may be more concentrated and more available as prey. When reservoir volume is greatly reduced, bull trout and other fish species may be forced into riverine habitats.

Upper Deschutes River

Construction of Crane Prairie Dam in 1922 and Wickiup Dam in 1949 blocked fish passage, reduced instream flows and caused subsequent increases in water temperature, altered streamflow regimes, and inundated spawning and juvenile rearing areas in the upper Deschutes River subbasin (Buchanan et al. 1997).

Although a loss of connectivity, habitat, and forage base due to dam construction may have been detrimental to bull trout populations, this cannot be the sole explanation for their extirpation, for they persisted in the upper Deschutes River subbasin for 16 years after the construction of Crane Prairie Dam.

Lower Deschutes River

The construction of the Pelton-Round Butte Project created a barrier to the upstream movement of bull trout in the mainstem Deschutes River and is also an obstacle to downstream movement. This project has had some effects to flows in the lower Deschutes River, however, it is not known whether or not these effects alter bull trout use of the mainstem Deschutes River (Newton and Pribyl 1994).

5.3.1.3 Competition with Exotic Species

Brook trout were introduced to Oregon and Idaho in the early 1900s (Buchanan et al. 1997). Brook trout not only compete directly with juvenile bull trout for food, but are genetically close enough to the bull trout to permit hybridization. The hybrids are sterile and represent a dead end for bull trout genes. The danger is especially acute when there are few bull trout and the hybrids cannot contribute to the bull trout population.

Other introduced species that provide forage and have different habitat preferences, such as kokanee, may actually benefit bull trout. However, when brown trout, bass, and lake trout are present in the same waters as bull trout, they may depress or replace bull trout populations through competition for prey and may also prey upon juvenile bull trout.

5.3.1.4 Reduced Populations from Overfishing or Eradication Efforts

Some populations of bull trout were eliminated and others have not recovered from overfishing and deliberate efforts to eradicate them. The populations remaining may suffer from a loss of genetic diversity and may not be able to sustain themselves.

Angling and harvest of bull trout influences the current status of this species, which may be vulnerable to overharvest. Although the direct, legal harvest of bull trout has been eliminated or restricted in most states, incidental takes of this species in recreational trout fisheries and by poachers, especially in streams supporting large migratory fish, may further impact bull trout abundance. During a regulated season, the ODFW allows anglers to harvest one bull trout per day with a 24-inch minimum length from Lake Billy Chinook.

5.3.1.5 Catastrophic Events

Catastrophic fire events can drastically alter water quality, water temperature, woody debris, bank vegetation, and streamflow characteristics. Wildfire has been documented as impacting bull trout populations (Burton 1997). Salvage timber sales have a high potential to impact isolated bull trout populations. Drought conditions result in reduced summer streamflows (and reduced reservoir elevations) and increased water temperature and will predictably reduce spawning success and survival of bull trout (Knowles and Gumtow 1996). Climate change as a result of global warming could reduce bull trout spawning success (Knowles and Gumtow 1996).

Environmental stochasticity or the effect of a catastrophic event (such as deep reservoir drawdowns for flood control or during drought conditions) influence the probability of bull trout extinction when population size is small (Rieman and McIntyre 1993).

5.3.1.6 Recovery Efforts

The 1997 “Status of Oregon's Bull Trout” (Buchanan et al. 1997) reports that 81 percent of Oregon's bull trout populations are considered to be at a “moderate risk of extinction,” “high risk of extinction,” or “probably extinct.” This report discusses life history, habitat needs, potential limiting factors, and risks for bull trout populations on a basin-by-basin basis. The report concludes with a section on research and management needs, followed by recommendations.

In the Deschutes River basin, efforts were initiated to protect and enhance bull trout in the Metolius subbasin in 1983. These efforts were initiated by the Metolius Bull Trout Working Group comprised of representatives from ODFW, USFS, CTWSRO, and PGE. Since then the group has been expanded to include the entire Deschutes River basin and additional representatives from USFWS, BLM, Reclamation, Central Oregon Flyfishers, Trout Unlimited, Oregon Department of Forestry, and Oregon State Parks and Recreation Department. Another working group has been formed to work on bull trout in the Odell Lake basin. This group includes representatives from the USFS, ODFW, and resort owners around the lake. Both working groups have been drafting conservation strategies for bull trout in their respective basins (Buchanan et al. 1997).

In November 2002, the draft rule for bull trout critical habitat in the Columbia and Klamath River basins was published in the Federal Register by the USFWS. This proposal includes bull trout critical habitat for the Deschutes River basin. A final rule was expected in October 2003. However, USFWS has postponed further work to develop a final rule until fiscal year 2004 because of lack of funding.

Critical habitat refers to specific geographic areas that are essential for the conservation of a threatened and endangered species. Primary constituent elements are physical and biological features that are essential to the conservation of the species and that may require special management considerations or protection. Currently, there are nine primary constituent elements considered for bull trout that describe physical and biological features essential to the conservation of the species. Physical features include temperature, flow regime, water chemistry and habitat constituents such as stream channel type, substrate composition, and migratory corridor considerations. Biological features include consideration of competitive nonnative species interaction and food base and forage requirements. An important consideration for the proposed action is the effect, if any, to the primary constituent elements described above. Since present operations of Reclamation facilities in the Deschutes and Crooked River subbasins reflect ongoing actions that have occurred in the recent past, there will be no effect to the hydrograph and potential physical or biological features associated with critical habitat proposed for bull trout.

The USFWS is expecting completion of final bull trout recovery plans in November 2004. Recovery plans are a much larger blueprint for the recovery and eventual delisting of a species, as it provides recommendations concerning habitat and various other factors that need to be addressed to achieve recovery.

5.3.2 Environmental Baseline Conditions in Project Area

5.3.2.1 Upper Deschutes River Subbasin — Headwaters to Bend

As described earlier in this chapter, bull trout are no longer found in Reclamation project reservoirs (i.e., Crane Prairie, Wickiup) and the upper Deschutes River system, and are thought to be "probably extinct" (Buchanan et al. 1997). Since few studies by management agencies focused on bull trout, basic information is lacking, such as accurate estimates of their historical population sizes and distribution within the upper Deschutes River subbasin. The only population remaining in the upper basin is that associated with Odell Lake, which is not a project facility and is not affected by operation of Reclamation projects. The Odell Lake population is considered to be at "high risk" of extinction. The presence of a public campground on Trapper Creek in the only identified bull trout spawning area in the Odell subbasin may put spawning bull trout at risk from illegal harvest. Harvest management of bull trout is the main conservation management tool used at this time (Marx 2000).

5.3.2.2 Middle Deschutes River Subbasin ― Bend to Lake Billy Chinook

The middle Deschutes River is delineated as the area downstream from the City of Bend at RM 165 to Lake Billy Chinook (RM 120). Below the city of Bend, the Deschutes River changes from forested to desert canyon habitats. Following irrigation development, nearly the entire flow at the North Canal Dam at Bend was diverted during the irrigation season. Flows recorded immediately downstream from Bend during the irrigation season are typically less than 50 cfs.

Streamflows

The Deschutes River from Bend to Lake Billy Chinook does not have an established minimum flow. Reductions in streamflow and changes in flow patterns due to water diversions in Bend and upstream have drastically altered flow in the middle Deschutes River, as well as the aquatic environment.

Prior to reaching Lake Billy Chinook, substantial groundwater discharge occurs along the lower 2 miles of Squaw Creek and the Deschutes River between Lower Bridge (RM 135) and Lake Billy Chinook. These discharges provide substantial cooling to the Deschutes River. A 2001 ODEQ thermal infrared study showed a surface water temperature decrease of approximately 16°F between RM 132 and RM 120.

This discharge of water and subsequent good water quality in this reach of the Deschutes River is likely the reason that bull trout are present from Lake Billy Chinook to Big Falls (RM 132). These groundwater discharge gains occur even during dry periods and the driest months of the year. In 1994 (Caldwell 1998), the streamflow increased by more than 430 cfs from RM 138 to RM 120.

Bull Trout

As described earlier in this chapter, the bull trout populations in the middle Deschutes subbasins occur in the Metolius River subbasin, Lake Billy Chinook Reservoir, the Deschutes River upstream from Lake Billy Chinook to Big Falls, lower Squaw Creek, and the lower part of Crooked River up to the Opal Springs Dam. The Metolius River and its tributaries are the primary spawning and rearing streams, while Lake Billy Chinook and its respective riverine arms (Deschutes, Metolius, and Crooked Rivers) provide foraging habitat for overwintering adults and growing subadults and has produced a trophy-sized bull trout fishery. Life histories of these fish are summarized as follows from Buchanan et al. (1997).

Most bull trout in the Metolius River and tributaries age 5 and older spawn between 15 August and early October, with some individual spawners found between July through late October. It appears that the extremely cold (39° to 46°F) Metolius River tributaries provide the critical spawning and juvenile rearing habitats that support the Metolius River bull trout population.

Juvenile bull trout typically rear in their natal streams for 2 to 3 years before migrating downstream to Lake Billy Chinook. Although migrating juveniles were observed in all months, most migration peaked in May and June. Many of these fish appeared to migrate directly to Lake Billy Chinook when about 8 inches (200 mm) long. Subadult bull trout tagged in the lake at the head of the Metolius arm moved into all available waters. After 2 to 3 years in the reservoir (age 5-6), they migrated back up the Metolius River during April through July. Maturing adult bull trout were captured at the head of the Metolius arm of Lake Billy Chinook beginning in April and continuing through August.

Most maturing bull trout remained in the lower Metolius River until mid-July when they initiated their upstream migration. After migration commenced, most fish quickly moved up the Metolius River and resided near the mouth of the intended spawning tributary. Adult bull trout entered tributary streams beginning in late July and continuing through the last week of September. Migration into the spawning tributary, spawning, and migration back to the Metolius River usually took place within 2 weeks. Most post-spawned bull trout moved back down to Lake Billy Chinook within 4 weeks after spawning, demonstrating an adfluvial life history pattern. However, some bull trout appeared to demonstrate a fluvial life history pattern and remained in the upper Metolius River.

Number of Fish – The number of bull trout redds and number of spawning adults has generally been increasing since the late 1980s. Trends in spawning population size have increased since 1986 from 27 redds to about 760 redds in 2001 (PGE 2002). Estimated population numbers for adult fish system-wide increased from 818 in 1993 to 1,895 in 1994 (Buchanan et al. 1997). Bull trout abundance has increased dramatically in recent years because of restrictive angling regulations, education, and a large forage base of kokanee in Lake Billy Chinook. The healthy Metolius/Lake Billy Chinook bull trout population (Ratliff and Howell 1992) has allowed a limited harvest of trophy fish to continue.

The number of bull trout counted in the Metolius River basin through 2001 suggests that this population is fit and robust enough to prevent excessive inbreeding. Growth rates in Lake Billy Chinook are some of the highest reported in the literature (Riehle et al. 1997).

Habitat Conditions/Water Quality **–** Because of low streamflows, land management activities, and multiple uncontrolled variables such as air temperatures from Bend to about 30 river miles downstream, water quality does not meet State standards. Water quality problems include high water temperatures, low dissolved oxygen, high pH, high nutrient loading, high fecal coliform, high toxins (pesticides, fertilizers), moderate turbidity and high sedimentation. High volumes (about 500 cfs) of cold spring water substantially improve the water quality in the remaining 12 miles to Lake Billy Chinook. The influence of these springs provides a relatively cool and stable year-round water temperature for bull trout that inhabit this reach of the river.

5.3.2.3 Crooked River Subbasin

While there is no historical documentation of bull trout spawning in the Crooked River subbasin, Metolius basin bull trout used the lower Crooked River for juvenile rearing and adult holding areas.

The apparent absence of bull trout from the remainder of this basin is consistent with the habitat requirements of the species, which is generally found in watersheds that receive substantial year-round flow from cold water springs.

Currently, bull trout in the lower Crooked River are confined to Lake Billy Chinook and in the river upstream to the Opal Springs Dam and hydroelectric facility, an impassible barrier since 1982. There are no records of their abundance in the lower Crooked River. Similar to the Deschutes River upstream from Lake Billy Chinook, the lower Crooked River experiences significant groundwater inflow between RM 6 to RM 14. Caldwell (1994) documented gains of up to 1,006 cfs in this reach. During summer and fall periods, lower Crooked River flows upstream from the groundwater discharge sites is typically very low with warm water temperatures. Near the mouth of the Crooked River, contributions from Opal Springs provide good water temperatures and refugia for bull trout during extreme summer and winter temperatures.

5.3.2.4 Lower Deschutes River Subbasin

The lower Deschutes River is delineated as the area downstream from Pelton Reregulating Dam at RM 100.1 to the mouth.

Streamflows

The lower Deschutes River is a remarkably uniform and stable river (Fassnacht et al. 2002, and Figures 3-17 and 3-19). Russell (1905, cited in O'Connor et al. 1999) noted that the Deschutes River exhibited "certain peculiarities not commonly met with." Henshaw et al. (1914 cited in O'Connor et al. 1999) recognized the uniform and stable flows in the Deschutes River and O'Connor et al. (1999) attributed the steady flow of the Deschutes River to "the poorly integrated drainage system in the southern and western portions of the Deschutes Basin, and the substantial groundwater storage in the young volcanic fields along the flanks of the Cascade Range." Daily average streamflows in cfs in the lower Deschutes River on a monthly basis for the period 1990 to 2001 at USGS streamflow gaging stations at Madras and Moody, located at RM 100.1 and 1.4, respectively, are shown in Table 5-3. The period 1990 to 2000 was selected to represent current conditions, and includes some wet, dry, and "normal" water years. This more recent time period does not include some extremely dry years that occurred in the 1930s, but does reflect current baseline environmental conditions and operations for this consultation. The State of Oregon instream flow recommendations based on Aney et al. (1961) are met or exceeded year round in this reach where bull trout occur, when compared to the average flow from 1990-2001.

Table 5-3. Daily Mean Flows (cfs) for USGS Streamflow Gages in the Lower Deschutes River near Madras and Moody, OR

Madras, OR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avg 1990-2001	5,185	5,523	5,378	5,067	4,456	4,296	3,968	3,917	3,955	4290	4,699	5,010
Recommended Annual Flows (Aney et al. 1967)	4,500	4,500	4,500 4,000	4,000	4,000	4,000	4,000 3,500	3,500	3,500 3,800	3,800	3,800	4,500
Percent Exceedance												
90%	4,055	3,952	3,906	3,739	3,637	3,643	3,424	3,586	3,566	3,708	4,053	4,023
50%	4,591	4,836	4,775	4,149	4,081	3,923	3,777	3,832	3,773	3,977	4,305	4,525
10%	9,600	8,974	7,732	7,643	5,807	5,899	4,863	4,695	4,911	5,410	5,714	7,253
Moody, OR												
Avg 1990-2001	6,747	7,807	7,064	6,613	5,778	5,170	4,517	4,367	4,373	4,762	5,476	6,236
Percent Exceedance												
90%	4,873	4,595	4,418	4,560	4,166	3,988	3,606	3,748	3,809	4,167	4,652	4,446
50%	5,425	5,503	6,717	5,494	5,604	4,731	4,309	4,302	4,110	4,410	5,043	5,389
10%	14,981	16,981	9,512	9,880	7,717	7,297	5,715	5,351	5,285	5,860	6,716	11,312

Bull Trout

Dams and lack of fish passage greatly restricted and eliminated migrations of upriver groups of bull trout into the lower Deschutes River and tributaries. The majority of bull trout in the lower Deschutes River subbasin exhibit a fluvial life history pattern and are found from Sherars Falls upstream to the Pelton Reregulating Dam (Brun and Dodson 2001). Adult bull trout spawn near the headwaters of the Warm Springs River and Shitike Creek. Brun and Dodson (2001) found that adult bull trout leave the Deschutes River and enter the spawning tributaries from early May through mid-June. Juvenile bull trout rear from 2 to 3 years in these streams before migrating to the Deschutes River. The majority of juveniles were documented leaving Shitike Creek beginning early March and continuing through mid-June (Brun and Dodson 2001).

Results from a 1999-2000 telemetry study (Brun and Dodson 2001) confirm that Shitike Creek is a major spawning tributary for bull trout residing in the lower Deschutes River. Prior to spawning migration, lower Deschutes River bull trout move little during the winter through early spring. During May and June, they make a quick migration to Shitike Creek where they hold and later spawn (Brun and Dodson 2001). Following spawning in September, they rapidly emigrated back to the Deschutes River. This migration timing appears similar to the adjacent Lake Billy Chinook-Metolius populations (Thiesfield et al. 1996).

The estimated number of spawning bull trout for the Warm Springs River has remained about the same with 232 reported in 1998 and 260 in 2002 (Brun 2003). In Shitike Creek, 269 bull trout were estimated to have spawned in 1998 and 469 bull trout in 2002 (Brun 2003). Bull trout abundance has increased in recent years because of restrictive angling regulations and education.

Bull trout monitoring studies conducted on the Warm Springs River found that 80 adult bull trout were documented passing the Warm Springs National Fish Hatchery weir in 2001, which was the second highest recorded since 1995 (Brun and Dodson 2001).

5.4 MIDDLE COLUMBIA RIVER STEELHEAD

5.4.1 Factors Contributing to Species Decline

Some factors contributing to the decline of MCR steelhead populations include hydropower development, which affect both juvenile and adult passage; water diversion/withdrawal; agricultural land use activities, such as livestock grazing; predation; harvest; and hatchery effects, including interactions between hatchery and wild steelhead (NMFS 1996). Some habitat constraints to production of wild steelhead in the Deschutes River basin include sedimentation below the White River, streambank degradation, and low flows and high water temperatures in tributaries (NPPC 1990).

Hydropower development has been a major factor contributing to decline of MCR steelhead (NMFS 1996). Construction of dams has blocked access to miles of previously productive habitat. Modification of natural flow regimes by dams has resulted in increased water temperatures, changes in fish community structure, and increased travel time of migrating adults and juveniles. The Corps, Portland District, has funded extensive juvenile and adult salmonid studies for many years at mainstem Columbia and Snake River dams, including The Dalles and Bonneville Dams. The Deschutes River population of the MCR steelhead ESU pass through these two dams on their downstream and upstream migration. Other populations in this ESU further upstream pass through additional dams. Juvenile fish from upstream from McNary Dam may be collected and transported during their outmigration.

The Dalles Dam has less effective juvenile fish passage facilities compared to other Columbia River projects and mortality of inriver outmigrants passing the project is greater than at other Columbia River projects (Ploskey et al. 2001). The Dalles Dam does not have a mechanical screen juvenile bypass system (NMFS 2000b). Spillway passage generally has higher survival than turbine passage (Whitney et al. 1997, cited in Giorgi et al. 2002) and sluiceway passage (Ploskey et al. 2001). The Dalles Dam spillway is located on what was a shallow basalt bluff (NMFS 2000b). Spill survival at The Dalles Dam for juvenile salmonids was lower than that for other Columbia River projects, and in some cases actually decreased with increasing levels of spill. Spillway survival through The Dalles Dam ranged from 76 to 100 percent since 1997, depending on spill volume, season, and year (NMFS 2000b). BioSonics (1999 cited in NMFS 2000b) estimated juvenile spring passage at 40.7 and 25.8 percent for 30 and 74 percent spill, respectively, and juvenile summer passage at 35.2 and 26.2 percent for 30 and 64 percent spill, respectively. Juvenile passage rates in the spring were slightly higher in the morning during these spill tests. Studies done to date have been limited to yearling and subyearling Chinook salmon and coho salmon. Spill survival of outmigrating juvenile steelhead may be of the same magnitude.

Fish that pass through turbines experience higher mortality rates than those that pass hydropower projects via a mechanical bypass or in spill (NMFS 2000b). Iwamoto and Williams (1993 cited in NMFS 2000b) noted that turbine survival averaged approximately 90 percent per dam. When fish pass through bypass systems, mortality is generally less; survival for steelhead passing Little Goose Dam on the lower Snake River in 1997 was estimated at 95.3 percent (Muir et al. 1998 cited in NMFS 2000b). Survival of juvenile salmonids was highest in spill, ranging from about 98 to 100 percent, dependent in part on spill level.

Adult MCR steelhead probably experience a 5 to 10 percent mortality per project, rates similar to spring and summer Chinook salmon. However, during low flow cycles, mainstem mortality can be substantially higher. Some mortality may occur when adults fall back through the turbines. Since adult steelhead generally do not feed during their upstream migration, delays due to ineffective powerhouse facilities, powerhouse and spillway operations, and poor flow and water quality conditions may contribute to mortality rates by depleting limited energy reserves. Turbulent water conditions near dam bypasses, turbine outfalls, water conveyances, and spillways may disorient juvenile fish and make them more vulnerable to predation.

Warm, slackwater reservoirs create ideal conditions for the growth and abundance of the native piscivorous northern pikeminnow (*Ptychocheilus oregonensis*) and introduced predator gamefish such as walleye (*Sander vitreus*), smallmouth bass (*Micropterus dolomieu*), and channel catfish (*Ictalurus punctatus*). Although smallmouth bass are present in Lake Billy Chinook and the Columbia River, they are not present in the lower Deschutes River. They were only documented there for one season after a large flood in 2000 caused by a rain-on-snow event. Numbers remained low and they were no longer found in the river after about September. Smallmouth bass probably do not survive well in the lower Deschutes River due to unfavorably cool water temperatures and the steep gradient (Pribyl 2002).

Biologists also cite interactions between hatchery and wild steelhead as a major cause of decline (Reisenbichler 1996, Chilcote 1999). About 80 percent of downstream migrant steelhead passing Lower Granite Dam are hatchery steelhead. Juvenile steelhead released from hatcheries could potentially interact adversely with native wild juvenile steelhead in the migration corridor, the estuary, and the ocean (NMFS 1999). Although many of these hatchery produced smolts are transported, some migrate inriver. Many steelhead hatcheries include composite stocks that have been domesticated over a long period of time with an associated loss or reduction of fitness.

5.4.2 Environmental Baseline Conditions in Project Area

5.4.2.1 Lower Deschutes River Subbasin

The lower Deschutes River is delineated as the area downstream from Pelton Reregulating Dam, located at RM 100.1.

Streamflows

The lower Deschutes River is a remarkably uniform and stable river (Fassnacht et al. 2002). Russell (1905, cited in O'Connor et al. 1999) noted that the Deschutes River exhibited "certain peculiarities not commonly met with." Henshaw et al. (1914, cited in O'Connor et al. 1999) recognized the uniform and stable flows in the Deschutes River and O'Connor et al. (1999) attributed the steady flow of the Deschutes River to "the poorly integrated drainage system in the southern and western portions of the Deschutes Basin, and the substantial groundwater storage in the young volcanic fields along the flanks of the Cascade Range." Daily average streamflows in cfs in the lower Deschutes River on a monthly basis for the period 1990 to 2001 at USGS streamflow gaging stations at Madras and Moody, located at RMs 100.1 and 1.4, respectively, were shown in Table 5-3. The period 1990 to 2001 was selected to represent current conditions, and includes some wet, dry, and "normal" water years. This more recent time period does not include some extremely dry years that occurred in the 1930s, but does encompass a range of flow conditions and reflects current baseline environmental conditions and operations for this consultation. Table 5-3 illustrates the relatively uniform and stable flow regime in the lower Deschutes River. With inflows into the lower Deschutes River from several major and numerous minor tributaries, the measured flows at the USGS Moody gage are higher than at the Madras gage, as expected. Irrigation diversions from the lower Deschutes River are primarily from tributaries.

Summer Steelhead

Evaluating the status of wild Deschutes River summer steelhead is a complex task because four different groups of steelhead occur in this basin (Chilcote 1998, NMFS 2000b). They include hatchery fish produced within the basin at Round Butte Hatchery, hatchery strays from the Snake and upper Columbia River basins, wild strays also from these upriver locations, and wild fish produced within the Deschutes River basin. The Deschutes River also contains conspecific resident rainbow/redband trout (Behnke 1992).

Number of Fish

The number of adult steelhead captured at the Sherars Falls trap has fluctuated substantially since 1977, with a substantial increase in 2001 (Table 5-4 and Figure 5-5) (ODFW 2002). In 2001, 3,904 hatchery and 957 wild steelhead were captured there compared to 1,635 hatchery and 931 wild steelhead in 2000. The proportion of hatchery to wild steelhead in the Deschutes River has increased substantially since 1977, with over 80 percent of the fish being hatchery fish since 1991, except for 1999 and 2000 (Table 5-4). In 2001, 80.31 percent of the 4,861 steelhead captured at the Sherars Falls trap were hatchery-origin, while 19.69 percent were wild. In 1995, 90.56 percent of the 1,950 steelhead captured were hatchery-origin, which was the highest for the period of record.

Table 5-4. Wild and Hatchery Steelhead Captured at the Sherars Falls Trap

Year	Wild	Hatchery	Total	% wild	% Hatchery
1977	673	744	1417	47.49	52.51
1978	437	772	1209	36.15	63.85
1979	386	1,142	1528	25.26	74.74
1980	461	1,102	1563	29.49	70.51
1981	686	778	1464	46.86	53.14
1982	362	320	682	53.08	46.92
1983	417	934	1351	30.87	69.13
1984	238	422	660	36.06	63.94
1985	364	767	1131	32.18	67.82
1986	412	1,424	1836	22.44	77.56
1987	372	785	1157	32.15	67.85
1988	374	992	1366	27.38	72.62
1989	455	1,287	1742	26.12	73.88
1990	294	801	1095	26.85	73.15
1991	293	1,278	1571	18.65	81.35
1992	196	1,120	1316	14.89	85.11
1993	190	991	1181	16.09	83.91
1994	55	398	453	12.14	87.86
1995	184	1,766	1950	9.44	90.56
1996	299	2,311	2610	11.46	88.54
1997	166	1,218	1384	11.99	88.01
1998	391	1,645	2036	19.20	80.80
1999	695	1,939	2634	26.39	73.61
2000	931	1,635	2566	36.28	63.72
2001	957	3,904	4861	19.69	80.31

Information adapted from table 7 and 8 ODFW 2002

Number of Hatchery Strays

Adult steelhead escapement estimates for the Deschutes River demonstrate a significant increase in out-of-basin strays since the early 1990s (ODFW 2002). The percentage of stray hatchery fish as determined by fin marks at Sherars Falls has exceeded 70 percent of the hatchery component from 1993 to 2000 but decreased to 67.7 percent in 2001 (Table 5-5); 32.3 percent of the hatchery fish were of Round Butte Hatchery origin. From 1988 to 1992, stray hatchery-origin steelhead at the Sherars Falls trap ranged from 32.8 to 67.4 percent. During the same period (1988 to 1992) the percentage of wild fish ranged from 14.9 to 27.4 percent (Table 5-4). While some of the stray steelhead that enter the Deschutes River are known to leave and return eventually to their streams of origin elsewhere in the Columbia basin prior to spawning (preliminary findings from a tagging study by Bjornn and Jepson [NMFS 2000a]), the evidence suggests that the majority of the stray steelhead migrating past Sherars Falls spawn in the Deschutes River basin. ODFW (2002) estimated recently that the percentage of wild fish in the Deschutes basin that are strays is about 3 percent (Table 5-6, adapted from ODFW 2002 Table 14).

Straying has been observed during periods when the water of the Deschutes River is cooler than that of the Columbia River. The cooler water provides a thermal refugium for upstream-migrating adult steelhead. Straying behavior may occur as steelhead seek cooler water, it may be associated with transportation, and may be an evolutionary adaptation that enhances survival (NMFS 2000b). Peery and Bjornn (2002) reported that evidence suggests that some salmon and steelhead will delay their upstream migration to avoid warm water conditions.

Redd Counts

Redd counts for Buck Hollow Creek, Bakeoven Creek, and Trout Creek have exhibited an increasing trend from 1990 to 2002 (Table 5-7, adapted from ODFW [2002] Table 11; Table 5-8, adapted from ODFW [2002] Table 12; and Table 5-9, adapted from ODFW [2002] Table 13, respectively). In Buck Hollow Creek, although the same sites were not surveyed every year, early in the time series starting in 1990, redd counts were low, ranging from 8 to 85 from 1990 to 1996; from 1997 to 2002, redd counts increased and ranged from

110 to 445 in 2001. The number of redds decreased to 221 in 2002. If one looks at one site such as the Powerline/Mouth site, the number of redds ranges from 7 in 1994 to 241 in 2001. Overall, the increase in number of redds from 1997 to 2002 compared to the number of redds from 1990 to 1996 seems to indicate an increase in the number of spawning steelhead. In Bakeoven Creek, there was also a low number of redds from 1990 to 1996 with a steady increase from 1997 to 2002, with a high of 480 redds in 2001, followed by a decrease to 214 in 2002. In Trout Creek, starting in 1994, redd numbers per mile are low until 2000, when the number increases dramatically from that seen from 1994 to 1999, reaching a high of 16.3 per mile in 2001, with a decrease to 13.3 in 2002. This is the same temporal pattern of recently increased numbers of redds documented in Buck Hollow and Bakeoven Creeks, although units differ. These counts include redds from both wild and hatchery summer steelhead.

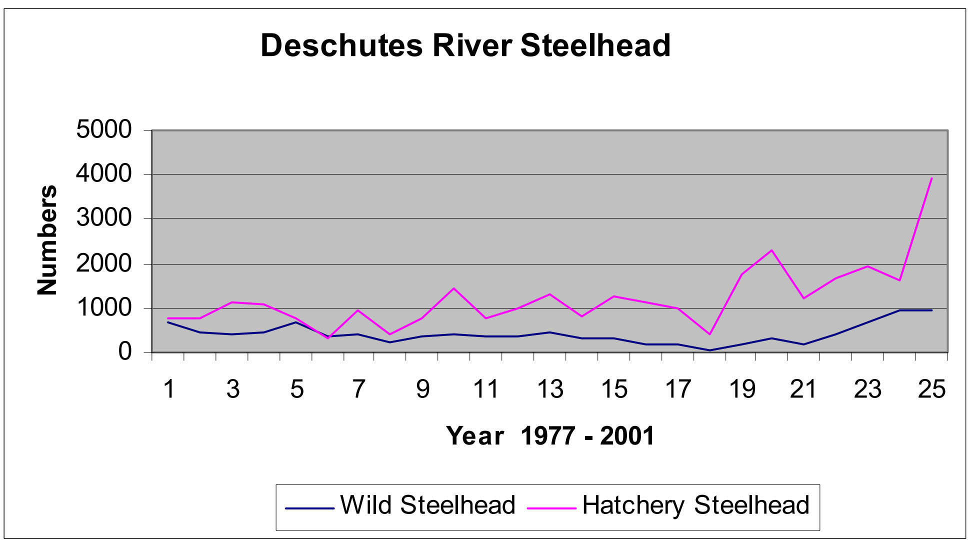

Figure 5-5. Wild and Hatchery Steelhead Captured at the Sherars Falls Trap

Table 5-5. Number and Percent of Round Butte Hatchery Origin and Stray Hatchery-Origin Summer Steelhead as Determined by Fin Mark, Captured at the Sherars Falls Trap, By Year

Trap Year	Round Butte Hatchery		Stray Hatchery-Origin	
	Number	% Total Catch	Number	% Total Catch
1988	665	67.2	324	32.8
1989	521	40.5	776	59.5
1990	352	44.0	448	56.0
1991	417	32.6	861	67.4
1992	506	45.2	614	54.8
1993	196	19.8	795	80.2
1994	118	29.7	280	70.3
1995	458	25.9	1,308	74.1
1996	649	28.1	1,662	71.9
1997	280	23.0	936	77.0
1998	423	25.8	1,220	74.3
1999	465	24.0	1,474	76.0
2000	483	29.6	1,147	70.4
2001	1,262	32.3	2,642	67.7

Source: (Prybil 2002).

Table 5-6. Number and Percent of Wild, Stray, and Round Butte Hatchery-Origin Summer Steelhead Returning to the Pelton Trap, By Run Year.

	Wild Origin		Stray Hatchery		Round Butte Hatchery	
Run Year	Number	%	Number	%	Number	%
81-82	245	11.3	156	7.4	1,760	81.3
82-83	344	16.7	167	8.8	1,547	74.6
83-84	814	17.3	1,452	33.0	2,439	49.7
84-85	603	12.9	795	17.0	3,278	71.1
85-86	686	14.4	943	19.7	3,153	65.9
86-87	467	10.7	1,538	33.4	2,640	57.6
87-88	160	6.6	796	32.1	1,484	61.3
88-89	123	7.4	300	17.7	1,247	74.9
89-90	136	9.1	524	35.2	829	55.7
90-91	82	7.4	428	35.8	606	56.8
91-92	101	4.4	849	36.7	1,365	58.9
92-93	59	3.6	427	26.0	1,157	70.4
93-94	65	12.0	288	53.0	190	35.0
94-95	27	2.0	642	53.0	753	45.0
95-96	32	1.6	976	48.6	1,000	49.8
96-97	126	2.2	2,001	34.9	3,605	62.9
97-98	194	3.8	2,459	48.3	2,440	47.9
98-99	155	6.0	1,284	49.9	1,135	44.1
99-00	83	4.4	768	40.4	1,050	55.2
00-01	114	4.1	1,103	39.2	1,593	56.7
01-02	282	3.2	3,674	41.3	4,942	55.5

Information adapted from ODFW 2002 Table 14

Table 5-7. Summer Steelhead Redd Counts, Buck Hollow Creek, By Section, By Year

Stream section	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Hauser/Bronx								4	0	2	5	ns*	ns
Bronx/Finnegan										1	2	1	3
Finnegan/Mays										5	5	39	1
Spears/Bronx							5						
Bronx/Mays	5					0	3	7	10				
Mays/Powerline	7				1	5	9	63	36	37	64	164	78
Powerline/Mouth	73	72	34 3	40	7	64	48	62	133	107	34	241	
Powerline/ Webb fence			5										139
Webb fence/ Mouth													ns
Total	85	72	34	48	8	69	65	136	179	152	110	445	221

Information adapted from ODFW 2002 Table 11.

Table 5-8. Summer Steelhead Redd Counts, Bakeoven Creek, By Section, By Year

Site	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Sugarloaf	1	0	-	2	-	7	14	18	11	33	22	154	23
Powerline	21	8	9	19	13	13	21	39	57	56	61	326	191
Total	22	8	9	21	13	20	35	57	68	89	83	480	214

All survey dates were in March except for 1993, 1994, and 1997 when the surveys were conducted in April.
Information adapted from ODFW 2002 Table 12.

Table 5-9. Results of Summer Steelhead Redd Surveys in the Trout Creek Drainage, By Year

Year	Miles Surveyed	Number Fish	Number Redds	Fish Per Mile	Redds Per Mile
1988	9.4	17	23	1.8	2.5
1989	10.5	24	23	2.8	2.2
1990	14.4	22	42	1.5	2.9
1991	16.9	3	16	0.2	1.1
1992	16.4	6	6	0.4	0.4
1993	28.2	4	15	0.1	0.5
1994	16.25	0	0	0.0	0.0
1995	18.25	0	8	0.0	0.4
1996	12.5	6	14	0.5	1.1
1997	23.5	21	50	0.9	2.1
1998	21.0	13	44	0.6	2.1
1999	22.95	12	59	0.2	2.6
2000	54.1	39	461	0.7	8.5
2001	36.6	56	595	1.5	16.3
2002	65.2	95	866	1.5	13.3

Starting in 1993, surveys were conducted only above the confluence with Foley Creek. Data should not be compared before and after 1993. 1996 data all downstream from Foley Creek.

Information adapted from ODFW 2002 Table 13.

Juvenile Outmigration

Deschutes River hatchery and wild steelhead generally outmigrate in the spring as 2-year-old fish, and pass The Dalles Dam and Bonneville Dam. As discussed above, The Dalles Dam has no mechanical juvenile fish bypass system, so juvenile fish pass the dam via spill, through the turbines or the sluiceway. Zabel et al. (2001) reported that for combined hatchery and wild juvenile Snake River-origin steelhead, the estimated survival from John Day Dam tailrace to Bonneville Dam tailrace averaged 0.753 (s.e. 0.063). Estimated survival for juvenile steelhead decreased as the migration season progressed from early May to the end of May. Although no specific information is available for The Dalles Dam, the Zabal et al. (2001) estimate might be representative of survival of outmigrating Deschutes River juvenile steelhead, with the exception that they would not have been exposed to the same level of predation and other potentially unfavorable environmental conditions in The Dalles pool as those fish migrating downstream from the John Day Dam tailrace. The Deschutes River enters the Columbia River at RM 205, a little less than half the distance from The Dalles Dam to John Day Dam.

5.4.2.2 Wild Deschutes River Steelhead

Wild Deschutes River steelhead are characteristic of A-run summer steelhead (Pribyl 2002; Busby et al. 1996). One of the major factors limiting wild steelhead in the Deschutes River is the migration blockage created by the Pelton and Round Butte Dams (NMFS 2000a; Pribyl 2002), completed in 1957 and 1964, respectively. These dams have eliminated access to spawning and rearing habitats in the middle Deschutes, Metolius, and Crooked River systems (Figure 9-1). Fish passage was attempted at these dams soon after construction but with limited success. Passage of adults upstream was relatively successful, but dowstream migrating smolts became disoriented once they entered Lake Billy Chinook. It became apparent that upriver salmonid runs could not be sustained naturally with these facilities; therefore, efforts to maintain naturally spawning salmonid populations were abandoned. Historically, Big Falls on the middle Deschutes River at RM 132 created a natural barrier that prevented access to the upper Deschutes River subbasin by steelhead and other anadromous salmonids. Apparently Big Falls at RM 132 was passable in some years, although it is now considered the upstream extent of essential fish habitat for Chinook salmon in the upper Deschutes River, as discussed in Chapter 9.

As described in Chapter 7 of this BA, ODFW and others are actively studying ways to restore anadromous fish runs (including wild steelhead) above the Pelton-Round Butte Project in conjunction with the Federal Energy Regulatory Commission relicensing of the project. This BA does not address any aspect of efforts to restore anadromous salmonid populations above the Pelton-Round Butte Project. A major obstacle to establishing viable self-sustaining anadromous salmonid runs above the project is getting outmigrating juvenile salmonids back downstream. There are complex currents in Lake Billy Chinook due to temperature and density differences and inflows that disorient migrating juvenile salmonids, preventing them from easily locating an exit or outflow. Also, Ochoco and Bowman Dams remain migration obstacles further up the system, blocking potential passage to historic spawning habitats in the upper Ochoco Creek and Crooked River subbasins. However, these areas still have the potential, with substantial stream and riparian rehabilitation efforts, to support summer steelhead (Marx 2000).

Deschutes River adult summer steelhead enter the lower river from June through October. Steelhead pass Sherars Falls from July through October, with peak movements normally occurring in late September. Summer steelhead spawn in the mainstem Lower Deschutes River, the Warm Springs River system, Shitike Creek, Skookum Creek, Wapinitia Creek, Eagle Creek and Nena Creeks, the Trout Creek system, Bakeoven Creek system, and the Buck Hollow Creek system (CTWSRO 1999). Warm Springs River is a significant steelhead producer, as is Shitike Creek (Pribyl 2002). Aney et al. (1967) reported that less than 1 percent of the lower Deschutes River provides suitable spawning habitat, and most of that is localized in the region downstream from RM 100.1 to about Shitike Creek. Potential spawning habitat in the White River is limited to the lower 2 miles by an impassable falls. ODFW does not routinely survey the White River and is uncertain whether steelhead occur in this area (Pribyl 2002), although a 2001 BLM and USFS biological assessment indicated that spawning occurs there (BLM and USFS 2001), as do Cramer and Beamesderfer (2001). The Warm Springs National Fish Hatchery operates a collection weir at RM 9 on the Warm Springs River, where it sorts migrating adult salmonids and retains sufficient fish for hatchery production. The hatchery releases wild steelhead back into the river to spawn naturally (Pribyl 2002). Good quality spawning habitat exists upstream from the Warm Springs National Fish Hatchery.

Spawning in the relatively warmer eastside tributaries, such as Trout Creek and Bakeoven Creek, occurs from January through mid-April. Spawning in the lower Deschutes River and the cooler westside tributaries such as Warm Springs River and Shitike Creek, usually begins in April and continues through May (CTWSRO 1999). Westside tributaries are generally colder than eastside tributaries since their flows mostly originate from snowmelt on the eastern slopes of the Cascades, while eastside tributaries are mostly groundwater fed (Pribyl 2002). Eastside tributaries also likely have reduced flows during the hotter part of the summer. Steelhead appear to be opportunistic and in some years ascend small tributaries during short periods of high water to spawn in late winter and spring. The majority of the juvenile steelhead rear for 2 years before smolting and emigrating to the ocean. However, smolt ages can vary from 1 to 4 years. Steelhead generally rear in the ocean for 2 years before returning to the Deschutes River system as adults to spawn.

Chilcote (ODFW 2002) reported that the estimated preharvest abundance of wild steelhead in the Deschutes River at Sherars Falls has generally increased in the last few years from lows in the early 1990s (Table 5-10).

Chilcote (1998) hypothesized that the potential for ecological and genetic interactions between resident rainbow/redband trout and naturally spawning steelhead in the Deschutes River may also be a significant factor in the decline of wild steelhead numbers. However, Zimmerman and Reeves (2000) reported that native wild steelhead and rainbow/redband trout appear to be reproductively isolated in the Deschutes River.

Table 5-10. Estimated Preharvest Abundance of Wild Steelhead in the Deschutes River at Sherars Falls.

Run year/spawn year	Numbers
1994/1995	547
1995/1996	1887
1996/1997	3862
1997/1998	2067
1998/1999	4240
1999/2000	5274
2000/2001	9493
2001/2002	9273

Cumulative Risk Initiative Modeling for Deschutes River Steelhead

McClure et al. (2000) in their Cumulative Risk Initiative modeling indicated that the steelhead populations in the Deschutes River, Shitike Creek, and Warm Springs National Fish Hatchery had a λ (lambda or population growth rate) of 0.96, 0.93, and 0.91. These rates assumed zero percent success of hatchery fish spawning in the wild. Under various scenarios in a Dennis Extinction Analysis, with the assumption that hatchery fish reproduce at 20 and 80 percent the rate of wild fish, for the Deschutes River summer steelhead, there is a probability of 1.0 that Deschutes River summer steelhead will decline 50 percent in 24, 48, and 100 years, as well as decline by 90 percent in 24, 48, and 100 years (McClure et al. 2000). For the MCR steelhead ESU as a whole, NMFS (2000a) estimated that the median population growth rate (lambda) over the base period ranged from 0.88 to 0.75, decreasing as the effectiveness of hatchery fish spawning in the wild increases compared to that of wild fish. McClure et al. (2000) estimated the risk of absolute extinction within 100 years for the Deschutes River summer steelhead as 1.00, assuming that hatchery fish spawning in the wild do not successfully reproduce (i.e., hatchery effectiveness = 0) (Table B-5 in McClure et al. 2000); assuming that the hatchery fish spawning in the wild do reproduce as successfully as wild-origin fish (hatchery effectiveness = 100 percent), the risk of absolute extinction within 100 years for the Deschutes River summer steelhead is also 1.00 (Table B-6 in McClure et al. 2000). McClure et al. (2000) used data from brood years 1980 to 1994, so their analysis does not consider recent increases in adult steelhead returns.

Overall, evidence appears to indicate that the wild Deschutes River steelhead may remain at some risk, especially when environmental factors are less favorable (i.e., reduced ocean productivity and conditions in migration corridor of the Columbia River). Data over time have shown that there is an upward trend in populations numbers when environmental conditions improve, such as the recent increased returns of salmon and steelhead to the Columbia River in 2001 and 2002 thought to be mediated by substantially improved ocean conditions (lower water temperature and increased prey populations and abundance, among other factors). The decadal-scale fluctuations in ocean productivity and environmental conditions were not considered in the McClure et al. (2000) extinction analysis.

Interim Abundance and Productivity Targets

The NMFS has set interim abundance and productivity targets for naturally produced Deschutes River steelhead population. The target is 6,300 naturally produced spawners below Pelton Dam, and since the MCR steelhead ESU is currently below recovery levels, lambda will need to be greater than 1.0 over a 40-48 year period (4 April 2002 letter from Mr. Bob Lohn to Mr. Frank L. Cassidy). The NPPC (1990) noted that the objective for summer steelhead is to provide 5,000 to 11,000 fish for recreational and tribal fisheries, and a spawning escapement of 10,000 natural spawners and 600 to 1,000 hatchery brood stock all through a return of 16,000 to 22,000 summer steelhead annually to the Deschutes River. These levels of wild and hatchery adult steelhead returns have not yet been achieved (Table 5-4).

Instream flow studies for the lower Deschutes River in the 1960s indicated that while flows in the lower Deschutes River may be mostly adequate to sustain anadromous salmonid populations (e.g., steelhead), improved (or higher) flows would be beneficial to habitat maintenance and would increase usable spawning habitat (Pribyl 2001). The lower Deschutes River is fortunate to have fairly stable and uniform flows (NPPC 1990, Fassnacht et al. 2002). On below-average flow years, reduced flows may result in reduced habitat and water velocity for salmonids. In high water years, upstream diversion may actually be beneficial in reducing peak flows that reduce juvenile habitat along the edges of the lower river. While drought may also have contributed to reduced steelhead production, this may be less important as a factor contributing to decline, partly because during the same time period the resident/redband trout population has apparently remained stable. There remains the concern by ODFW that there may be the loss in reproductive capacity of wild Deschutes River steelhead due to genetic mixing with large numbers of out-of-basin, out-of-ESU strays, as well as reduced survival of wild fish due to interactions between hatchery and wild steelhead (ODFW 2003).

Habitat Conditions

NMFS has formulated a matrix of pathways and indicators that contribute to determining whether watersheds are properly functioning, at risk, or not functioning properly. The six pathways with their associated indicators are shown in Table 5-11, adapted from NMFS Matrix of Pathways and Indicators. Complete details regarding these pathways and indicators are available at <http://www.nwr.noaa.gov/1habcon/habweb/ pubs/matrix.pdf>. We use the matrix to address major habitat features in the lower Deschutes River.

Discussed below are the pathways and indicators and summarized or referenced information relevant to evaluating the potential effects of the continued operation and maintenance of Reclamation's Deschutes River basin projects on steelhead for these pathways and indicators. Some of this information is reiterated from above discussions.

Table 5-11. NMFS Matrix of Watershed Pathways and Indicators.

Pathway	Indicators
Water quality	Temperature Sediment/Turbidity Chemical contaminants/ Nutrients
Habitat Access	Physical barriers
Habitat Elements	Substrate Large woody debris Pool frequency Pool quality Off-channel habitat Refugia (remnant habitat)
Channel Conditions and Dynamics	Width/Depth ratio Streambank condition Floodplain connectivity
Flow/Hydrology	Change in peak/base flows Increase in drainage network
Watershed conditions	Road density and location Disturbance history Riparian reserves

Water Quality

Water temperature data for the lower Deschutes River near Madras, Oregon, for the period 1972 to 1988 were compiled by Huntington et al. (1999) and provide a reasonably comprehensive assessment of recent water temperatures (Table 5-12). These average water temperatures are less than the ODEQ criteria of 64°F (17.8°C) for anadromous salmonids.

Table 5-12. Mean Weekly Water Temperatures for the Lower Deschutes River at the USGS Gage near Madras, OR, 1972-1988, (by month)

Month	Number of weeks	Mean weekly	S.E. (Standard Error)
October	54	12.5°C	0.10
November	59	10.3°C	0.10
December	61	8.1°C	0.11
January	63	6.6°C	0.09
February	60	6.2°C	0.07
March	68	6.9°C	0.08
April	68	8.0°C	0.09
May	68	9.6°C	0.10
June	69	11.3°C	0.13
July	62	12.7°C	0.14
August	58	13.5°C	0.11
September	52	13.6°C	0.09
Data extracted from Huntington et al. 1999, Table 6.			

The White River below Lower Falls is listed as exceeding the water temperature standard of 64°F (17.8°C) for 100, 58, and 72 days in 1992, 1993, and 1994, respectively. However, ODFW has not documented use of the lower 2 miles of the White River by steelhead. Raymond et al. (1998) reported that the river temperature during their May study period averaged 12.5°C and about 16°C in July. Deschutes River water temperatures increased downstream from the Pelton Reregulating Dam to the mouth by about 2.5°C in May and September, and by 7.5°C in July. As reported by Aney et al. (1967), the majority of suitable spawning habitat is located in the Deschutes River downstream from RM 100.1 to Shitike Creek. Water temperatures for spawning, incubation, and early rearing are suitable in this reach of the river. The Deschutes River from its mouth upstream to the White River is 303(d) listed for pH and summer water temperature.

Sediment/Turbidity – O'Connor et al. (2002) provide an extensive review of sediment sources and the sediment budget of the Deschutes River basin. There are low rates of sediment delivery to the Deschutes River due to steady streamflows with low sediment supply. Sediment recruitment has been reduced by diversions, lakes, and dams. Sources of sediment to the lower Deschutes River are limited (Fassnacht and Grant 1995). Trout Creek, Warm Springs River, and the White River are likely the principal sources of sediment to the lower Deschutes River (O'Connor et al. 2002). The White River gaging station at Tygh Valley recorded an annual suspended sediment load of 108,821.96 tons during the 1983 water year (Fassnacht and Grant 1995), one of the major contributors of sediment to the lower Deschutes River since sediment contributions from the Crooked River are now for the most part retained in Lake Billy Chinook. The White River transports large quantities of glacial material to the lower Deschutes River (Fassnacht et al. 1995; Pribyl 2002).

Nutrients and Contaminants – As discussed in the water quality report (Appendix B), water quality in the lower Deschutes River in large part is driven by operation of the Pelton-Round Butte Project and the seasonal dynamics of environmental conditions in the reservoirs. The water quality in the Pelton-Round Butte Project reservoirs is generally good, even though there are phosphorous and silicon inputs from natural sources in tributaries to the reservoirs and introduced nitrogen from upstream anthropogenic activities that create seasonal algal blooms that somewhat degrade reservoir water quality. The reservoirs of the Pelton-Round Butte Project retain water from the nutrient-rich tributaries, the Deschutes, Crooked, and Metolius Rivers in the epilimnion during the summer when biological activity is at its peak, and discharge cooler water with lower nutrient concentrations downstream. Groundwater recharge offsets some of the adverse effects of upstream uses on water quality in the reservoirs.

A 3-year limnological study of the Pelton-Round Butte Project found that the concentration of nitrogen in the Deschutes River downstream from the project was lower than the expected concentration (PGE 2002). Pollutants from agricultural activity and private land use in the Wapinitia Project area have a minimal affect on water quality in the lower Deschutes River.

Dissolved Oxygen – From the Pelton Reregulating Dam to the mouth of the White River, the Deschutes River is on the Oregon DEQ 303(d) list of water quality limited waterbodies because it fails to meet the dissolved oxygen standard for spawning salmonids (11 mg/L or 95 percent saturation) from 1 October to 31 July (Lewis and Raymond 2000). Dissolved oxygen levels have sometimes been below the existing standard for coldwater aquatic life (8 mg/L or 90 percent saturation) from mid-summer to early fall (Lewis and Raymond 2000). Lewis and Raymond (2000) reported that mean ambient dissolved oxygen concentrations for four sites in the Deschutes River from just downstream from the Pelton Reregulating Dam to Trout Creek increased from 7.46 to 9.22 mg/L in September 1999. Under various spill scenarios, dissolved oxygen concentrations increased, but not proportional to the volume of spill. Spill provided some reaeration of the river water, but the effect diminished progressively downstream.

Habitat Access

Steelhead reportedly migrated as far as 140 miles up the Crooked River, and up the Deschutes River to Big Falls at RM 132. Access to the upper Deschutes River and other tributaries was eliminated with the construction of Pelton Dam. Except for some attempts at passing adult fish around the Pelton-Round Butte Project in the 1960s and an ongoing hatchery steelhead operation, steelhead are now restricted to the lower Deschutes River downstream from Pelton Reregulating Dam at RM 100.1. Steelhead have unrestricted access to the major and minor tributaries to the lower Deschutes River, such as Shitike Creek, Warm Springs River, Trout Creek, Bakeoven Creek, and Buck Hollow Creeks.

Habitat Elements

Substrate – Aney et al. (1967) reported that the lower Deschutes River is mostly coarse rubble, boulders, and bedrock. They note that in the 100-mile lower river, gravel areas for suitable fish spawning make up less than 1 percent of the total stream bottom. The highest amount of spawning gravel is located in the reach of the lower river downstream from the Pelton-Round Butte Complex to Shitike Creek, where about 9 percent of the total streambed is suitable for spawning. Areas downstream from Shitike Creek have substantially less suitable spawning gravels as a percentage of the total streambed. Tributaries downstream contribute sediment that reduces the quality of spawning habitat. The White River and other tributaries contribute substantial sediment in the form of silt and sand. Some areas of the river near the mouth and between Maupin and Twin Tunnels is nearly all basalt bedrock.

Large Woody Debris – Very large woody debris (> 50 ft in length) is sparse in the lower Deschutes River (Minear 1999). In 1995, 13 occurrences of very large wood were recorded in the 100 miles of the lower Deschutes River, compared to 7 pieces in 1944. Most of this wood was located in the main channel of the river, and more was associated with curves than straight sections of the channel. Large wood (> 13 ft in length), not including estimated pieces of wood in logjams and rootwads, was more abundant in the upper 30 miles of the lower river and less so between RM 50 and 70, and had an overall density of 31.5 pieces per river mile (Minear 1999). By including the estimated amount of wood pieces in logjams and rootwads, the amount of wood increased to 53.4 pieces per mile. Most of this large wood (88 percent) occurred in the main channel. However, after the 1996 flood event, less wood was present in the upper 50 miles of river compared to the lower 50 miles of river, and there was less wood overall, 24.5 pieces per river mile compared to 31.5 prior to the flood. Minear (1999) described the source of large woody debris to the lower Deschutes River, its composition, and stated that the results of her study indicated that there is a greater abundance of large wood in the lower Deschutes River than is typical of other streams in the region. One possible reason for this is that the constant base flow of the river does not subject the riparian vegetation to annual periods of desiccation that occurs in many other high desert streams, so the relatively abundant riparian vegetation, including white alder and cottonwood, contribute to a greater supply of in-channel wood.

Refugia – Islands that are formed as a result of the input of large wood, contributing to localized changes in geomorphology and creation of more complex and heterogeneous habitat, can provide refugia for fish and other aquatic organisms (Minear 1999).

Channel Conditions and Dynamics

Width/Depth Ratio – The channel width of the lower Deschutes River averaged 219 feet and increased with distance downstream (Minear 1999). Aney et al. (1967) reported a lower Deschutes River average width of 236 feet, with a range from 30 to 560 feet. Sherars Falls is the most constrained point on the lower river. No data on depth in the Deschutes River were available comparable to the width information reported by Aney et al. (1967). A modified IFIM study was conducted under contract, but was limited to a wadable depth (Pribyl Sept. 3, 2003), so there are no complete cross-sectional profiles available for the lower Deschutes River that could provide data to estimate a width/depth ratio.

Streambank Condition – Over 100 years of livestock grazing seriously degraded the streambanks of the lower Deschutes River and caused extensive loss of riparian vegetation. Grazing has been excluded from the lower 25 miles of the lower river since 1985, and riparian vegetation has increased substantially since that time (Minear 1999). At 14 sites along the lower Deschutes River, from RM 87.0 (the mouth of Trout Creek) to RM 30.5, Minear (1999) reported improved riparian conditions at 10 sites, and no change at 4 sites, relative to historic conditions documented in old photographs. Some of the riparian white alder and cottonwood contribute to the large wood found in the river.

Floodplain Connectivity – The river is mostly constrained in a deep canyon and has a relatively limited floodplain. The Deschutes River is unique in that it is a high desert stream originating from snowmelt on the east side of the Cascade Mountains, with some snowmelt-sourced tributaries on the west side and some smaller groundwater-fed tributaries on the east side.

Flow/Hydrology

Change in Peak/Base Flows – Fassnacht et al. (2002) reported that the lower Deschutes River has a relatively uniform and stable flow. One report indicated that the difference from minimum to maximum flow at the mouth of the Deschutes River was only about 6 times, indicating a very stable and steady flow. Some large floods have occurred historically; in recent times large flood events have occurred in 1964, 1996, and 2000, with 1996 being the largest with an instantaneous flow of 70,300 cfs on 8 February. Table 5-3 shows daily mean flows in cfs on a monthly basis along with 10, 50, and 90 percent exceedance values.

Increase in Drainage Network – Since the lower Deschutes River is a component of a relatively stable watershed and is constrained in a relatively steep and stable canyon, there is little opportunity for any increase or change in the drainage network at this time.

Watershed Conditions

Road Density and Location – The lower 25 miles of the Deschutes River is nearly roadless; there is a gravel road on the east side restricted to authorized vehicle use only, but open to hikers, bicyclists, and horseback riders. An unrestricted road exists from near Sherars Falls to Mack's Canyon for recreational access to the river, and there is a paved highway along the river from Sherars Falls to Maupin. There are some gravel access roads upstream from Maupin, but in general the river has limited road access. There are additional paved roads further upstream. Road construction can be a source of sediment to the river, degrading water quality, altering hydrologic regimes, and restricting the width of the riparian area (Minear 1999).

Disturbance History – In the early part of the 20th century, two competing companies attempted to build railroads up both sides of the canyon from the Columbia River. The railroad curently operates mostly on the west bank to approximately 12 miles north of Madras. Sidecasting of material during railroad construction may have altered the riverine geomorphology, but it is unknown to what degree this occurred. Livestock grazing has disturbed the watershed, especially the riparian area, as has road construction. Livestock grazing has been restricted in some reaches of the lower river, and the condition of the riparian zone has improved notably (Pribyl 2002).

5.5 CANADA LYNX

5.5.1 Factors Contributing to Species Decline

Although over-trapping in the 1980s drastically reduced lynx numbers, it is the destruction and modification of important lynx and hare habitat that is the main threat to Canada lynx survival within the United States (BLM and USFS 2001; Federal Register

65:16052; USFWS 2000a). According to the USFWS, in the Cascades Region 99 percent of lynx forest types (totaling 4.1 million acres) is managed by the USFS. The remaining 1 percent is divided between the BLM and other ownership. Eighty-seven percent of lynx forest types managed by government agencies occur in non-developed land allocations. Forests are changed through timber harvest, fire suppression, and conversion to agricultural land. However, as a very large proportion of lynx type forest within the Cascades Region occurs on Federal lands managed in non-developmental status, it is determined that regional effects of timber harvest and land conversion are at levels non-threatening to the Canada lynx (Federal Register 65:16052).

5.5.2 Current Status

There is no evidence of self-maintaining populations of Canada lynx in the state of Oregon (Verts 1998). Lynx have probably always occurred intermittently in Oregon, although the historical or current presence of resident populations within the State has not been confirmed (USFWS 2000a). Their Oregon presence may be a result of migrating individuals in search of better foraging opportunities as prey populations in the northern lynx range decline (Federal Register 65:16052).

In 1999, lynx surveys were conducted on the Deschutes and Ochoco National Forests using a survey designed to attract lynx to a site to “cheek rub” on a carpet pad, leaving hair that was collected for DNA analysis. These surveys resulted in no lynx detections. This same survey was repeated in 2000 and 2001, but results are not yet available (BLM and USFS 2001).

The second edition of the LCAS, released in August 2000, identified one Lynx Analysis Unit on the Deschutes National Forest, based on primary habitat requirements (vegetation providing denning, foraging, and cover opportunities) (BLM and USFS 2001). This Lynx Analysis Unit is located southwest of Sisters, west of Bend, and north of Crane Prairie and Wickiup Reservoirs, outside of any Reclamation project O&M impact area. The USFS and USFWS have mapped the scrub habitats west, north, and east of Wickiup Dam as potential secondary habitat due to the likely existence of snowshoe hares. These habitat areas consist of dry, second-growth lodgepole/bitter brush and perennial grasses communities. Vegetation density ranges from sparse to dog hair thickets (dense, stagnated stand of small diameter trees).

According to data collected by the Oregon Natural Heritage Information Center (ONHIC), Canada lynx occurrences within Oregon are uncommon, with only five sightings in the past two decades within the Deschutes River basin. Insufficient evidence exists to determine whether or not these lynx were resident (ONHIC 2002a).

5.6 NORTHERN SPOTTED OWL

5.6.1 Factors Contributing to Species Decline

Loss and fragmentation of suitable habitat is the primary threat to the northern spotted owl (Federal Register 55:26114 and 57:1796; Tuchmann 1996; BLM and USFS 2001). This is due primarily to timber harvest practices, particularly when even-aged (i.e., clearcutting) rather than mixed-aged techniques are used. At the time of listing, more than 90 percent of the timber harvest throughout the range of the northern spotted owl was accomplished using clearcutting methods that produced even-aged stands. In addition, timber management regimes at that time indicated it was most economically beneficial to harvest stands aged 60-90 years, the approximate age at which these stands are beginning to support northern spotted owls. This reduction in habitat forces northern spotted owls to crowd into areas that can support the species. If alternate suitable habitat does exist, it will often be forced over carrying capacity, reducing the viability of the northern spotted owls residing therein (Federal Register 55:26114).

5.6.2 Current Status

The final rule for the designation of critical habitat for the northern spotted owl identifies 190 areas, encompassing a total of nearly 6.9 million acres. Within Oregon, 76 CHUs totaling 3.2 million acres were specified; 2.2 million acres occur on USFS land and 1.0 million acres occur on BLM land (Federal Register 57:1796). Three CHUs occur near the action area; OR-2 near Wasco Dam and Clear Lake, OR-6 near Crane Prairie Dam and Reservoir, and OR-7 near Wickiup Dam and Reservoir. Late-successional reserves established by the Northwest Forest Plan, totaling 7.4 million acres, generally overlap critical habitat areas. In fact, OR-2 has 90 percent overlap acres, OR-6 has 100 percent overlap acres, and OR-7 has 99 percent overlap acres (BLM and USFS 2001). The Oregon Natural Heritage Information Center provided the most comprehensive data for northern spotted owl occurrences (nesting, roosting, foraging territories). According to the Oregon Natural Heritage Information Center, there are approximately 150 nesting, roosting, and foraging territories within the Deschutes River basin, including several near Wasco Dam and Clear Lake and Crane Prairie Dam and Reservoir (ONHIC 2003b).

CHAPTER 6.0 EFFECTS OF THE PROPOSED ACTION

6.1 INTRODUCTION

"Effects of the action" refers to the direct and indirect effects of a proposed action on listed species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action. These effects are considered along with the environmental baseline and the predicted cumulative effects (Chapter 7) to determine the overall effects on the species (50 CFR § 402.02).

In accordance with the provisions of the ESA implementing regulations and the USFWS and NMFS Section 7 Handbook (USFWS and NMFS 1998), Reclamation used the following definitions to make its effects determinations for each listed species:

No effect: The conclusion if the action agency determines its proposed action will not affect listed species or critical habitat.

May affect: The conclusion if the action agency determines its proposed action may pose effects on listed species or designated critical habitat. The action agency must also determine whether the effects constitute an adverse effect as defined below.

Not likely to adversely affect: Effects on listed species are expected to be discountable, insignificant, or completely beneficial. "Beneficial effects" are contemporaneous positive effects without any adverse effects to the species. "Insignificant effects" relate to the size of the impact and should never reach the scale where take occurs. "Discountable effects" are those extremely unlikely to occur. Based on best judgment, a person would not: 1) be able to meaningfully measure, detect, or evaluate insignificant effects; or 2) expect discountable effects to occur.

Likely to adversely affect: Any adverse effect to listed species that may occur as a direct or indirect result of the proposed action or its interrelated or interdependent actions, and the effect is not: discountable, insignificant, or beneficial. In the event the overall effect of the proposed action is beneficial to the listed species, but is also likely to cause some adverse effects, then the proposed action "is likely to adversely affect" the listed species. If incidental take is anticipated to occur as a result of the proposed action, an "is likely to adversely affect" determination should be made.

Reclamation has provided this BA to analyze the effects of its proposed action and to assist USFWS and NMFS in preparing a coordinated BiOp. Section 6.2 describes the hydrologic model that was developed to determine the hydrologic effects associated with the proposed action. Analysis of the effects on each listed species is presented individually in Sections 6.3 through 6.7.

6.2 HYDROLOGIC EFFECTS ANALYSIS

Reclamation used the MODSIM model to simulate Reclamation's project operations. Modeled output was used to evaluate the hydrologic effects of the proposed action on ESA-listed species. The computer model's development and assumptions are described in Appendix C. Modeled output is available on CD ROM "*MODSIM Simulation of Deschutes River Basin Projects Operations Modeling Results"* (Stillwater 2003) and is available from Reclamation's Pacific Northwest Regional Office, PN-6200, 1150 N. Curtis Road, Suite 100, Boise, Idaho, 83706. Modeled system inflows were developed from measured flows and reservoir contents from water years 1962 through 1999.

6.2.1 Description of Modeled Scenarios

Reclamation developed a hydrologic baseline representing the hydrology component of the environmental baseline. The hydrologic baseline provides an analytical tool to isolate flow effects of Reclamation's proposed action.

Two scenarios were modeled and are described in detail below. One scenario simulates all current and ongoing operations in the Deschutes River basin, including Reclamation's proposed action. The second scenario simulates hydrologic conditions if Reclamation's ongoing operations were removed -- without the proposed action. The "with Reclamation" scenario can be compared to the "without Reclamation" scenario to determine the hydrologic effects of the proposed action.

Hydrologic Baseline including the Proposed Action (with Reclamation)

This computer simulation, hereafter referred to as "with Reclamation," represents current facilities and ongoing operational practices within the Deschutes, Crooked River, and White River subbasins. The proposed action is a continuation of current Reclamation operations. Operational practices reflect the proposed action, interrelated and interdependent actions, and other actions such as private irrigation and hydropower operations. Table 6-1 summarizes major facilities operating in this scenario.

Hydrologic Baseline with Proposed Action Removed (without Reclamation)

This computer simulation, hereafter referred to as "without Reclamation," represents the hydrology without Reclamation facilities operating. Changes to interrelated and interdependent actions that result from the absence of Reclamation operations are reflected in the modeled results. The "without Reclamation" simulation differs from the "with Reclamation" simulation in that:

- The effects of operating Crane Prairie, Wickiup, Haystack, Prineville, and Wasco Reservoirs and Dams are removed;
- The North Unit Main Canal and Crooked River Feed Canal do not divert flow, including natural flows;
- NUID's Crooked River Pumping Plant does not divert from the Crooked River.

In the "without Reclamation" scenario, non-Reclamation actions continuing to occur include storage and other operations at Ochoco and Crescent Lake Dams and Reservoirs; diversions into Walker Canal, Arnold Canal, Central Oregon Canal, Bend Feed Canal, North Canal (Pilot Butte), and diversions by Tumalo, Lone Pine, and Swalley Irrigation Districts, and operations at the Pelton-Round Butte hydropower complex.

Removing the operations of Reclamation dams in the "without Reclamation" scenario means that reservoirs become run-of-the-river. In addition, water bypasses the North Unit Main Canal, the Crooked River Feed Canal, and NUID's Crooked River Pumping Plant. Since the modeled systems are dynamic, non-Reclamation facilities respond to these changes in operations. For example, Ochoco Reservoir is drawn on more heavily in the "without Reclamation" scenario because supplemental water is not available from Prineville Reservoir. Run-of-the-river operations dictate that Reclamation reservoirs forego their right to fill, so the natural flow that would have been stored is made available for distribution to other water rights holders in priority. Natural flows that would have been diverted by North Unit Main Canal, the Crooked River Feed Canal, and the Crooked River Pumping Plant also are made available for distribution to other water rights holders.

Table 6-1 summarizes the major facilities that continue to operate in the "without Reclamation" scenarios.

Table 6-1. Summary of Major Facilities and Actions Included in Each Modeled Scenario

	Scenario 1: With Reclamation	Scenario 2: Without Reclamation
Deschutes Project		
Crane Prairie Dam and Reservoir	✔ storage and release	✔ passes natural inflow
Wickiup Dam and Reservoir	✔ storage and release	✔ passes natural inflow
Crescent Lake Dam and Reservoir	✔ storage and release	✔ storage and release
Walker Canal	✔ diverts natural flow	✔ diverts natural flow
Arnold Diversion Dam and Canal	✔ diverts Crane Prairie Reservoir storage and natural flow	✔ diverts natural flow only
Central Oregon Headworks and Canal	✔ diverts Crane Prairie Reservoir storage and natural flow	✔ diverts natural flow only
Bend Feed Canal	✔ diverts Crescent Lake storage and natural flows	✔ diverts Crescent Lake storage and natural flows
North Unit Headworks and Main Canal	✔ diverts Wickiup Reservoir storage and natural flow	✔ no diversions
North Canal (Pilot Butte)	✔ diverts Crane Prairie Reservoir storage and natural flow	✔ diverts natural flow only
Lone Pine Canal	✔ diverts Crane Prairie Reservoir storage and natural flow	✔ diverts natural flow only
Swalley Canal	✔ diverts natural flow	✔ diverts natural flow
Diversions from Tumalo and Squaw creeks	✔ diverts natural flow	✔ diverts natural flow
Haystack Dam and Reservoir	✔ storage and release	✔ no operation
Crooked River Pumping Plant	✔ diverts Crooked River natural flow	✔ no operation
Crooked River Project		
Bowman Dam and Prineville Reservoir	✔ storage and release	✔ passes natural inflow
Crooked River Diversion Dam & Feed Canal	✔ diverts Prineville Reservoir storage and natural flow	✔ no diversion
Crooked River Distribution Canal	✔ delivery of Prineville Reservoir storage and conveyance of natural flow	✔ no operation
Barnes Butte Pumping Plant and Ochoco Re-lift Plant	✔ delivery of Prineville Reservoir storage and conveyance of natural flow	✔ no operation
9 small pumping plants	✔ delivery of Prineville Reservoir storage and conveyance of natural flow	✔ no operation
Ochoco Dam and Reservoir	✔ storage and release	✔ storage and release
Ochoco Main Canal, Rye Grass, and other distribution canals	✔ diverts Ochoco Reservoir storage and natural flow; conveys Prineville Reservoir storage and Crooked River natural flow	✔ diverts Ochoco Reservoir storage and natural flow only (no Crooked River water)
Rice Baldwin Ditch	✔ diverts Prineville Reservoir storage and natural flow	✔ diverts natural flow only
People's Ditch	✔ diverts Prineville Reservoir storage and natural flow	✔ diverts natural flow only

	Scenario 1: With Reclamation	Scenario 2: Without Reclamation
Central Ditch	✔ diverts Prineville Reservoir storage and natural flow	✔ diverts natural flow only
Lowline Ditch	✔ diverts Prineville Reservoir storage and natural flow	✔ diverts natural flow only
Wapinitia Project		
Wasco Dam and Clear Lake	✔ storage and release	✔ passes natural inflow
Other		
Pelton-Round Butte Hydro Complex	✔ hydropower operations	✔ hydropower operations

6.2.2 Determination of Flow Effects

Modeled output for the computer simulations can be viewed using *Pisces,* and is available on the CD ROM "*MODSIM Simulation of Deschutes River Basin Projects Operations Modeling Results.*" Modeled output is provided for reservoir elevations and river flows as time series; typical wet, dry, and normal years; and exceedance curves. Modeled end-of-the-month reservoir elevations are provided for Crane Prairie, Wickiup, Crescent Lake, Prineville, and Ochoco Reservoirs. Modeled river flows are provided for the Deschutes River below Wickiup Reservoir, below Bend, near Culver, near Madras (below Lake Billy Chinook), and at Moody, and for the Crooked River below Bowman Dam, and near Terrebonne (below Crooked River Pumping Plant).

The effects of the proposed action on streamflows in the middle and lower Deschutes can be evaluated by comparing the modeled average monthly flows for the "with Reclamation" to the "without Reclamation" flows at the 10, 50, and 90 percent exceedance levels. Table 6-2 shows modeled average monthly flows at these exceedance levels for the two scenarios at three locations on the Deschutes River.

- Deschutes River Near Culver (14076500)
- Deschutes River Near Madras (14092500)
- Deschutes River at Moody (14103000)

Figure 3-1 (Chapter 3) shows the relative location of these stream gages.

An exceedance level is the probability that the value is equaled or exceeded. For example, in Table 6-2 at the Deschutes River Near Culver for the "with Reclamation" scenario, there is a 10 percent probability that average monthly October flows will equal or exceed 1,603 cfs. There is a 50 percent probability that average monthly October flows will equal or exceed 774 cfs. There is a 90 percent probability that average monthly October flows will equal or exceed 687 cfs.

The flow effects due to the proposed action are determined by subtracting the "without Reclamation" scenario flows from the "with Reclamation" scenario flows. Although this approach does not distinguish flow differences on a year by year basis, it can be used to evaluate the magnitude and trends of the proposed action effects. Comparing "without Reclamation" to "with Reclamation" flows listed in Table 6-2, demonstrates the following general trends in the Deschutes River Near Culver and downstream.

- Reclamation activities decrease spring and summer flows when Reclamation diverters rely on natural flows versus storage water; because releases from storage are not being made;
- Reclamation activities maintain or increase summer flows when Reclamation diverters rely on stored water;
- Reclamation activities reduce winter flows (with some exceptions) by storing in Reclamation reservoirs; and
- River flows are increased from year-round gains attributed to recharge from irrigators using project water. See Appendix C for discussion of groundwater gains.

TABLE 6-2. MODELED FLOWS IN THE DESCHUTES RIVER

Percent Exceedance (%)	Deschutes River Near Culver: With Reclamation (cfs)	Without Reclamation (cfs)	Flow Effects due to Proposed Action (cfs)	Deschutes River Near Madras: With Reclamation (cfs)	Without Reclamation (cfs)	Flow Effects due to Proposed Action (cfs)	Deschutes River at Moody: With Reclamation (cfs)	Without Reclamation (cfs)	Flow Effects due to Proposed Action (cfs)
	October			**October**			**October**		
10	1603	1944	-341	4928	5337	-409	5648	5839	-191
50	774	1396	-622	4201	4593	-392	4742	5155	-413
90	687	1157	-470	3719	4098	-379	4127	4465	-338
	November			**November**			**November**		
10	1618	2138	-520	5420	6133	-713	6494	7240	-746
50	1116	1751	-635	4635	5208	-573	5454	5904	-450
90	931	1465	-534	4268	4701	-433	4799	5293	-494
	December			**December**			**December**		
10	2058	2243	-185	6372	6956	-584	9507	10409	-902
50	1252	1721	-469	5144	5526	-382	5987	6421	-434
90	926	1379	-453	4156	4620	-464	4962	5224	-262
	January			**January**			**January**		
10	1956	2156	-200	6883	7356	-473	9319	9936	-617
50	1254	1633	-379	5395	5652	-257	6586	6996	-410
90	927	1305	-378	4171	4559	-388	5034	5414	-380
	February			**February**			**February**		
10	2004	2214	-210	7816	8292	-476	11610	11993	-383
50	1555	1732	-177	5548	6001	-453	7557	7769	-212
90	945	1306	-361	4174	4415	-241	4733	5045	-312
	March			**March**			**March**		
10	2017	2323	-306	7873	8636	-763	10144	11060	-916
50	1312	1612	-300	5170	5931	-761	6734	7491	-757
90	969	1330	-361	4061	4748	-687	5063	5647	-584
	April			**April**			**April**		
10	1459	1910	-451	6956	7583	-627	9378	9737	-359
50	774	1206	-432	5090	5822	-732	6894	7408	-514
90	564	799	-235	3900	4260	-360	4652	5031	-379
	May			**May**			**May**		
10	766	1337	-571	5631	6213	-582	7511	8021	-510
50	549	810	-261	4399	4734	-335	5954	6120	-166
90	488	418	70	3707	3835	-128	4299	4439	-140
	June			**June**			**June**		
10	868	1603	-735	5199	5759	-560	6809	7395	-586
50	571	762	-191	4181	4231	-50	5091	5148	-57
90	486	385	101	3749	3615	134	4282	4142	140
	July			**July**			**July**		
10	669	1123	-454	4863	5110	-247	5560	5990	-430
50	525	574	-49	4212	4119	93	4745	4714	31
90	474	352	122	3861	3716	145	4247	4103	144
	August			**August**			**August**		
10	682	1087	-405	4649	4778	-129	5190	5348	-158
50	516	592	-76	4074	3963	111	4506	4362	144
90	474	361	113	3653	3474	179	4034	3874	160
	September			**September**			**September**		
10	870	1259	-389	4623	4755	-132	5185	5315	-130
50	568	774	-206	4007	3999	8	4465	4518	-53
90	496	480	16	3522	3432	90	3833	3826	7

6.2.2.1 Diversions Above the Deschutes River Below Bend Gage (DEBO)

Although other diversions occur in the model, diversions from the Deschutes River above DEBO (RM 164.4) have the greatest influence on groundwater gains to the Lake Billy Chinook region.

The median (50 percent exceedance) "with Reclamation" total diversion above DEBO is more than 2,260 cfs at the peak of the irrigation season. The proposed action comprises less than 650 cfs of the total diversion. Modeled diversions above DEBO by month are shown in Table 6-3. Reclamation's proposed action comprises about 19 to 34 percent of the total diversions during the period from March to October.

Table 6-3. Modeled Total Diversions from the Deschutes River above the "Deschutes River below Bend" Gage.

(Values shown are the median –50% exceedance – of average monthly flows)

	With Reclamation	Without Reclamation	Diversions due to Proposed Action (With Reclamation minus Without Reclamation)
Oct	718	473	245
Nov	132	126	6
Dec	83	80	3
Jan	82	82	0
Feb	98	98	0
Mar	137	111	26
Apr	889	605	284
May	1898	1375	523
Jun	2201	1582	619
Jul	2263	1622	641
Aug	2057	1583	474
Sep	1701	1300	401

6.2.2.2 Deschutes River Near Culver

The Deschutes River Near Culver gage is located directly upstream from Lake Billy Chinook and downstream from Squaw Creek at RM 120.1. Modeled flows at this location are shown in Table 6-2. Median "without Reclamation" flows range from about 570 cfs in July to 1,750 cfs in November. The proposed action decreases median flows (at the 50 percent exceedance level) by 9 to 45 percent. Reductions to flow tend to be greatest from September through January and again in early spring (April and May).

April through October

Median "without Reclamation" flows range from about 570 to 810 cfs during May through September. The proposed action reduces median flows by less than 265 cfs in May, June, and September and insignificantly in July and August. The proposed action increases low flows (at the 90 percentile level) by about 70 to 120 cfs during May through August. These effects reflect the diverters' reliance on stored flows. This is reasonable, because even though Reclamation diversions above DEBO were about 640 cfs during the peak of the irrigation season (see the Section 6.2.2.1 "Diversions Above the Deschutes River Below Bend Gage"), most Reclamation diversions during that period are from stored water. The effects of groundwater gains from Reclamation diversions above DEBO increase the low flows near Culver.

Median "without Reclamation" flows are about 1,200 cfs in April. The proposed action reduces April median flows by about 430 cfs due to the diversion and storage of natural flow. Similar conditions exist in October when median "without Reclamation" flows are about 1,400 cfs and the proposed action reduces those flows by about 620 cfs.

November through March

Median "without Reclamation" flows for November through March are about 1,610 to 1,750 cfs. The proposed action reduces these median flows by about 180 to 640 cfs, due to the storage of flows in Crane Prairie and Wickiup Reservoirs. These flow reductions include any groundwater gains from the Reclamation diversions above DEBO.

6.2.2.3 Deschutes River Near Madras

The Deschutes River Near Madras gage is located directly downstream from Lakes Billy Chinook and Simtustus at RM 100.1. Flows at this location include contributions from the Metolius and Crooked Rivers. Modeled flows at this location are shown in Table 6-2. Median "without Reclamation" flows range from about 3,960 cfs in August to 6,000 cfs in Februrary. In general the proposed action decreases median flows (at the 50 percent exceedance level) by 5 to 13 percent during the October through May period. Insignificant decreases or increases in flow occur during the remaining months.

April through October

The median "without Reclamation" flows in April are about 5,820 cfs. The proposed action reduces these flows by about 730 cfs. The median "without Reclamation" flows in May are about 4,730 cfs. The proposed action reduces median May flows by about 340 cfs. Median "without Reclamation" flows June through September are about 3,960 to 4,230 cfs. The proposed action reduces median flows by about 50 cfs in June, increases median flows by about 90 to 110 cfs in July and August, and increases median flows insignificantly in September. The proposed action increases low flows (at the 90 percentile level) by about 90 to 180 cfs in June through September.

The Deschutes River Near Madras gage reflects the regulation that was observed at the Deschutes River Near Culver location upstream. In addition, Prineville Reservoir often fills through April and sometimes May, reducing the contributions from the Crooked River. NUID's Crooked River pumps also contribute to flow reductions in April through June. The June through September effects indicate Reclamation diverters' reliance on stored water, in addition to the flow-increasing effects of groundwater gains from the Reclamation diversions above DEBO.

Median “without Reclamation” October flows are about 4,590 cfs. The proposed action reduces these flows by about 390 cfs due to natural flow diversions and storage in Prineville Reservoir.

November through March

Median “without Reclamation” flows from November through March are about 5,200 to 6,000 cfs. The proposed action reduces these flows by about 260 to 760 cfs due to the combined effects of storing flows in Crane Prairie, Wickiup, and Prineville Reservoirs. These flow reductions also reflect any groundwater gains from the Reclamation diversions above DEBO.

6.2.2.4 Deschutes River at Moody

The Deschutes River at Moody gage is located at RM 1.4, at the mouth of the Deschutes River where it enters the Columbia River. Modeled flows at this location are shown in Table 6-2. Median “without Reclamation” flows range from about 4,360 cfs in August to 7,770 cfs in February. In general, the proposed action decreases median flows (at the 50 percent exceedance level) by 10 percent or less most months, with a short increase in flows in July and August.

April through October

Median “without Reclamation” flows in April, May, and October are about 5,160 to 7,400 cfs. The proposed action reduces these median flows by about 170 to 510 cfs. Median “without Reclamation” flows from June through September are about 4,360 to 5,150 cfs. The proposed action reduces median flows in June and September by about 55 cfs, and increases median flows in July and August by about 30 to 140 cfs. The proposed action increases low flows (at the 90 percentile level) by about 140 to 160 cfs in June through August. In addition to effects from Crane Prairie, Wickiup, and Prineville Reservoirs, Reclamation’s effects at Moody reflect the activities of the Wapinitia Project in the White River subbasin.

November through March

Median “without Reclamation” flows for November through March are about 5,900 to 7,770 cfs. The proposed action reduces these flows by about 210 to 760 cfs. These flow effects are due to filling Crane Prairie, Wickiup, and Prineville Reservoirs and also reflect the flow-increasing effects of groundwater gains from the Reclamation diversions above DEBO.

6.2.3 Summary

Computer simulations were performed to evaluate the hydrologic effects of the proposed action. The results of these modeling studies for the Deschutes River Near Culver, Near Madras, and at Moody are summarized in Table 6-2. Additional hydrologic effect data is available in the *MODSIM Simulation of Deschutes River Basin Projects Operations – Modeling Results* CD ROM (Stillwater 2003).

Modeling studies indicate that the greatest effect of the proposed action occurs during the irrigation season (April through October) at the Deschutes River Near Culver. Median “without Reclamation” flows for this period range from about 575 to 1,400 cfs. The proposed action reduces median “without Reclamation” flows by 9 percent to 45 percent. However in low flow years (90 percent exceedance level), the proposed action results in an increase of 17 to 35 percent, contributing about 70 to 122 cfs in the May through August period.

Downstream at the Deschutes River Near Madras, April through October median "without Reclamation" flows range from about 3,960 to 5,820 cfs. The proposed action reduces these median flows in April and October by less than 13 percent and alters May through September median flows insignificantly. "Without Reclamation" June through September low flows (at the 90 percent exceedance level) at the Deschutes River Near Madras range from about 3,430 to 3,720 cfs. The proposed action increases these low flows insignificantly. At the Deschutes River at Moody, April through October median "without Reclamation" flows range from about 4,360 to 7,410 cfs. The proposed action alters these median flows insignificantly. "Without Reclamtion" April through October low flows (at the 90 percent exceedance level) at this location range from about 3,830 to 5,030 cfs. The proposed action alters these low flows insignificantly.

November through March median "without Reclamation" flows at the Deschutes River Near Culver range from about 1,610 to 1,750 cfs. The proposed action reduces these median flows by 10 percent to 36 percent due to reservoir storage.

Downstream November through March median "without Reclamation" flows range from about 5,210 to 6,000 cfs at the Deschutes River Near Madras and from about 5,900 to 7,770 at the Deschutes River at Moody. The proposed action reduces these median flows by less than 13 percent, reflecting the influence of groundwater gains.

6.3 BALD EAGLE EFFECTS ANALYSIS

Reclamation analyzed possible effects of the annual operation and maintenance of Reclamation dams and reservoirs on both nesting and wintering bald eagles-- principally their primary prey base of fish and, to a lesser extent, waterfowl. Seasonal fluctuations in reservoir levels and alterations in streamflows below Reclamation dams were analyzed to evaluate the quantity and quality of prey population habitat, influence on prey health and abundance, and the ability of bald eagles to exploit available prey species, especially fish prey (by making prey more or less vulnerable to predation.)

There are several overriding principles which should be kept in mind while assessing the effects of continued operation and maintenance activities at project reservoirs.

1. Currently, the bald eagle population that inhabits these areas has been attracted to and has, at least in part, adapted to the conditions which have been and will continue to be present, i.e., fluctuating water levels which affect abundance and availability of prey.

2. Annual fish stocking programs at project reservoirs have helped ameliorate the effects of reservoir fluctuations on fish prey.

3. The bald eagle population in the Deschutes River basin and at project reservoirs has been a growing population over the last 30 years. This increase has occurred in spite of changes in annual and seasonal operation scenarios, responding to differing hydrologic conditions.

4. The establishment of breeding areas at project reservoirs may be at or nearing carrying capacity due to territorial conflicts, paucity of suitable nesting trees, and/or other environmental factors (see baseline discussion in Chapter 5).

The following analysis focuses on the potential effects from the “proposed action” which is continued operation and maintenance at Reclamation facilities in the Deschutes River basin. Since the growing bald eagle population has experienced and adapted to the existence of project reservoirs in the basin for the last 30 years, it is reasonable to establish the existence of reservoirs, i.e., historic and ongoing operations, as the baseline for the bald eagle. Evaluation was made of “proposed action” reservoir contents and streamflows in order to assess whether or not eagle foraging habitat and habitat conditions for prey populations change from baseline conditions as described in Chapter 5. Indirect effects are also discussed, as applicable.

Analysis of hydrologic effects used modeled end-of-month reservoir elevations simulated in the “with Reclamation” scenario described earlier in this section. The model used historic water supply data for water years 1962 through 1999, but applied current operational criteria, including current irrigation demands. Although graphs contained in this chapter reference past water years, they do not represent the actual operations for those years, but rather an indication of potential reservoir operations for water supply situations similar to past water years. This approach simulates the range of end-of-month reservoir elevations that may occur in the future.

6.3.1 Upper Deschutes Subbasin Effects Analysis

Reservoir storage under the proposed action would continue to vary considerably from year-to-year and season-to-season, depending on the water supply and demand for irrigation withdrawals.

6.3.1.1 Crane Prairie and Wickiup Reservoirs

Crane Praire Reservoir

The environmental baseline discussion assumed that the average 23,000 acre-feet end-of-October carryover may be a critical level for sustaining a productive reservoir fishery. Figure 6-1, illustrating the modeled reservoir storage elevations under the proposed action, indicates that the reservoir may be drawn down to or below this volume about 66 percent of the years. Figure 6-2, an exceedance curve for end-of-October reservoir elevations, indicates the reservoir would be at or above 23,000 acre-feet by the end of the irrigation season about 46 percent of the time. However, the reservoir would be at or above 22,000 acre-feet about 70 percent of the time.

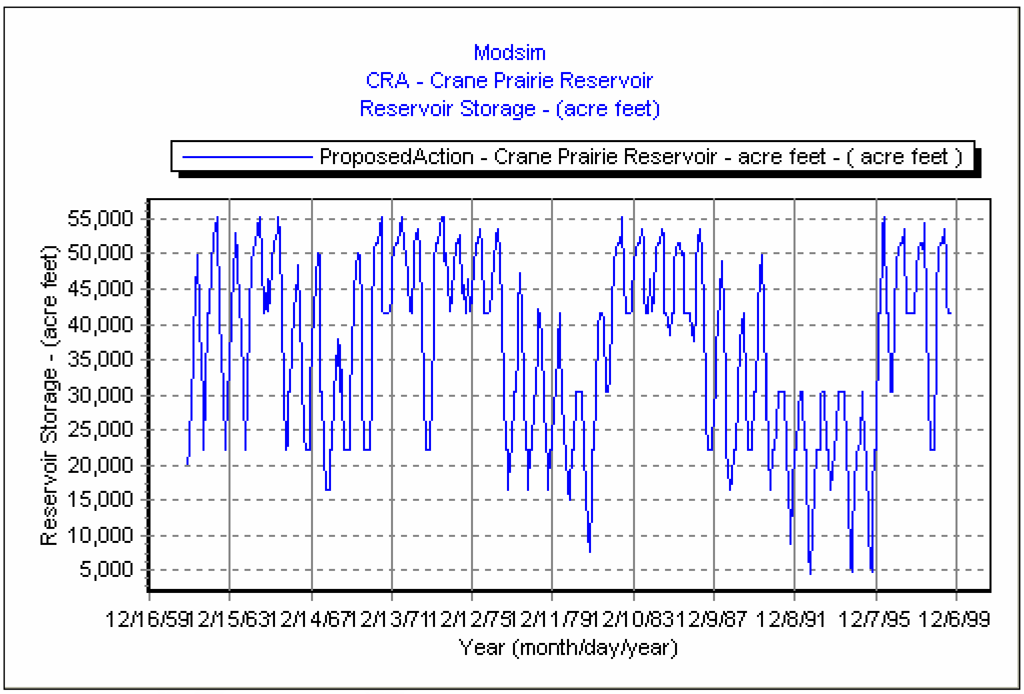

Figure 6-1. Crane Prairie Reservoir End-of-Month Storage – Proposed Action

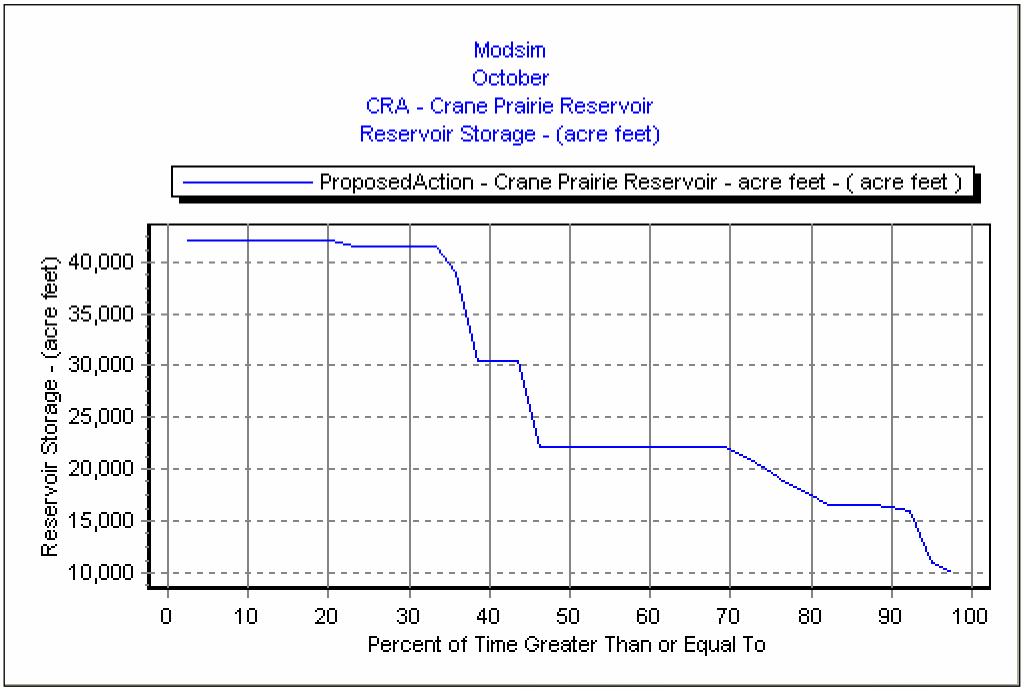

Figure 6-2. Crane Prairie Reservoir Storage End-of-October – Proposed Action Exceedance Curves

Wickiup Reservoir

As described in the environmental baseline discussion, when Wickiup Reservoir storage drops below 40,000 acre-feet, fish become concentrated in the Deschutes River channel of the reservoir and fish loss through the outlet increases (Fies et al. 1996a). Figure 6-3 indicates the reservoir would be drawn down to or below 40,000 acre-feet 32 percent of the years. However, end-of-October storage under the proposed action would be at or above 40,000 acre-feet about 81 percent of the time at the end of the irrigation season (Figure 6-4). At the 50 percent exceedance level, Wickiup Reservoir storage would be at or above 100,000 acre-feet at the end of October.

Effects on Foraging Habitat and Prey Base - The preceding analysis shows that the Crane Prairie and Wickiup Reservoirs content would continue to fluctuate seasonally and annually dependent on the water supply and demand, as has been the case historically.

As described in Chapter 3, Crane Prairie Reservoir levels and content have been substantially improved since Reclamation's rehabilitation of the dam in 1940. It has also operated with less variability and at higher minimum elevations since the coordinated operation with Wickiup Reservoir began in 1949. After 1970, annual fluctuations of Wickiup Reservoir have been more uniform and generally not drawn down as low as compared to pre-1970 data. These operational changes have improved the quality of the aquatic habitat for the reservoir fish populations, both resident and stocked, and have reduced the entrainment through Wickiup Dam.

Overall, continued operations at the reservoirs would not significantly change the habitat conditions for fish and waterfowl prey populations at the reservoirs from the environmental baseline. Continued fish stocking programs at the reservoirs would continue to help ameliorate the effects of reduced reservoir levels during low water years. Maintenance of the fish prey population, in particular, in the reservoirs would result in continued foraging success for bald eagles; although, there would continue to be fluctuations in the quantity and quality of aquatic habitat and dependent prey populations. Competition between eagles and other piscivorous birds (i.e., cormorants and ospreys) for fish prey, would continue.

Effects on Nesting Bald Eagles – The increasing year-round bald eagle use in close proximity to Crane Prairie and Wickiup Reservoirs (i.e., increased from 5 known breeding areas to 17 over a 30-year period in addition to occasional wintering birds) is an indication that a suitable prey base and other habitat requirements have been met historically at the reservoirs, and is not expected to change significantly.

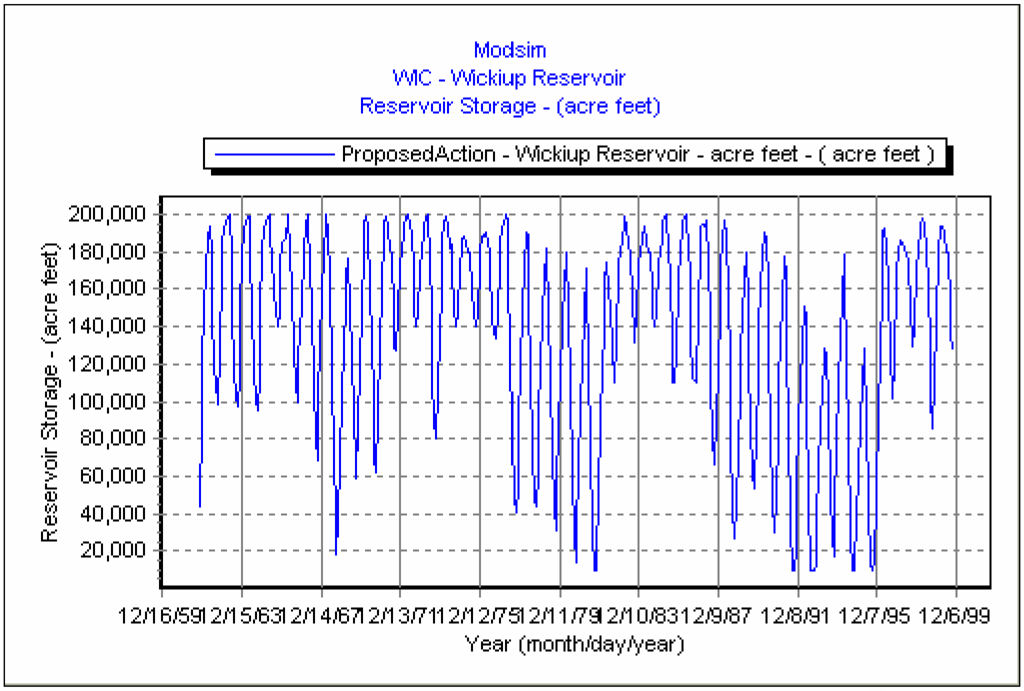

Figure 6-3. Wickiup Reservoir End-of-Month Storage – Proposed Action

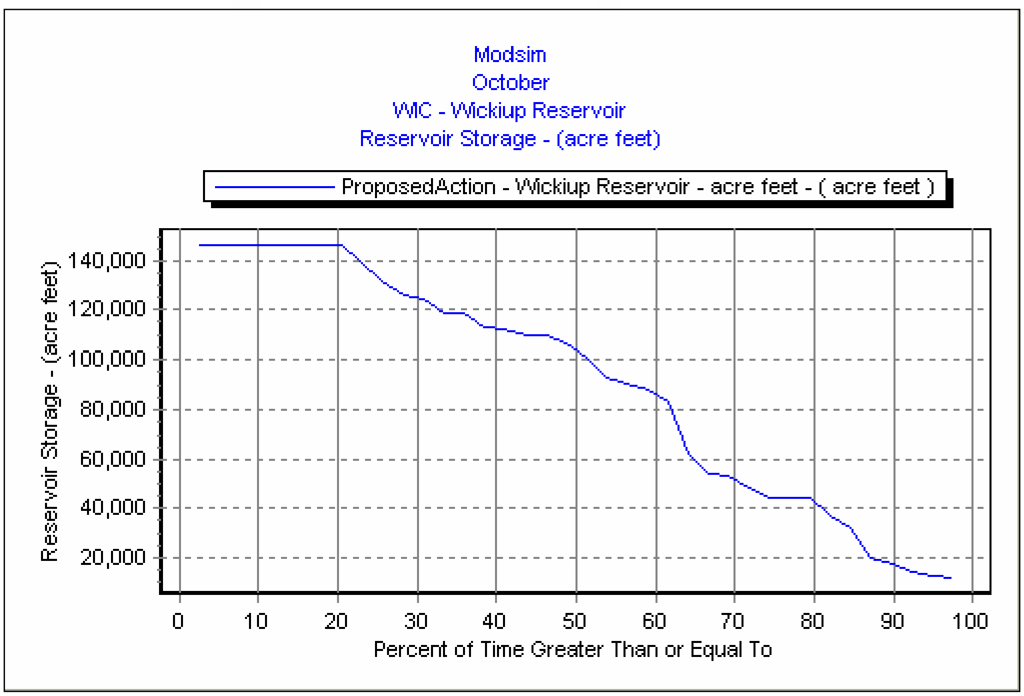

Figure 6-4. Wickiup Reservoir End-of-October Storage – Proposed Action Exceedance Curves

The potential relationship of project reservoir operations to bald eagle nesting success can be evaluated by examining the hydrologic conditions at Crane Prairie and Wickiup Reservoirs and the corresponding bald eagle nesting success of the last 30 years. The general trend has been an increase in breeding pairs with a corresponding increase in the production of young. However, there has been a great deal of fluctuation in these numbers (Table 5.1 and Figure 5.2) which cannot necessarily be explained in relationship to reservoir hydrologic cycles, with possibly one exception:

> *During the 1979-1981 historic period, Crane Prairie and Wickiup Reservoirs levels were drawn down to very low levels for three years in a row (Figures 3-2 and 3-7). The apparent result was an abrupt drop in the number of young eagles produced during the subsequent two nesting periods (1982 & 1983--See Table 5.1 & Fig. 5.2). This occurred even though the number of occupied breeding areas remained fairly constant. The effect was most apparent at Crane Prairie Reservoir, where there were no young produced during the two-year period following the 1979-81 drawdown years. Examination of climatic conditions (precipitation and temperature) for the 1982 breeding and nesting seasons indicated that there was above average precipitation during the May through July period, but that temperatures were near average. The question here would be whether or not these or other environmental factors also had an effect on the production of young. However, looking at the State of Oregon nesting record for 1982, it shows a general decrease in the average productivity of nesting pairs per occupied site--possibly indicating a general decline responding to widespread drought conditions in previous years (Isaacs and Anthony 2002).*

The number of breeding pairs which occupy nesting territories in the vicinity of Crane Prairie and Wickiup Reservoirs would be expected to continue to fluctuate annually with the proposed action, as under past operations. There may be some increases in numbers, depending on the suitability of environmental factors in addition to continued reservoir operations. Any possible increase in the number of occupied breeding territories under the proposed action would also depend on a number of factors, i.e., varying environmental conditions, competition for space, and availability of suitable nesting trees. Review of nesting data (Table 5-1) over the last 9 years indicate that the opportunity for establishing new breeding areas (nesting territories) at the reservoirs may be reaching carrying capacity. At Crane Prairie Reservoir, seven breeding areas were recorded in 1994 and increased by only one by the year 2000. At Wickiup Reservoir, there were eight recorded breeding areas as early as 1981, increasing by only one breeding area by 2001.

While it is uncertain as to whether the number of breeding areas may or may not increase under the proposed action, the continued operation of the reservoirs–resulting in a sustained prey base–would be expected to maintain the historic success of breeding pairs. The result may be at sustained or even higher numbers of occupied breeding territories (again dependent on competitive factors and annual environmental conditions) and continued success in raising and fledging young.

Effects on Wintering Bald Eagles –During severe winter months, when the lakes are mostly iced over, it is unlikely that the proposed action would have any differing effects on bald eagle habitat or food supply. Eagles often reside at the reservoirs until well into, or through, the winter months, feeding on wintering concentrations of waterfowl.

Early in the spring and sometimes in mild winters (i.e., at Wickiup Reservoir), ice either does not form or begins to recede at stream inlets to the reservoirs leaving small areas of open water. Waterfowl concentrate at these open water areas creating a ready source of food for the eagles. During this time, the proposed action would have little change on foraging opportunities from historic conditions.

This area also contains suitable perching and roosting sites nearby with little or no significant human disturbance in winter. These conditions would not change under the proposed action.

Other Effects –Disturbances to nesting activities in summer, due to recreational use of the reservoirs and adjacent landscapes, will continue to be a management concern under the proposed action, as has been the case historically. The USFS has addressed these concerns, as the authorized land manager, by establishing Bald Eagle Management Plans for all but the most recently recorded breeding areas at the reservoirs. Possibly more could be done to reduce disturbance effects on nesting eagles if some bays were restricted from access during the eagle nesting period (Dillon 2002). However, this would have to be a USFS action. Reclamation has no jurisdiction over recreation management on the reservoirs.

Routine operation and maintenance activities at Crane Prairie and Wickiup Dams would not result in disturbance or alteration of nesting, perching, or roosting sites. All routine activities would be concentrated at the dam locations and should have no disturbing effects on nesting or foraging eagles. If extraordinary maintenance activities requiring significant amounts of construction are proposed in the future, each would have to be assessed separately to determine potential disturbing effects, especially on eagle breeding and nesting success at nearby nest location, e.g., the nest site immediately downstream of Wickiup Dam.[1]

[1] The 2002 nesting activity at this sight was apparently adversely affected by ongoing construction activities associated with the Safety of Dams program. These activities were the subject of a separate Section 7 ESA consultation.

6.3.1.2 Deschutes River Below Project Reservoirs

Under the proposed action, the flows of the Deschutes River below Wickiup Dam would continue to vary considerably from year-to-year and season-to-season depending on the water supply and demands for irrigation (Figure 3-8). Maximum and minimum releases and overall flow patterns would be similar to conditions in the most recent past.

Any proposed action effects on bald eagles would be due primarily to continued fluctuating flow patterns and their effect on Deschutes River fish populations. However, according to Marx (2002) there are few issues associated with these flows relative to the availability of a food source for wintering eagles, i.e., there appears to be a sustained prey base (fish and waterfowl) in most years. During ice-over conditions, wintering birds move to lower elevations in the basin to roost and feed.

The three breeding areas on the upper Deschutes River have been established since 1990. The breeding pairs which utilize these areas are possibly year-long residents and rely on the Deschutes River fish and waterfowl populations as a main source of food. During the bald eagle nesting season, the riverine environment plus surrounding prey habitat appear to have provided a relatively stable prey base for the nesting eagles in recent years and would continue to do so under the proposed action. Fluctuations in breeding and fledging success and in numbers of wintering eagles along the river would be expected to continue as in the past.

6.3.2 Middle Deschutes River Subbasin Effects Analysis

Bald eagles nesting and wintering in the middle Deschutes River area are not affected by Reclamation project O&M activities. They are mostly influenced by operation of the Pelton-Round Butte Project reservoirs (i.e., Lake Billy Chinook) which, along with westside tributaries, provide abundant food sources for nesting and wintering eagles as described in Chapter 5. Nesting opportunities would continue to be limited by the paucity of suitable nesting trees.

6.3.3 Crooked River Subbasin Effects Analysis

The reservoir storage content at Prineville and Ochoco Reservoirs under the proposed action would continue to vary considerably from year-to-year and season-to-season depending on the water supply and irrigation demands.

6.3.3.1 Prineville and Ochoco Reservoirs

Figure 6-5 depicts the simulated end-of-month Prineville Reservoir storage for the proposed action. As described in the environmental baseline discussion, the average end-of-October carryover storage in Prineville Reservoir has been about 83,000 acre-feet, dipping below this level in only extreme drought years. Under the proposed action, end-of-October storage (end of irrigation season) would be expected to be at or above 83,000 acre-feet about 68 percent of the time (Figure 6-6).

The hydrological analysis for Ochoco Reservoir is important to the bald eagle effects analysis as it relates to winter forage habitat provided by a facility that is operationally interrelated and interdependently with Reclamation operations. Figure 6-7 depicts the simulated end-of-month storage for the proposed action. Overall fluctuations in Ochoco Reservoir elevations and content would continue as in the past. Historically, Ochoco Reservoir's average end-of-October carryover storage is 14, 750 acre-feet. Under the proposed action, the reservoir would be at or above this historic average carryover, about 73 percent of the time (Figure 6-8). The overall winter condition of the reservoir would not change significantly from past operations. Ochoco Reservoir has been held at higher elevations since the construction of Bowman Dam, because of coordinated operations.

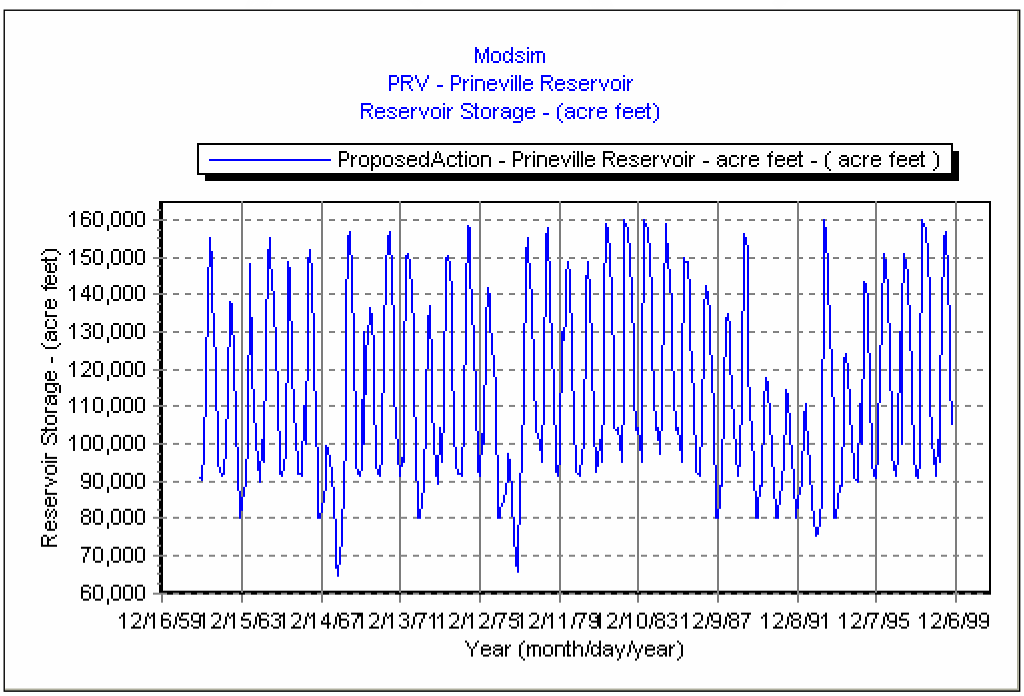

Figure 6-5. Prineville Reservoir End-of-Month Storage – Proposed Action

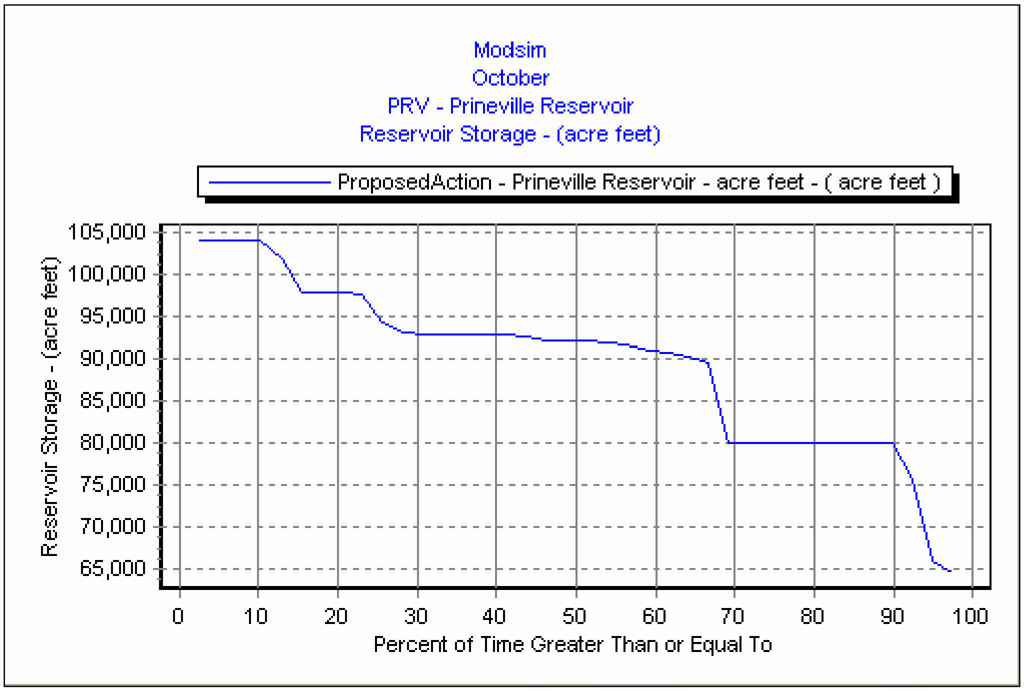

Figure 6-6. Prineville Reservoir End-of-October Storage – Proposed Action Exceedance Curve

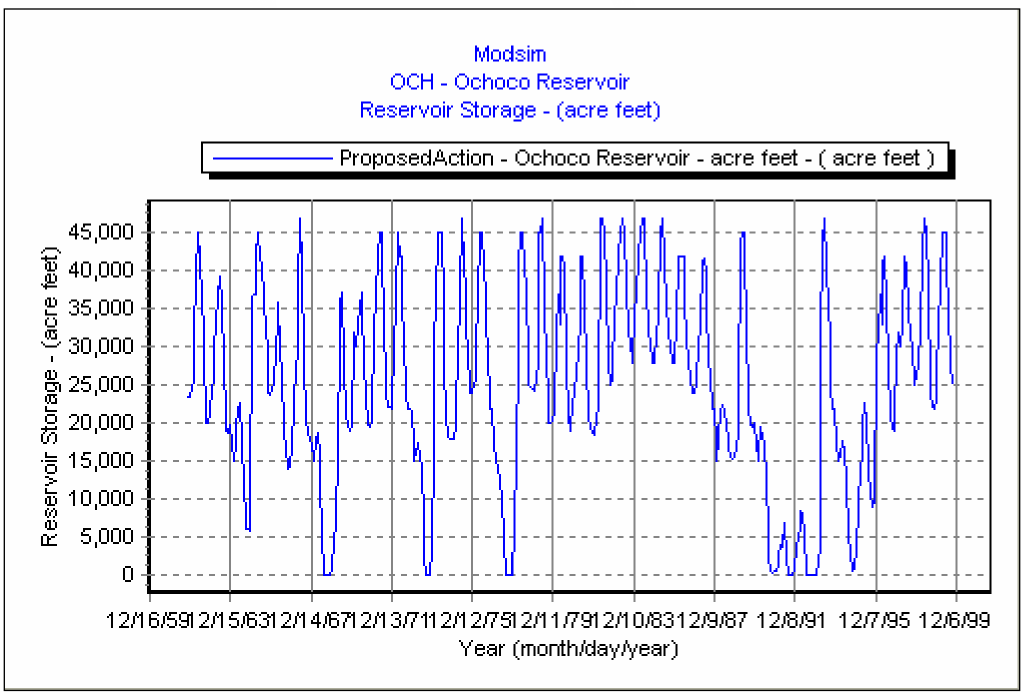

Figure 6-7. Ochoco Reservoir End-of-Month Storage – Proposed Action

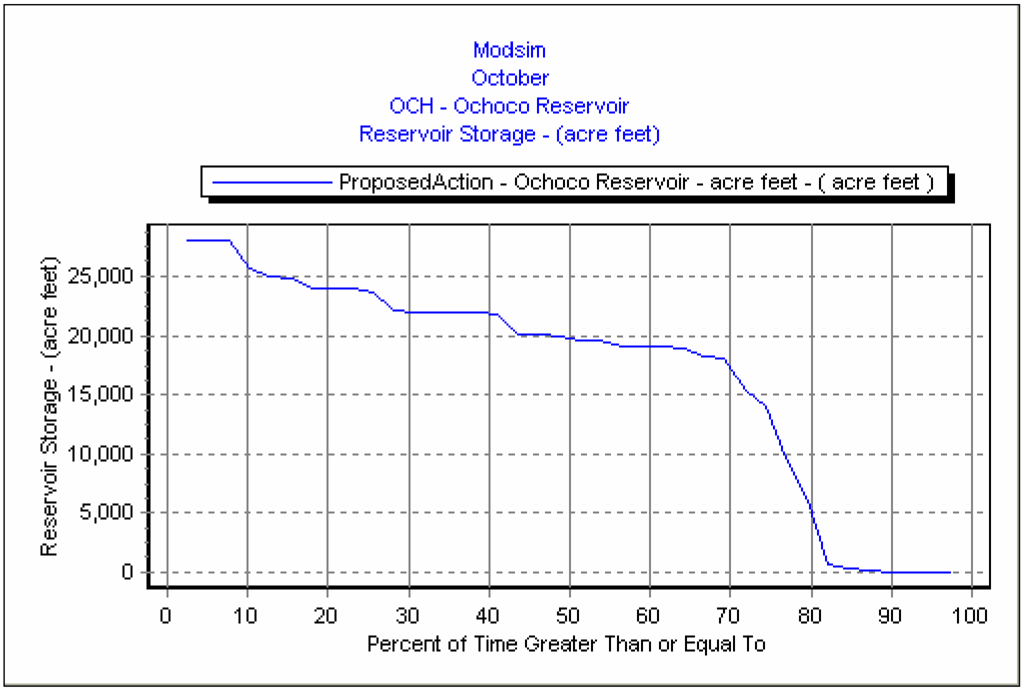

Figure 6-8. Ochoco Reservoir End-of-October Storage – Proposed Action Exceedance Curve

Effects on Foraging Habitat and Prey Base – The preceding analysis shows that under the proposed action there would remain a sizeable carryover content at Prineville Reservoir, as has been historically; and extreme drawdowns would be avoided. It is expected that the quality and quantity of the aquatic habitat for the reservoir fish populations, both resident and stocked, would be maintained at historical conditions. However, there would continue to be fluctuations in the quantity and quality of aquatic habitat and dependent prey populations.

Maintained conditions for fish prey population in the reservoir would probably have no significant change on the foraging success for the single resident breeding pair of bald eagles at Prineville Reservoir. Prey would remain readily available to these birds and to any new breeding pairs that may be able to find a suitable nesting site near the reservoir--although, as described under baseline conditions, suitable nesting trees are in short supply and the resident pair is extremely territorial.

Unchanged winter carryover conditions at Ochoco Reservoir would maintain the winter fishery and waterfowl prey base in the reservoir at current levels.

Effects on Nesting Eagles – Based on the foregoing, Prineville Reservoir would continue to be operated in a similar manner as it has been historically. Future bald eagle nesting success would respond to a continuation of similar environmental factors along with available prey.

Effects on Wintering Eagles – During severe winter months, when the reservoirs are mostly iced over, it is unlikely that the proposed action would have any effects on bald eagle habitat or food supply. But at these lower elevation reservoirs, eagles often reside well into, or through, the winter months, feeding on wintering concentrations of waterfowl and fish at the reservoirs and/or upland carrion on adjacent lands.

During this time, the proposed action would have little change on foraging opportunities from historic conditions, because reservoir fisheries and waterfowl, and their availability as exploitable prey, would not significantly change from historic conditions.

This area also contains suitable perching and roosting sites nearby with little or no significant human disturbance in winter. These conditions would not change under the proposed action.

Other Effects – Disturbances to nesting activities in summer, due to recreational use of the reservoirs and adjacent landscapes, has not been perceived as an issue at Prineville Reservoir in the past. Nesting sites are extremely limited by the availability of suitable nesting trees. If the resident pair or other eagles nest in closer proximity to the reservoir, as attempted in 2002, then conflicts with recreation use could occur. This could happen with or without implementation of the proposed action. Reclamation would continue to work with other agencies to minimize effects on recreation use on bald eagle breeding and nesting activities at Prineville Reservoir.

Routine operation and maintenance activities at Bowman Dam (Prineville Reservoir) and Ochoco Dam would not result in disturbance or alteration of nesting, perching, or roosting sites of breeding, nesting, or wintering bald eagles. All routine activities would be concentrated at the dam locations and should have no disturbing effects on nesting or foraging eagles. If extraordinary maintenance activities requiring significant amounts of construction are proposed in the future, each would have to be assessed separately to determine potential disturbing effects, especially on eagle foraging activities. At present there are no nest sites in the near vicinity of the dams.

6.3.3.2 Crooked River Below Bowman Dam

Under the proposed action, Crooked River flows below Bowman Dam would continue to vary considerably from year-to-year and season-to-season depending on the water year and on withdrawals for irrigation (Figure 3-25). Releases and overall flow patterns would not change significantly from recent past historic conditions. Minimum releases to sustain downstream fisheries (provided since 1990) would remain in effect.

Any effect of the proposed action on bald eagles would be due primarily to the continued fluctuating flow patterns and their effect on Crooked River fish populations. It is expected that continued release of minimum winter flows (as described in Chapter 2) would continue to sustain a healthy fishery below the dam during the nonirrigation season. This along with upland carrion sources would continue to provide a sustained foraging base for the bald eagles which winter along the river corridor.

6.3.4 Lower Deschutes River Subbasin Effects Analysis

6.3.4.1 Clear Lake

It is not known how operations at Clear Lake may affect the nesting success of the Clear Lake nesting territory. There is evidence that the eagles have been in the area for years, but monitoring of nesting activity began only about 6 years ago. Since then, there has been recorded nesting success in only the last 2 years. Fish resources are limited at Clear Lake, but there appears to be adequate foraging areas when considering all of the lake and stream fisheries in the general area. These conditions would not change with the proposed action. Clear Lake would continue to be operated in the same manner as it has been historically and future bald eagle nesting success would respond to a continuation of similar environmental factors.

6.3.4.2 Lower Deschutes River

This reach of the Deschutes River below Lake Billy Chinook would continue to support an abundance of waterfowl and fish prey. Bald eagle nesting would continue to be limited by the paucity of suitable nesting trees. Year-round bald eagle use (one nesting territory actually near the river and significant numbers of wintering eagles) of the lower Deschutes and tributaries is an indication that a sustained prey base (i.e., fish resources along with waterfowl and winter-killed big game) and other habitat features (i.e., suitable perching and roosting sites) are, and will continue to be, available. The bald eagle prey base in the lower river and tributaries is not likely to be adversely affected under the proposed action. Streamflows and dependent prey populations are generally adequate in the lower river and will remain so under the proposed action.

6.3.5 Summary of Effects

Based on the previous analysis and the fact that there has been and continues to be a growing bald eagle population in the Deschutes River basin, it is Reclamation's conclusion that overall the proposed action "may affect, but is not likely to adversely affect" the breeding, nesting, or wintering success of bald eagles in the Deschutes and Crooked River subbasins.

6.3.5.1 Upper Deschutes River Subbasin

- The number of breeding pairs which occupy nesting territories in the vicinity of Crane Prairie and Wickiup Reservoirs would be expected to continue to fluctuate annually with the proposed action, as under past operations. There may be some changes in numbers, depending on the suitability of environmental factors in addition to reservoir level fluctuations. Such changes have been the case in the recent past with the growing eagle population. [May Affect, Not Likely to Adversely Affect]

- While the number of breeding areas may or may not increase under the proposed action, it is expected that breeding success would continue to fluctuate as in the past. [May Affect, Not Likely to Adversely Affect]

- Success of breeding pairs downstream of Wickiup Dam would be likely to remain about the same as historically. [No Effect]

- Conditions for winter eagles would probably not change significantly. [No Effect]

- Routine operation and maintenance activities at Crane Prairie and Wickiup Dams would not result in disturbance or alteration of nesting, perching, or roosting sites. [No Effect]

6.3.5.2 Middle Deschutes River Subbasin

- Bald eagles nesting and wintering in the middle Deschutes River area are not affected by Reclamation project O&M activities. [No Effect]

6.3.5.3 Crooked River Subbasin

- The proposed action would have little change on foraging opportunities from historic conditions at Prineville Reservoir because reservoir fisheries and their availability as exploitable prey will continue to be more than adequate for the resident breeding pair and wintering eagles. [No Effect]

- Routine operation and maintenance activities at Bowman Dam (Prineville Reservoir) and Ochoco Dam would not result in disturbance or alteration of nesting, perching, or roosting sites of breeding, nesting, or wintering bald eagles. [No Effect]

- It is expected that the commitment to providing minimum winter flows would continue to sustain a healthy fishery in the Crooked River below Bowman Dam during the nonirrigation season. This along with upland carrion sources would continue to provide a sustained foraging base for the bald eagles which winter along the river corridor. [No Effect]

- Winter carryover conditions at Ochoco Reservoir would remain unchanged. The winter fishery prey base in the reservoir would not change significantly. [No Effect]

6.3.5.4 Lower Deschutes River Subbasin

- Clear Lake would continue to be operated in the same manner as it has been historically and future bald eagle nesting success would respond to a continuation of similar environmental factors. [No Effect]

- The bald eagle prey base in the lower river and tributaries is not likely to be adversely affected under the proposed action. Streamflows and dependent prey populations are generally adequate in the lower river and will remain so under the proposed action. [May Affect, not Likely to Adversely Affect]

6.4 BULL TROUT

6.4.1 Upper Deschutes River Subbasin

6.4.1.1 Effects Analysis

Operation of project facilities at Crane Prairie Reservoir, Wickiup Reservoir, and diversion facilities downstream would have no effect on bull trout in the upper Deschutes subbasin since there are no longer any known bull trout populations in these reservoirs nor in the tributary streams above or immediately below the reservoirs.

6.4.2 Middle Deschutes River Subbasin

6.4.2.1 Effects Analysis

Effects of flow alterations resulting from the operation of Reclamation facilities of the Deschutes and Crooked River Projects and private facilities reduce inflows to the middle Deschutes River. Diversions related to the Deschutes Project and other private diversions have severely affected streamflow and water quality in the 33 stream miles from Bend downstream to Big Falls. Water quality and spatial habitat is severely depleted through this reach (Marx 2000). Downstream from Bend, large spring inflows (from irrigation groundwater recharge) restore or replace a significant amount of the water that is stored or diverted upstream.

Historic hydrologic analysis (Chapter 3) and hydrologic modeling of flows in the Deschutes River basin (Section 6.2) were conducted by Reclamation and described earlier. The hydrological model calculated daily mean streamflows on a monthly basis for two hydrologic scenarios (with Reclamation projects operating, and those expected if the proposed action were removed.) This provided the information to illustrate percent exceedance curves for the USGS streamflow gage near Culver, Oregon, just upstream from Lake Billy Chinook. Table 6-4 shows modeled 50 percent exceedances for each month for the Culver gage under the "with Reclamation" and "without Reclamation" conditions, and the percent difference in the streamflow for these two modeled simulations. Table 6-4 shows that there is a reduction in modeled downstream flow attributable to Reclamation operations for 12 months of the year at the Culver gage at the 50 percent exceedance level. Generally, these modeled flow changes reflect periods when Reclamation, under the proposed action, is storing or releasing water. These seasonal reductions in flow may contribute to reduced water quality conditions in the mainstem middle Deschutes River from the city of Bend downstream to Big Falls. Non-Federal water storage and diversion facilities similarly contribute to a net reduction in flows, due to the complex hydrology of the basin.

According to modeling results, storage of Reclamation project water along with any private storage have decreased winter streamflows. Diversion of natural flows has decreased flows during the irrigation season. Even so, spring inflows to the Deschutes River upstream from Lake Billy Chinook help ameliorate the effects of project caused flow reductions in the river and dilute potential nutrients and agricultural chemicals contained in irrigation return flows. Flows and water quality in this lower reach of the middle Deschutes River appear to be adequate, even during drought years, as evidenced by use of bull trout as far upstream as Big Falls, a natural barrier, and also provide bull trout access to lower Squaw Creek. The State of Oregon instream flow recommendations of 250 cfs year round are also met in this reach where bull trout occur (Marx 2003).

Table 6-4. Modeled Daily 50 Percent Exceedances for Streamflow in the Middle Deschutes River Near Culver, OR, (by month, in cfs)

Culver, OR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
With Reclamation	1254	1555	1312	774	549	571	525	516	568	774	1116	1252
Without Reclamation	1633	1732	1612	1206	810	762	574	592	774	1396	1751	1721
% Δ Q	-23.2	-10.2	-18.6	-35.8	-32.2	-25.1	-8.5	-12.8	-26.6	-44.6	-36.3	-27.3

Reclamation has been actively working with the DRC to fund and carry out several water conservation projects in Squaw Creek, Crooked River, and the Deschutes River to improve habitat and flows for bull trout, resident fish, and potentially for future reintroduction of anadromous fish. Other conservation projects have improved flows and water quality of Tumalo Creek and the middle reach of the Deschutes River.

Storage and diversion of flows on the Deschutes and Crooked Rivers do not significantly affect the levels of Lake Billy Chinook as this is a run-of-the-river operation. Operation of the Pelton-Round Butte Hydroelectric Project has the major influence on water quantity in Lake Billy Chinook and its tributary arms. Minor daily fluctuations help sustain lake levels to the benefit of bull trout by minimizing entrainment of kokanee and zooplankton. Even with the winter season drawdown of the lake for flood control, there appears to be adequate water surface and volume to provide for the increasing bull trout population in Lake Billy Chinook.

Return flows from irrigated project lands add nutrients, bacteria, and agricultural chemicals into Lake Billy Chinook via the Deschutes and Crooked River inflows. While these pollutants are diluted by large spring inflows, they do reduce the overall water quality of the lake, which is generally good, but which experiences seasonal algal blooms. However, there is no indication to date that water quality of Lake Billy Chinook is adversely affecting bull trout populations in the lake.

Overall, these project and nonproject influences, especially in the lower reaches of the middle Deschutes River basin, likely do not negatively influence adult and subadult bull trout.

6.4.2.2 Effects Conclusion

Reclamation project operations have no effect on the Metolius River subbasin spawning, rearing, and fluvial habitats of bull trout because there are no Reclamation facilities in the Metolius River nor its tributaries. Project operations may affect, but are not likely to adversely affect bull trout from Lake Billy Chinook upstream to Big Falls in the Deschutes River.

Reclamation does not anticipate any incidental take of bull trout in the middle Deschutes River associated with the continued operation of Reclamation facilities.

6.4.3 Lower Deschutes River Subbasin

6.4.3.1 Effects Analysis

Hydrologic modeling of flows in the Deschutes River basin was conducted by Reclamation and is described in Section 6.2. The model calculated a hydrologic baseline with Reclamation's proposed action and without its proposed action for daily mean flows on a monthly basis, and provided the information to illustrate percent exceedance curves for the USGS streamflow gage near Madras, Oregon just downstream from Pelton Reregulating Dam. Table 6-5 shows modeled 50 percent exceedances by month for "with Reclamation" and "without Reclamation" conditions and the percent difference in the streamflow near Madras.

Table 6-5. Modeled Daily 50 Percent Exceedances for Streamflow in the Lower Deschutes River Near Madras and at Moody, OR. (by month, in cfs)

Madras, OR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
With Reclamation	5395	5548	5070	5090	4399	4181	4212	4074	4007	4201	4635	5144
Without Reclamation	5652	6001	5931	5822	4734	4231	4119	3963	3999	4593	5208	5526
% Δ Q	-4.5	-7.5	-14.5	-12.6	-7.1	-1.2	+2.3	+2.8	+0.2	-8.5	-11.0	-6.9
Moody, OR												
With Reclamation	6586	7557	6734	6894	5954	5091	4745	4506	4465	4742	5454	5987
Without Reclamation	6996	7769	7491	7408	6120	5148	4714	4362	4518	5155	5904	6421
% Δ Q	-5.9	-2.7	-10.1	-6.9	-2.7	-1.1	+0.7	+3.3	-1.2	-8.0	-7.6	-6.8

The proposed action reduces modeled streamflows at the Madras gage for 9 months of the year, except for July, August, and September. During July, August, and September, the proposed action increases modeled streamflows slightly. At the 50 percent exceedance level, the decrease in modeled flows under the proposed action ranges from 1.2 to 14.5 percent for these 9 months, and is greater than 10 percent in November, March and April. The increase in modeled flow during these months ranges from 0.2 percent to 2.8 percent.

Generally, these modeled flow changes reflect periods when Reclamation, under the proposed action, is storing or releasing water. These seasonal reductions in flow coupled with increased air temperature and other variables, may contribute to reduced water quality conditions (e.g., increased water temperatures) in the mainstem lower Deschutes River. Non-Federal water storage and diversion facilities have similarly contributed to a net reduction in flows, due to the complex hydrology of the basin. Modeled results indicate storage of project water along with any private storage decrease winter streamflows. Diversion of natural flows decreases flows during the irrigation season. Even so, flows in the lower Deschutes River are remarkably uniform and stable (Fassnacht et al. 2002), and in most cases the modeled change in flow is within the general accepted accuracy range of streamflow gages, i.e., about 10 percent.

Project operation and maintenance activities have no effect on bull trout spawning tributaries in the lower Deschutes River subbasin mentioned above. Flows and water quality in the lower Deschutes River are primarily driven by the operation of the Pelton-Round Butte Complex and partially ameliorated by downstream surface and groundwater inflows. Natural warming of the river as it flows downstream is also a factor, especially in the summer months, when flows are somewhat reduced. Overall, these project and nonproject influences, especially warmer water temperatures in the lower Deschutes River downstream of Madras, may influence fluvial bull trout. However, the timing of these warmer water temperatures is typically when lower Deschutes River adult fluvial bull trout are in tributary streams that provide cooler water.

Therefore, the impacts, if any, would be minimal to adult bull trout. Impacts to subadult bull trout in the lower Deschutes River are unknown. However, any potential impacts are likely minimal based on an estimated increase in bull trout spawning populations for Shitike Creek and the Warm Springs River, plus the ability of bull trout to seek out suitable habitat.

Reclamation has been actively working with DRC to fund and carry out conservation projects in the Warm Springs River, Trout Creek, Mack's Canyon, and other subbasins of the lower Deschutes River to improve water quality, habitat, and flows for resident and anadromous fish.

Bull trout are not found in the White River subbasin (possibly because of the natural turbidity of the river caused from the suspension of glacial flour; natural barrier in the lower river; and warmer waters of the lower river); therefore, bull trout are not influenced by operation of Wasco Dam and Reservoir on Clear Creek, an upper tributary of the White River.

6.4.3.2 Effects Conclusion

Reclamation project operations may affect, but are not likely to adversely affect bull trout in the lower Deschutes River. Reclamation does not anticipate any incidental take of bull trout in the lower Deschutes River associated with the continued operation of Reclamation facilities.

6.4.4 Crooked River Subbasin

6.4.4.1 Effects Analysis

Operation of project facilities at Prineville and Ochoco Reservoirs would have no effect on existing bull trout populations; only the lower Crooked River below Opal Springs Dam supports wandering Metolius basin bull trout in the lower Crooked River subbasin. See the analysis in Section 6.4.2 "Middle Deschutes River Subbasin" for a description of effects on bull trout in the lower few miles of the Crooked River and in the Crooked River arm of Lake Billy Chinook. Unknown numbers of bull trout are found in the lower Crooked River, from Lake Billy Chinook to Opal Springs Dam that are a component of the Metolius River bull trout population. According to Gannett (2001), groundwater discharge of over 1,000 cfs occurs in this reach, providing suitable rearing habitat for Lake Billy Chinook bull trout. This groundwater discharge into the lower Crooked River results in instream flows that exceed State of Oregon instream flow recommendations from Opal Springs to Lake Billy Chinook.

Reclamation has partnered with DRC and National Fish and Wildlife Foundation to provide funding for conservation projects in the Crooked River subbasin to improve water quality and habitat, and has constructed new fish screen facilities at the Crooked River Project main diversion facility.

6.4.4.2 Effects Conclusion

Reclamation project operations may affect, but are not likely to adversely affect bull trout in the Crooked River.

Reclamation does not anticipate any incidental take of bull trout in the Crooked River associated with the continued operation of Reclamation facilities.

6.5 MIDDLE COLUMBIA RIVER STEELHEAD

6.5.1 Effects Analysis

Historic hydrologic conditions are described and hydrologic modeling of streamflows in the Deschutes River basin were conducted by Reclamation (see Chapter 3 and Section 6.2, respectively). The hydrologic model calculated daily mean streamflows on a monthly basis with Reclamation projects operating and without Reclamation. This information was used to produce percent exceedance curves for streamflow near Madras, Oregon, just downstream from Pelton Reregulating Dam, and at Moody, Oregon. Table 6-5 shows modeled 50 percent exceedances for each month near Madras and at Moody for the “with Reclamation” and the “without Reclamation” modeled scenarios, and the percent difference in the streamflow at those locations. Table 6-5 shows that Reclamation’s proposed action reduces modeled downstream flow for 9 months of the year at the Madras gage and for 10 months of the year at Moody.

The proposed action reduces modeled streamflows near Madras for 9 months of the year, except for July, August, and September. At the 50 percent exceedance level, the proposed action decreases modeled flows near Madras ranging from 1.2 to 14.5 percent and are greater than 10 percent in November, March, and April, with an average 8.2 percent decrease for the 9-month period. During July, August, and September, the proposed action increases modeled streamflows slightly. Increased modeled flows near Madras range from 0.2 to 2.8 percent for these 3 months.

Generally, these modeled flow changes reflect periods when Reclamation, under the proposed action, is storing or releasing water. These seasonal reductions in flow may contribute to reduced water quality conditions in the mainstem lower Deschutes River, but the reductions generally occur during periods when ambient air temperatures are less likely to adversely affect water temperatures. However, as shown in Table 5-12, weekly water temperatures for a 17-year period are lower than the ODEQ water temperature criterion for salmonid fish rearing. Non-Federal water storage and diversion facilities similarly contribute to a net reduction in flows, which generally follow the same seasonal scenario of storing and releasing water.

Modeled hydrologic results indicate storage of Reclamation project water decreases winter streamflows. Diversion of natural flows decreases river flows during the irrigation season. Even so, flows in the lower Deschutes River are remarkably uniform and stable (Fassnacht et al. 2002), and in most cases the modeled change in flow is within the generally accepted accuracy range of streamflow gages, i.e., about 10 percent. Table 5-3 of historic flows shows that the average end-of-month streamflow for the period 1990-2001 meet or exceed the recommended instream flows. Table 6-5 depicting modeled streamflows under "with Reclamation" and "without Reclamation" conditions, indicates recommended instream flows are met or exceeded at the 50 percent exceedance levels.

Project operation and maintenance activities have no effect on the steelhead spawning tributaries in the lower Deschutes River subbasin mentioned above since no Reclamation projects occur there, with the possible exception of the White River. However, steelhead spawning and rearing in this short 2-mile reach of river below the 150-foot-high falls has not been documented by ODFW (Pribyl 2002). Flows and water quality in the lower Deschutes River are modified and controlled in large part by the operation of the Pelton-Round Butte Hydroelectric Project and are partially ameliorated by downstream surface and cooler groundwater inflows. Natural warming of the river as it flows downstream occurs, especially in the summer months when flows are somewhat reduced (Aney et al. 1967), but this is not a result of Reclamation operations.

The Wapinitia Project on Clear Creek, a tributary of the White River, utilizes Wasco Dam for storage of some irrigation water. The project has natural flow water rights that are supplemented by water from Clear Lake. During winter nonirrigation months, storage is accruing to Clear Lake and flows in the White River and to the Deschutes River are reduced by a maximum of 102 cfs in February. During the irrigation season, there is an average increase of 6 cfs to the Deschutes River flow (Appendix C).

Streamflow gages in the lower Deschutes River were installed only near Madras and at Moody. Modeled exceedance values near Madras and at Moody indicate flows are at least 3,100 cfs and 3,500 cfs, respectively. The calculated increase of 6 cfs to the Deschutes River from the White River is about 0.2 percent of the flow measured at Madras and is negligible. Change in flow in the lower Deschutes River attributable to the Wapinitia Project and storage in Wasco Dam is barely measurable, and within the range of accuracy of streamflow gages. Over time, return flows offset some of the water diverted upstream. However, the additional non-Federal upstream agricultural diversions could affect flows during the 1 May to 1 October irrigation season. Data are unavailable to determine the extent of any affect from non-Federal irrigation. But despite these unquantifiable effects on flow in the White River, there is still substantial flow in the lower Deschutes River as indicated by streamflow measurements at the USGS Moody gage (Table 5-3).

ODFW has not documented use of the lower 2-mile reach of the White River by steelhead. The water quality of this 2-mile reach of river is affected by the natural turbidity of the river caused by the suspension of glacial flour, some sediments carried into the river by agricultural return flows, and naturally warming conditions. The White River below Lower Falls is listed as exceeding the water temperature criterion of 64°F (17.8°C) for anadromous salmonids for 100, 58, and 72 days in 1992, 1993, and 1994, respectively. The White River at the National Forest boundary exceeded the 64°F (17.8°C) water temperature criterion for 45 and 3 days in 1992 and 1994, respectively. Clear Creek, at a USFS site at Road 42, exceeded the water temperature criterion for an unspecified length of time in 1995 (Oregon's Final 2002 303(d) List; http://www.deq.state.or.us/wq/WQLData/View303dList02.asp). Reclamation has been working with the JFDIC to improve irrigation efficiencies, reduce return flows, and improve water quality on Wapinitia Project lands. The trend toward sprinkler irrigation in the basin will improve efficiency and help reduce water quality effects of agricultural practices.

Reclamation has been actively working with the DRC to fund and implement conservation projects in the Warm Springs River, Trout Creek, Mack's Canyon, and other subbasins of the lower Deschutes to improve water quality, habitat, and flows for resident fish and wild steelhead. Cooperative projects are also being planned and carried out in the upper basin, e.g., Squaw Creek and Crooked River subbasins, to improve habitat conditions for resident fish and the potential reintroduction of anadromous fish.

The NMFS habitat matrix was used as a general guide to describe and discuss some habitat features as part of the environmental baseline for steelhead ESU in the lower Deschutes River. Table 6-6 summarizes these conditions where we had sufficient data and notes the effects of the proposed action. In general, operation of Reclamation's projects in the Deschutes River subbasin has no discernable effect on steelhead habitat in the lower Deschutes River.

Table 6-6. NMFS Matrix Checklist Documenting Environmental Baseline and General Effects of Reclamation's Operations on MCR Steelhead in the Lower Deschutes River.

PATHWAYS	ENVIRONMENTAL BASELINE			EFFECTS OF ACTIONS		
Indicators	Properly Functioning	At Risk	Not Properly Functioning	Restore	Maintain	Degrade
Water Quality Temperature		✔			✔	
Sediment/Turbidity		✔			✔	
Chem. Contaminants/ Nutrients		✔			✔	
Habitat Access Physical Barriers	✔				✔	
Habitat Elements Substrate		✔			✔	
Large Woody Debris		✔			✔	
Pool Frequency	UNK			UNK		
Pool Quality	UNK			UNK		
Off-channel Habitat	N/A			N/A		
Refugia	✔				✔	
Channel Conditions and Dynamics Width/Depth Ratio	✔				✔	
Streambank Condition		✔			✔	
Floodplain Connectivity	✔				✔	
Flow/Hydrology Change in Peak/Base Flows	✔				✔	
Increase in Drainage Network	N/A			N/A		
Watershed Conditions Road Density and Location	✔				✔	
Disturbance History		✔			✔	
Riparian Reserves	UNK			UNK		

UNK = unknown

N/A = not applicable

See narrative of indicators in Section 5.4.2.2.

6.5.2 Effects Conclusion

Reclamation projects in the Deschutes River basin have resulted in an average reduction of 8.2 percent in modeled 50 percent exceedance streamflows near Madras, just downstream from Pelton Reregulating Dam, for the period October through June. The reduction in modeled 50 percent exceedance streamflows during this 9-month period ranges from 1.2 to 14.5 percent (50 cfs in June to 861 cfs in March). Conversely, during July, August, and September, modeled 50 percent exceedance streamflows increase for the proposed action, ranging from 0.2 percent in September to 2.8 percent in August (Table 6-5). The 861 cfs (14.5 percent) reduction in modeled 50 percent exceedance streamflow in March reflects storage to project reservoirs, while the late summer increase in modeled streamflows reflects some return flows from springs in the area upstream from the Madras streamflow gage.

The overall effects of Reclamation's proposed action in the lower Deschutes River subbasin (i.e., annual altered modeled streamflows ranging from -14.5 to +2.8 percent, averaging -5.7 percent) on the Deschutes River component of the MCR steelhead ESU appear to be negligible. Much of the Deschutes River steelhead spawning habitat occurs in the numerous eastside and westside tributaries where adverse effects on the fish caused by passage at two mainstem Columbia River dams; the Pelton-Round Butte Hydroelectric Project dams that block access to historically occupied habitat upstream; the potential adverse effects of out-of-basin, out-of-ESU hatchery strays spawning with wild Deschutes River steelhead; and the potential adverse ecological interactions between wild and hatchery-origin steelhead have a greater impact than Reclamation's upper Deschutes River projects. A small portion of Deschutes River steelhead spawn in the upper reaches of the mainstem lower Deschutes River. Inasmuch as these factors and environmental conditions considered together have adverse effects on steelhead life stages, Reclamation's proposed action will slightly reduce modeled 50 percent exceedance streamflows for 9 months of the year, with an unquantifiable but likely insignificant effect on wild steelhead stocks in the lower Deschutes River.

Population abundance of both wild and hatchery Deschutes River steelhead has increased in recent years. Historic streamflows in the ESA-defined environmental baseline as well as the modeled 50 percent exceedance streamflows in the "with Reclamation" and "without Reclamation" scenarios exceed the annual recommended streamflows (Aney et al. 1967). Annual water temperatures meet the ODEQ water temperature criterion of 64°F (17.8°C) for anadromous salmonids except for a period in the summer as measured near the mouth of the river at the Moody gage. Any effect of Reclamation's proposed action on wild MCR steelhead in the lower Deschutes River is substantially outweighed by the numerous other factors listed above. It is Reclamation's determination that Reclamation's proposed action, the continued operation and maintenance of Reclamation projects in the Deschutes River basin, may affect, but is not likely to adversely affect, listed wild MCR steelhead stocks in the Deschutes River basin.

6.6 CANADA LYNX

6.6.1 Effects Analysis

Reclamation project O&M activities that could possibly have an effect on Canada lynx include reservoir drawdowns and clearing dam surfaces of vegetation that could be potential snowshoe hare habitat. However, reservoir fluctuations do not affect the surrounding habitat above the maximum high-water line where lynx and hare might occur, and dam surfaces are cleared on a routine basis and do not provide suitable habitat for hare.

Recreational opportunities created by reservoirs increase human activity within reservoir areas. Human presence and activity may limit the use of the reservoir shoreline and adjacent lands by lynx, if present. However, research into concerns that human activity negatively impacts resident lynx populations has shown that lynx tolerate some level of human disturbance (USFWS 2000a). As the USFS manages recreational activities in the Clear Lake, Crane Prairie and Wickiup areas, they are the agency responsible for consulting with USFWS on any potential recreational impacts.

6.6.2 Effects Conclusion

If Canada lynx are indeed present in the action area, there would be no impact to this species by Reclamation project O&M activities. Project O&M does not include alteration of any potential lynx habitat, and snowshoe hare and other small mammal species comprising lynx diet are not affected by project O&M. Therefore, the proposed action would have no effect on Canada lynx.

6.7 NORTHERN SPOTTED OWL

6.7.1 Effects Analysis

Reclamation project O&M activities that could possibly have an effect on northern spotted owls include reservoir drawdowns and removal of vegetation from dam surfaces and along reservoir shorelines and canals. However, reservoir fluctuations do not affect the surrounding habitat above the maximum high-water line where spotted owl nesting, roosting, and foraging territories are located. As northern spotted owls do not prey on aquatic species, reservoir drawdowns do not affect their prey base, nor are the owls attracted to reservoirs. In addition, northern spotted owls do not rely on habitat that is routinely cleared from the dam surfaces, reservoir shorelines, and canal margins.

Recreational opportunities created by reservoirs increase human activity within reservoir areas. No evidence exists to determine whether or not this increased activity negatively impacts the northern spotted owl. However, it has been found that despite being a secretive species, the northern spotted owl is relatively unafraid of human beings. Additionally, northern spotted owls are nocturnal, and recreational activity drops significantly at night (Federal Register 55:26114). The USFS biological assessments do mention the possibility of effects by human activity, stating that USFS actions within ¼-mile of northern spotted owl nesting, roosting, and foraging areas that exceed ambient (background) levels during the time period between March 1 and September 30 require USFWS consultation (Jeffries 2002). Further, as the USFS is the agency managing recreational activity on land surrounding Clear Lake, Crane Prairie, and Wickiup Reservoirs, they are the agency responsible for consulting on potential recreational impacts.

Reclamation project O&M activities have been ongoing and unchanged from the time the northern spotted owl was listed in 1990. The current existing northern spotted owl population status takes into account these ongoing actions, and it would appear there is no adverse effect (Jeffries 2002).

6.7.2 Effects Conclusion

Although numerous northern spotted owl nesting, roosting, and foraging territories occur near Reclamation projects within the Deschutes River basin, northern spotted owls do not forage on fish or other aquatic species that would attract them to Reclamation project reservoirs, nor is their prey base affected by project O&M activities. In addition, northern spotted owls do not depend on habitat provided by Reclamation project facilities, including dams and reservoirs. Therefore, Reclamation project O&M activities would have no effect on northern spotted owls.

CHAPTER 7.0 CUMULATIVE EFFECTS

7.1 INTRODUCTION

Cumulative effects are those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (USFWS and NMFS 1998).

7.2 POPULATION GROWTH

Most future cumulative actions in the Deschutes River basin may be associated with an increasing population. The Deschutes River basin population increased dramatically through the early 1900s with the improvements in irrigation facilities, then remained steady or increased at moderate levels up to the mid-1900s (Reclamation and OWRD 1997). Most of these people are in the upper basin. Even people who do not rely upon the agricultural industry for their livelihoods still rely upon storage reservoirs and river systems for domestic and industrial water supplies, food, and recreation. From 1970 to 1990 there was a dramatic increase in population centered around the major cities, especially Bend and Redmond. Deschutes County more than doubled in population during this period and continues to grow at a higher than average rate. The area's beauty, lifestyle, land values, and other positive "pull" factors have attracted many new residents, resulting in growth unusual in a small, rural county without major industrial development. Tourism and recreation have also become a major industry in the basin.

The increasing population and associated housing developments and increased services may not directly influence ESA-listed species and their habitats in the basin. However, there may be indirect effects related to a decrease in water quality and more disturbance to biological and ecological needs of the species, as described below.

7.3 RECREATION

The demand for recreational opportunities in the Deschutes River basin is expected to increase (CTWSRO 1999). Much of the water-based recreation in the Deschutes River basin is focused on the lakes formed by storage dams. Reservoir and stream fishing and boating account for much of this water-based recreation. Rafting and canoeing on Wild and Scenic River sections located downstream of many of the major dams are increasingly important recreational endeavors in the basin. Recreation interests pressure state and Federal agencies to maximize water conditions, streamflows, and reservoir pool elevations for recreation.

Other than at access points and public use locations, increased recreation would seldom have adverse impacts on ESA-listed species. These desires may not be compatible with operations for irrigation or power production, and conflicts can arise. The indirect impacts of recreation include water quality degradation that results from constructing access to rivers and streams. Access points to recreation areas, ski resorts, boat docks, marinas, launch ramps, trails, hunting and fishing areas, can impact the habitat of listed species by degrading water quality, introducing noxious or competitive pest species, and can directly or indirectly interfere with species biological or ecological needs.

7.4 Non-Federal Land Management Practices

The effects of land management practices involving grazing, timber harvest, mining, or recreational uses, will continue to influence the respective watersheds in the basin by affecting land surfaces, water retention and runoff, and water quality of surface water and groundwater (USDA and USDOI 2000).

State, county, and local zoning ordinances and comprehensive plans may help ameliorate the adverse effects from land-use practices and developments directly or indirectly affecting streams and other water bodies.

The Warms Springs Reservation lands are managed under the Tribes' integrated resource management plans (CTWSRO 1999 and 2000). In these plans, the Tribes have designated management goals for specified land areas. The objective of these goals is to protect and conserve natural resource values of the reservation lands for the benefit of tribal members and provide recreational opportunities for the general public at specified sites.

7.5 Water Supply

Additional large-scale irrigation developments are not anticipated in the Deschutes River basin. Future irrigation needs center mainly around the continued demand for hobby farm and ranchette types of development. Some of these needs may be provided by existing infrastructure and water rights. In areas where there is no existing source of water, and/or no means of conversion, there will be more demand on groundwater supplies through drilling of wells.

The demand for increased and a more stable water supply for local communities is expected to continue as residential areas expand. Conversions of agricultural land to residential space will also create more demand for sustained municipal water supplies.

Water conservation measures are expected to be pursued in the basin by local governments and private irrigation companies in a continued effort to stretch water supplies and reduce costs of operation (Reclamation and OWRD 1997). Lining and piping of irrigation canals and farm laterals have been a growing interest in the basin and is expected to continue.

As demands increase in the basin, there is the potential for further depletions of stream flows. This may especially be the case as groundwater resources are reduced through 1) more well development and 2) implementation of conservation projects, which have the potential to reduce groundwater recharge, therefore, reducing contributions to spring discharge to the middle and lower Deschutes River.

The State of Oregon has put into effect several measures that may help ameliorate or counteract the effects which future water demands and conservation measures could have on streamflows.

> *"The Allocation of Conserved Water Program is a voluntary activity that provides benefits to both water right holders and instream values. The law allows a water user who conserves water to use a portion of the conserved water on additional lands, lease or sell the water, or dedicate the water to instream use…In exchange for granting the user the right to "spread" a portion of the conserved water to new uses, the law allocates a portion to the state for instream use. After mitigating the effects on any other water rights, the Water Resources Commission allocates 25 percent of the conserved water to the state (for an instream water right) and 75 percent to the applicant, unless the applicant proposes a higher allocation to the state or more than 25 percent of the project costs come from Federal or state non-reimbursable sources." (OWRD 1999)*

If public funding is used to complete the project, the allocation for instream use may go as high as 75 percent, depending on the percent of non-repayable public funding.

In a March 2001 published report, the OWRD and USGS determined a hydraulic connection between groundwater and surface water existed in the Deschutes River basin. To address this issue, the Oregon Legislature passed HB 2184 giving the Oregon Water Resources Commission the authority to create a system of mitigation credits under existing Department programs and to adopt rules to recognize local mitigation banks to facilitate transactions of mitigation credits.

In 2002, the Oregon Water Resources Commission adopted Deschutes Basin Groundwater Mitigation Rules to be administered by the OWRD (See OAR 690-505.0600.) These rules require applicants for new groundwater permits in the Deschutes River basin to mitigate its consumptive use by restoring streamflows equal to the consumptive use. The OWRD will limit the issuance of new groundwater permits not to exceed a cumulative total of 200 cfs.

The Oregon Water Resources Commission also adopted rules to establish a mitigation bank in the Deschutes River basin (see OAR 690-521-0100). The rules define the process to recognize and establish mitigation banks and establish, obtain, and assign mitigation credits. The DRC has applied with the Oregon Water Resources Commission and been approved as a charted entity to manage the mitigation bank in the Deschutes River basin. The mitigation credit and banking program's intent is to mitigate the impacts of new groundwater uses on surface water rights and scenic waterway flows in the lower Deschutes River and prevent any reductions in instream flows in the basin from additional groundwater pumping.

7.6 WATER QUALITY

M&I water usage can result in water quality degradation. Perhaps the greatest effect from future M&I water use may be the increased wastewater return flows that could add to the nutrient and bacteria loads in stream sections that have depleted flows. The total impact of a growing population on water quality are cumulative and would add to impacts coming from ongoing and future economic development sectors such as logging, food processing, sand and gravel mining, mineral mining, and grazing. Most discharge related to point source activities are regulated under the NPDES permitting program.

Water quality in the Deschutes River basin is managed by the State of Oregon under a framework provided in the Clean Water Act (CWA). The State of Oregon promulgates water quality standards in the Deschutes River basin for specific physical and chemical parameters in order to provide suitable conditions for the support of the recognized beneficial uses.

Section 303(d) of the CWA requires states to identify and develop a list of waters for which water quality is inadequate to fully support beneficial uses. The states then use the list to develop and implement water quality management plans, including pollutant load allocations. These water quality management plans and pollutant load allocations, commonly called Total Maximum Daily Load (TMDL), is scheduled for completion in 2005 for the Deschutes River basin.

Through an EPA and State of Oregon effort, the establishment of TMDLs are scheduled for completion in 2003 for the upper Deschutes River subbasin, 2004 for the lower and upper Crooked subbasins, and 2006 for the Lower Deschutes River subbasin. Oregon must develop these TMDLs to define pollutant discharge targets and responsibilities of point and non-point source contributors in achieving water quality goals. Activities associated with TMDL implementation should contribute to long-term improvements in the water quality of the Deschutes and Crooked Rivers by reducing point and non-point source pollutant loads. (http://www.deq.state.or.us/wq/TMDLs/TMDLs.htm)

Another program which may help to maintain or improve water quality in urban areas of the basin is EPA's Phase II Stormwater regulations. The Phase II regulations apply to smaller communities/cities requiring them to manage their stormwater (through the NPDES permit process) where they were not regulated in the past. This should reduce the amount of untreated stormwater from urban areas entering streams and rivers (http://cfpub.epa.gov/npdes/stormwater/swphase2.cfm?program_id=6).

7.7 WATERSHED RESTORATION

There has been a wide variety of ongoing conservation and restoration programs in the Deschutes River basin which promote improvements in instream flows and restoration of riparian ecosystems.

Currently, the Oregon Watershed Enhancement Board provides funding through a small grant program for watershed restoration and enhancement projects on forest, agricultural, range, urban, and rural residential lands that use existing technical guidance (OWEB 2003).

The DRC also provides matching funds for restoration projects throughout the basin, striving to improve Deschutes River basin water quality and quantity through on-the-ground restoration projects. Anyone is eligible for DRC support. The DRC has funded projects from watershed councils, irrigation districts, private landowners, tribes, soil and water conservation districts, environmental organizations, state and Federal agencies, and local businesses (DRC 2003).

The DRC is also working with the Deschutes Basin Coordination Group, a 16-party consortium of private, Federal, state, and tribal interests, to produce a comprehensive watershed restoration plan for the Deschutes River basin. The plan will be submitted to the Northwest Power Planning Council for adoption as a subbasin plan under the Council's Fish and Wildlife Program. The plan will follow the subbasin planning guidance adopted by the Council and will also be submitted to the OWEB for consideration and adoption by OWEB as the goals and priorities for watershed restoration in the Deschutes Basin under ORS 541.371(1)(c) [www.nwppc.org/fw/subbasinplanning/deschutes].

Local governments (e.g., soil and water conservation districts), private entities (e.g., watershed councils), and tribal efforts are expected to continue in supporting programs that benefit listed species. They will continue to participate with state and Federal agencies throughout the basin to implement ecological restoration measures which would incrementally improve instream flows and restore riparian ecosystems.

7.8 OREGON BULL TROUT STRATEGIES

By 1996, restrictive angling regulations (catch and release/no harvest) protected most bull trout populations throughout the State of Oregon. Statewide stocking of non-native brook trout has been discontinued in locations where ODFW managers believe they could migrate downstream and potentially interact with native bull trout. Also, hatchery stocking of legal-sized rainbow trout for recreational fisheries has been discontinued by ODFW managers in most locations near bull trout populations to reduce the incidental catch of bull trout.

In 1997, ODFW published a report titled “Status of Oregon’s Bull Trout; Distribution, Life History, Limiting Factors, Management Considerations, and Status” (Buchanan et al. 1997). This document summarized the best scientific information presently available for bull trout throughout Oregon and reviewed their historical and current status, in addition to providing management considerations for the maintenance and recovery of existing bull trout populations.

The State of Oregon has established a collaborative approach to restoration and protection of bull trout populations and their habitat by making use of local working groups comprised of fishery biologists, land managers, aquatic scientists, and concerned citizens to develop basinwide strategies for the protection and conservation of bull trout. These strategies will be incorporated into local watershed and regional ecosystem management plans, as well as Federal ESA recovery plans.

ODFW recommends that working groups focus their conservation and restoration efforts on the identification of factors limiting individual bull trout populations and then prioritize strategies to address these factors. These groups have played an integral part in recommending recovery measures, through the USFWS’ recovery planning effort.

7.9 OREGON PLAN FOR SALMON AND WATERSHEDS

As early as 1996, the Governor of Oregon launched the Coastal Salmon Restoration Initiative to help preserve and restore native coastal salmon and steelhead populations throughout the State. The State of Oregon through this program developed the “Oregon Plan” (www.oregon-plan.org) which is a conservation plan designed to restore salmon to a level at which they can once again be a part of people's lives (Oregon 1998). The emphasis is on coho salmon in coastal river basins. However, it is a model that will expand to include all salmon and trout throughout the state, including MCR steelhead. While the plan focuses on the needs of salmon, it will conserve and restore crucial elements of natural systems that support fish, wildlife, and people. No other state has ever attempted such a comprehensive program.

The Oregon Plan involves the following:

1. Coordination of effort by all parties (including government agencies such as Reclamation),
2. Development of action plans with relevance and ownership at the local level,
3. Monitoring progress, and
4. Making appropriate corrective changes in the future.

7.10 ODFW Fisheries Management Plans

The ODFW has prepared fisheries management plans, adopted by the Oregon Fish and Wildlife Commission, which establish policy and action items for the management and conservation of fisheries resources in the upper and lower Deschutes River, Crooked River, and Metolius River subbasins (See Fies et al. 1996a, ODFW 1997, Stuart et al. 1996, Fies et al. 1996b). These plans provide directions for specific fish species and waterways and include objectives to guide habitat maintenance or improvements and restoration of anadromous fish (Chinook salmon, sockeye salmon, and summer steelhead) and bull trout into historic ranges within the basin. Action items include restoration of fish passage, biological monitoring, enforcement actions, as well as hatchery fish stocking regimes, angling regulations, and maintenance of public angling access.

Consistent with the plans' objectives, ODFW has pursued improving fish passage at barriers within the Deschutes River basin. Specifically, it has worked with the Deschutes Valley Water District and other entities to examine construction of a fish ladder at the Opal Springs Dam to allow anadromous fish and bull trout to migrate up and downstream.

The ODFW is currently amending these fisheries management plans to provide additional direction for reintroduction of anadromous fish above the Pelton-Round Butte hydropower complex (Kunkel 2003). ODFW is developing draft administrative rules for approval by the Oregon Fish and Wildlife Commission and for subsequent comment by the public.

7.11 SUMMARY OF POTENTIAL CUMULATIVE EFFECTS ON LISTED SPECIES

7.11.1 Bald Eagle

- Degradation of potential breeding and nesting habitat could occur from future development and land practices on state and private lands, but most of the available habitat for the bald eagle is on Federal lands where habitat values would most likely be preserved.
- Increased number of recreationists and recreational pursuits in forested habitats may result in more disturbance to the breeding, reproductive, and foraging habits of the bald eagle.
- Future stream depletions and degradation of water quality could impair the habitat of the fish and waterfowl prey species.
- Ongoing stream and riparian restoration measures, TMDL processes, State of Oregon statutes and regulations, and other conservation activities in the basin would help ameliorate or reduce any adverse future effects on streamflows and water quality.

7.11.2 Bull Trout

- Future stream depletions and degradation of water quality could impair the habitat of fluvial and adfluvial bull trout populations.
- Ongoing stream and riparian restoration measures, TMDL processes, State of Oregon statutes and regulations, and other conservation activities in the basin would help ameliorate or reduce any adverse future effects on streamflows and water quality.
- Continued programs promoted under the Oregon Bull Trout Strategies, in conjunction with Federal recovery efforts, would help preserve and possibly improve habitat conditions for Deschutes River basin bull trout populations.

7.11.3 Steelhead

- Future stream depletions and degradation of water quality could impair the habitat of wild Deschutes River steelhead stocks.
- Ongoing stream and riparian restoration measures, TMDL processes, State of Oregon statutes and regulations, and other conservation activities in the basin would help ameliorate or reduce any adverse future effects on streamflows and water quality.

- Continued programs promoted under the Oregon Plan for Salmon and Watersheds, in conjunction with Federal recovery efforts, would help preserve and possibly improve habitat conditions for Deschutes River wild steelhead stocks.

7.11.4 Canada Lynx and Northern Spotted Owl

- Degradation of potential habitat could occur from future development and land practices on state and private lands, but most of the available habitat for these species is on Federal lands where habitat values would most likely be preserved.
- Increased numbers of recreationists and recreational pursuits in forested habitats may result in more disturbance to the breeding, reproductive, and foraging habits of these species.

CHAPTER 8.0 SUMMARY OF EFFECTS

8.1 SUMMARY OF EFFECTS ON LISTED SPECIES

Reclamation's proposed action is continuance of current O&M programs of Reclamation project facilities in the Deschutes River basin as described in the BA. The three projects that are addressed in the BA are: Deschutes Project, Crooked River Project, and Wapinitia Project.

The BA examined the proposed actions effects on ESA-listed species. Effects of interrelated and interdependent actions have also been included in the evaluation. These effects are added to the proposed action's environmental baseline to make a determination of the effect.

Reclamation has determined that the proposed action would have **no effect** on the following threatened species:

- Canada lynx
- Northern spotted owl

Reclamation's analysis shows that the proposed action **may affect, but is not likely to adversely affect** the following threatened species:

- Bald eagle
- Bull trout
- MCR steelhead (Deschutes wild steelhead stocks)

Table 8-1 summarizes the proposed action's effects on ESA-listed species, as described in Chapter 6.

Table 8-1. Summary of Proposed Action Effects on ESA Species Deschutes River Basin, Oregon

Project Location	Occurrence in Project Area	Effects Summary			Description of Anticipated Effects
		No Effect	Not Likely to Adversely Affect	Likely to Adversely Affect	
CANADA LYNX — LISTED THREATENED					
Wickiup and Crane Prairie Reservoirs	Lynx Analysis Unit	X			No effect on upland areas where there may be potential lynx habitat.
NORTHERN SPOTTED OWL — LISTED THREATENED					
Wickiup Reservoir, Crane Prairie Reservoir, and Clear Lake	Critical Habitat Units (CHU) Nesting, Roosting, & Foraging Territories	X X			No effect on upland CHU areas nor on nesting, roosting, & foraging territories.
BALD EAGLE — LISTED THREATENED					
Upper Deschutes River Subbasin: Wickiup & Crane Prairie Reservoirs	Breeding, Nesting & Wintering		X		Number of breeding pairs and nesting success would continue to fluctuate in response to varying environmental conditions as well as reservoir operations. Conditions for wintering eagles would not change.
Deschutes River below Wickiup Reservoir	Breeding, Nesting, & Wintering	X			Flow conditions would not change. Conditions for prey base would remain unchanged. Number of breeding pairs and nesting success would be expected to remain the same. Conditions for wintering eagles would not change.
Middle Deschutes River Subbasin	Breeding, Nesting, & Wintering	X			This population in the Metolius and near Lake Billy Chinook is not affected by the proposed action.

Project Location	Occurrence in Project Area	Effects Summary			Description of Anticipated Effects
		No Effect	Not Likely to Adversely Affect	Likely to Adversely Affect	
Crooked River Subbasin: Prineville Reservoir	Nesting Wintering	X X			Reservoir levels would continue to provide for an adequate prey base. No expected change in nesting or foraging opportunities. There would continue to be an adequate winter foraging base.
Ochoco Reservoir	Wintering	X			Winter reservoir carryover would remain unchanged.
Lower Deschutes River Subbasin: Clear Lake (White River Subbasin)	Breeding & Nesting	X			No change in reservoir operations. No expected change in nesting or foraging opportunities.
Lower Deschutes River	Breeding, Nesting, & Wintering		X		An adequate foraging base would continue in the lower river.
BULL TROUT — LISTED THREATENED					
Upper Deschutes River Subbasin	No longer present	X			NONE
Middle Deschutes River Subbasin: Middle Deschutes River	Adfluvial & fluvial population		X		Project operations would continue to influence flows and water quality, but there would continue to be adequate habitat conditions for the existing population which inhabits the middle Deschutes and Lake Billy Chinook.
Metolius River	Adfluvial population	X			Project operations have no effect on the Metolius River
Crooked River Subbasin: Upper Crooked River	No longer present	X			NONE
Lower Crooked River	Adfluvial population		X		Projects operations would continue to influence flows and water quality, but there would continue to be adequate habitat conditions for the

Project Location	Occurrence in Project Area	Effects Summary			Description of Anticipated Effects
		No Effect	Not Likely to Adversely Affect	Likely to Adversely Affect	
					existing population which inhabits the Crooked River arm of Lake Billy Chinook.
Lower Deschutes River Subbasin	Fluvial population		X		Project operations would continue to influence flows and water quality in the lower Deschutes River, but there would continue to be adequate habitat conditions for the growing population.
MIDDLE COLUMBIA RIVER STEELHEAD — LISTED THREATENED					
Middle Deschutes River Subbasin	No longer present	X			NONE
Crooked River Subbasin	No longer present	X			NONE
Lower Deschutes River Subbasin	Adult and juvenile migrants, adult spawners, juvenile rearing		X		Hydrologic modeling shows that project operations would continue to influence flows in the lower Deschutes River, but overall effects are not likely to adversely affect listed wild steelhead stocks.

CHAPTER 9.0 ESSENTIAL FISH HABITAT

9.1 INTRODUCTION

The Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended by the Sustainable Fisheries Act, requires Federal action agencies to consult with the Secretary of Commerce (i.e., NMFS) regarding any action or proposed action authorized, funded, or undertaken by the agency that may adversely affect EFH identified under the Act. The EFH regulations [50 CFR 600.920(e)(3)] enable Federal agencies to use existing consultation/environmental review procedures to satisfy EFH consultation requirements if they meet the following criteria: 1) the existing process must provide NMFS with timely notification of actions that may adversely affect EFH; 2) notification must include an assessment of impacts of the proposed action as discussed in section 600.920(g); and 3) NMFS must have made a finding pursuant to section 600.920(e)(3) that the existing process satisfies the requirements of section 305(b)(2) of the MSA. Such a finding was made by NMFS on March 28, 2000, as follows:

> *NMFS finds that the existing National Environmental Policy Act (NEPA), Endangered Species Act (ESA), and Fish and Wildlife Coordination Act (FWCA) consulting requirements used by the Bureau of Reclamation (Reclamation) for Federal activities can be used to satisfy the EFH consultation requirements of the MSA provided that NMFS and Reclamation adhere to the following steps: 1) Timely Notification...2) EFH Assessment...3) NMFS Conservation Recommendations... 4) Reclamation's Response... and 5) Dispute Resolution*...(NMFS 2000c).

9.2 DESCRIPTION OF ESSENTIAL FISH HABITAT

> *Essential Fish Habitat means those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. – Magnuson-Stevenson Act § 3*

EFH for the Pacific salmon fishery means those waters and substrate necessary to support a long-term sustainable salmon fishery and salmon contributions to a healthy ecosystem. The Pacific salmon EFH includes all those streams, lakes, ponds, wetlands, and other water bodies currently or historically accessible to salmon in Washington, Oregon, Idaho, and California. The geographic extent of freshwater EFH is specifically defined as all waters currently or historically accessible to salmon within the USGS hydrologic units identified by the Pacific Fishery Management Council (PFMC 1999). Salmon EFH excludes areas upstream from longstanding naturally impassible barriers (e.g., Big Falls on middle Deschutes River), but includes aquatic areas above all artificial barriers except the impassible barriers (dams) specifically listed by Pacific Fishery Management Council (1999), e.g., the Hells Canyon complex on the Snake River.

In the Deschutes River basin, Pacific Salmon EFH includes the hydrologic units as listed in Table 9-1 below.

Table 9-1. Deschutes River Basin, Pacific Salmon EFH Hydrologic Units [1]

Unit #	Hydrologic Unit Name	Species	Current or Historic Distribution
#17070301	Upper Deschutes River	Chinook salmon	Inaccessible Historic Habitat
#17070305	Lower Crooked River	Chinook salmon	Inaccessible Historic Habitat
#17070306	Lower Deschutes River (Barrier = Opal Springs Dam)[2]	Chinook salmon Coho salmon[3]	Current Habitat Current Habitat[3]
#17070307	Trout Creek	Chinook salmon Coho salmon[3]	Accessible but Unutilized Historic Habitat Current Habitat[3]

[1]Taken from PFMC (1999)
Reclamation Notes:
[2]Opal (corrected spelling) Springs Dam is actually on the lower Crooked River (USGS Steelhead Falls Quadrangle)
[3]According to CTWSRO (1999) and Pribyl (2000) coho salmon are neither indigenous nor current inhabitants of the Deschutes Basin.

Chinook salmon EFH overlaps in part the action area of the proposed action. Refer to Chapter 2 of this BA.

9.3 STATUS, LIFE HISTORY, AND HABITAT REQUIREMENTS OF DESCHUTES BASIN SALMON STOCKS

9.3.1 Spring Chinook Salmon

The lower Deschutes River supports both wild and hatchery runs of spring Chinook salmon (*Oncorhynchus tshawytscha*). Spring Chinook salmon of the Middle Columbia River Spring-run ESU are not listed under the ESA. These fish use the lower Deschutes River primarily as a migration corridor, although some spawning does occur and juveniles also use the river as rearing habitat. Wild stocks currently spawn in the Warm Springs River system and Shitike Creek, both tributaries of the lower Deschutes River on CTWSRO tribal lands (Figure 9-1). Hatchery spring Chinook salmon return to the Warm Springs National Fish Hatchery on the Warm Springs River and to the Round Butte Hatchery via the Pelton Fish Trap on the Deschutes River at the Reregulating Dam.

Deschutes River Basin
Spring Chinook Salmon

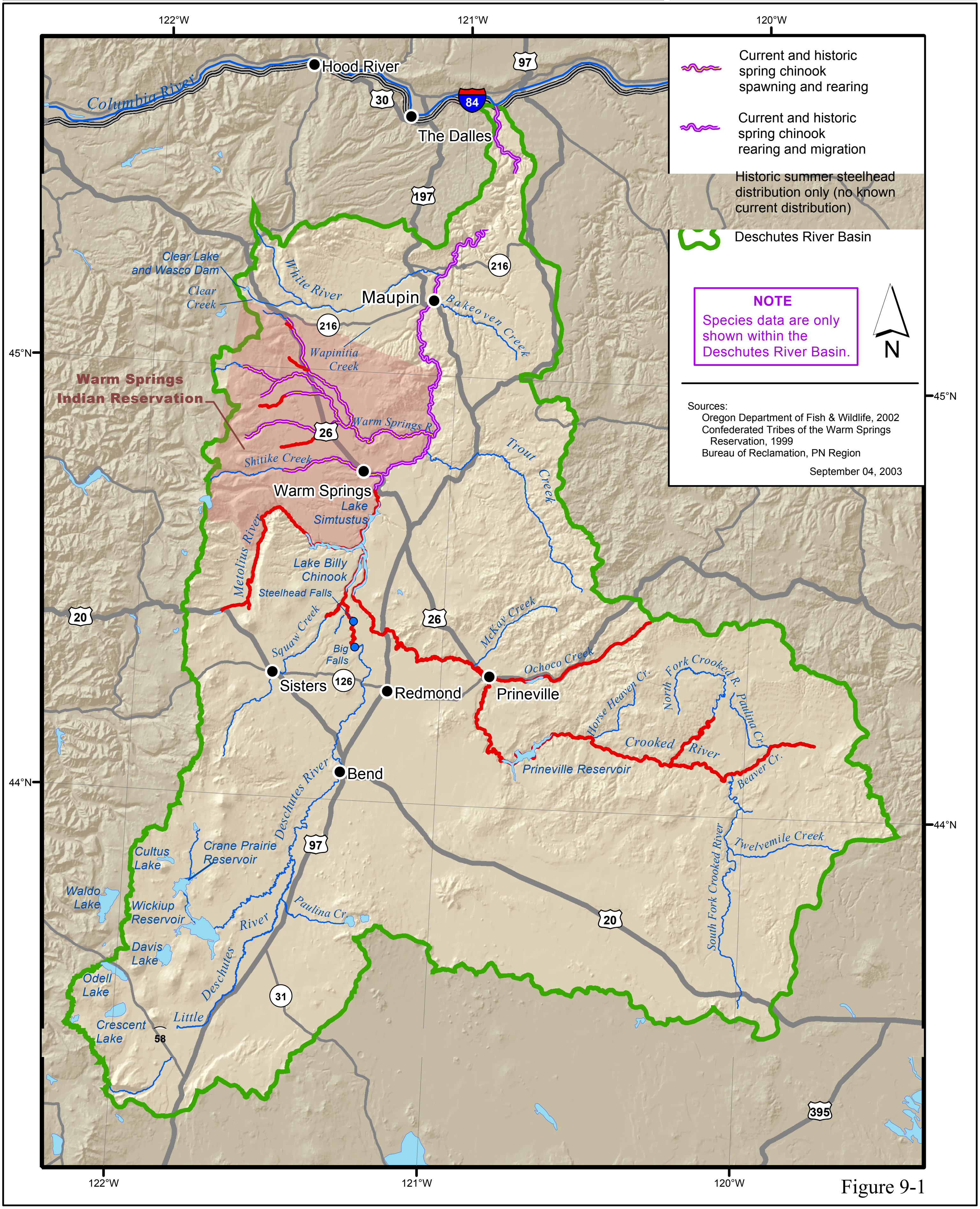

Figure 9-1

Spring Chinook salmon destined for the Warm Springs River and Shitike Creek enter the Deschutes River primarily during April, May, and June (CTWSRO 1999). They normally move quickly through the lower river to cooler water in higher elevation tributaries (Pribyl 2000). Wild stocks are separated from hatchery stocks at hatcheries. The fish mature over the summer and spawn during late August and September. Eggs incubate during the winter and fry emerge from the gravel in late winter or early spring. About one-half of these fish move out of the spawning tributary during the next fall, probably overwintering in the mainstem of the lower Deschutes River before emigrating to the ocean. Other spring Chinook salmon juveniles stay in the tributary until about 18 months of age, then emigrate directly to the ocean (age-1+ smolts). Approximately 80 percent of Deschutes River spring Chinook salmon return to the river after 2 years in the ocean (age-4 adults). Roughly 5 percent return after one year in the ocean (as age-3 jacks); and 15 percent return after three years in the ocean (age-5 adults). It is unknown if spring Chinook salmon use the lower 2 miles of the White River; water temperature periodically exceeds the ODEQ criterion of 64°F for anadromous salmonids.

According to CTWSRO (1999), the optimum management escapement goal for spring Chinook salmon in the Warm Springs River above the hatchery is 1,300 wild adults, a goal that has been met in 14 of the 26 years (including 2000 and 2002) from 1977 to 2002 (Pribyl 2003). Since 1977, the run of wild adult and jack spring Chinook salmon as enumerated at the Pelton fish trap and the Warm Springs National Fish Hatchery trap has averaged 1,954 fish. Escapement of wild adult and jack spring Chinook salmon has ranged from a high of 2,781 in 2000 to a low of 266 in 1995. The Warm Springs River above the hatchery and Shitike Creek are managed for wild fish only. Hatchery fish are not released in Shitike Creek or allowed to spawn in the Warm Springs River upstream from the hatchery. Since 1977, the spring Chinook salmon run (hatchery and wild fish) to the Deschutes River minus harvest has varied between about 1,100 (in 1980) to over 11,000 (in 2002).

Spring Chinook salmon once inhabited the Deschutes River above the current Pelton-Round Butte Project reservoirs, up to Steelhead Falls (a natural barrier at RM 128), as well as the Metolius River system and the Crooked River system. Access to these subbasins was eliminated with construction of the Pelton-Round Butte Project beginning in 1956. Fish passage facilities provided by the project were unsuccessful, and operation of the facilities was discontinued in 1968 because of the difficulty in attracting outmigrating juvenile anadromous fish to collection facilities (CTWSRO 1999). Hatchery compensation was initiated in 1968 (Nehlsen 1995). As described in Chapter 5 of this biological assessment, CTWSRO, ODFW, and others are actively studying ways to restore anadromous fish runs above the Pelton-Round Butte Hydroelectric Project. A major obstacle to restoration is getting outmigrating juvenile fish back down river because of currents in Lake Billy Chinook that apparently disorient the fish. Nehlsen

(1995) reported that the Round Butte cofferdam altered the behavior of downstream migrants in the Pelton pool.

9.3.2 Summer/Fall Chinook Salmon

The Deschutes River summer/fall-run Chinook salmon were indigenous to the lower Deschutes River. This is a distinct ESU not listed under the ESA. These fish used the river upstream and downstream from the Pelton-Round Butte Project site and probably the lower Metolius and Crooked River systems as well (Figure 9-2). Currently, summer/fall Chinook salmon spawn at preferred sites from the mouth of the Deschutes River to the Pelton Reregulating Dam. From the late 1960s through the early 1980s, large numbers of summer/fall Chinook salmon spawned in the upper portion of the lower Deschutes River. Construction of the fishway at Sherars Falls provided easier access to upstream spawning areas for fall migrants, especially during low water years. However, in the 1980s and 1990s, the number of fish spawning upstream from Sherars Falls has decreased, while the numbers spawning downstream from Sherars Falls has increased dramatically (CTWSRO 1999). Pribyl (2003) reported that 26.2 percent of summer/fall Chinook salmon redds were counted in the 57 miles of the lower Deschutes River upstream from Sherar Falls, while 73.8 percent of summer/fall Chinook salmon redds were counted in the 43 miles downstream from Sherar Falls, for the period 1989-2002. EFH for summer/fall Chinook salmon is combined with that for spring Chinook salmon in the Deschutes River basin by the PFMC (1999).

The Deschutes River summer/fall-run Chinook salmon ascend the Columbia River as maturing adults during mid-to late-summer and fall, and enter the Deschutes River from July through late November. Unlike spring-run Chinook salmon, these fish consist of only wild stocks that hold and spawn in the mainstem lower Deschutes River. There is no documented use of the lower White River by these fish (Pribyl 2000). Spawning takes place mainly during October and November. Fry emerge the following spring from March through June. Juvenile residence time in the Deschutes River is relatively short, only several months, with the subyearling smolts leaving the system the same spring or summer they emerge from the gravel and then migrate to the ocean. Mature summer/fall Chinook salmon range in age from 2 to 6 years (CTWSRO 1999). Because these fish spawn and rear in the normally warmer mainstem river, incubation and growth occurs somewhat faster than for spring-run Chinook salmon that spawn in the cooler headwater streams.

Over the last 25 years, the total run of wild summer/fall Chinook salmon has varied between about 2,800 (in 1992) to over 20,000 (in 1997). The 2002 run was about 13,200 fish.

Deschutes River Basin
Summer/Fall Chinook Salmon

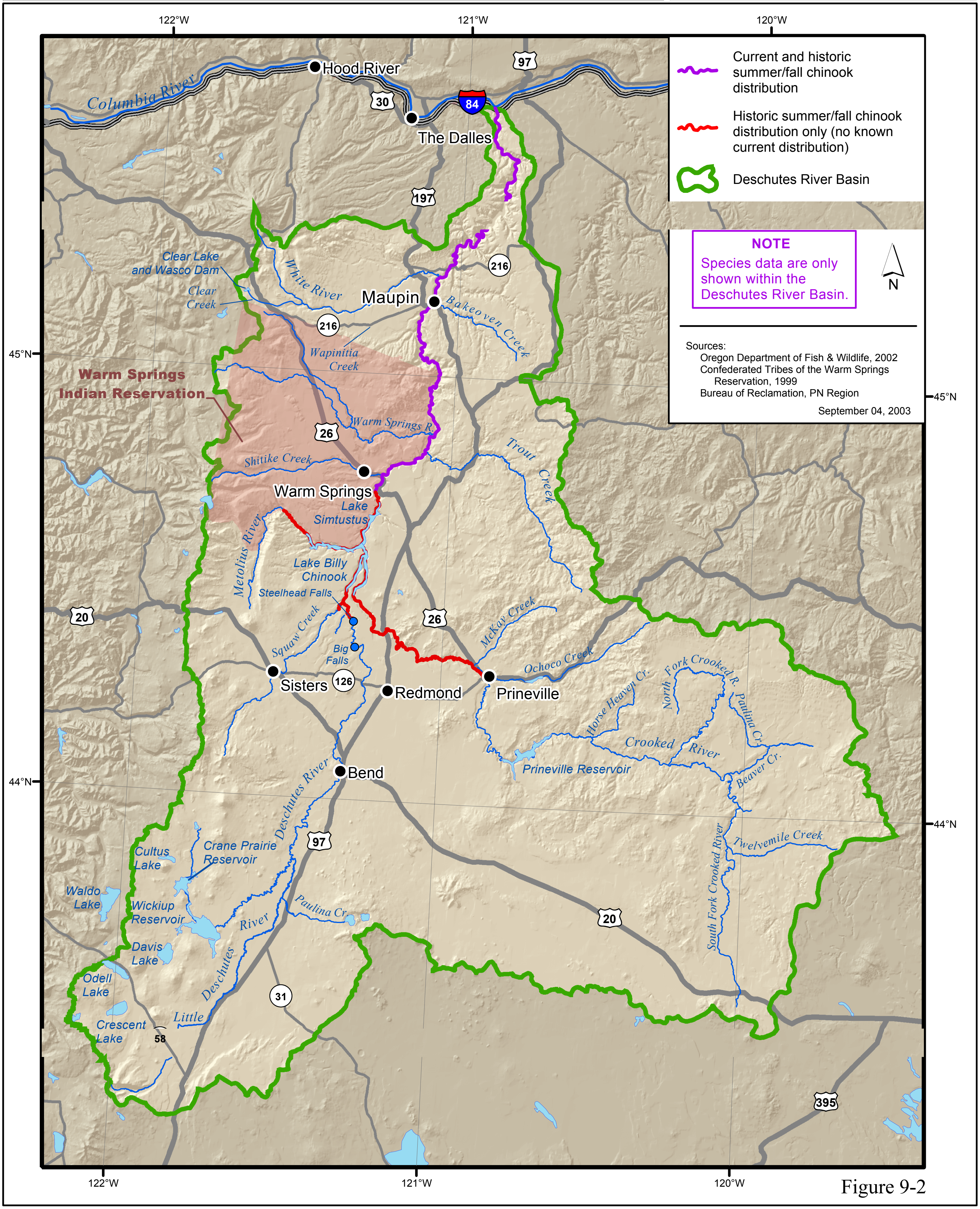

Figure 9-2

9.3.3 Coho Salmon

According to CTWSRO (1999) and Pribyl (2000), coho salmon (*Oncorhynchus kisutch)* are not indigenous to the Deschutes River basin and are not currently propagating in the basin as shown in Table 9-1. The PMFC (1999) designated EFH for coho salmon in the lower Deschtues River and Trout Creek, but since coho salmon are not indigenous to the Deschtutes River basin, their designation of EFH is most likely erroneous. During 24 years of operating the fish trap at Sherars Falls on the lower Deschutes River, Pribyl (2000) has documented only an occasional coho salmon (i.e., one stray every other year or so). CTWSRO released coho salmon in the basin in the 1960s, but these fish had only a one-life-cycle return to the basin.

9.4 EFFECTS ANALYSIS

9.4.1 Inaccessible Historic Habitat (Middle Deschutes Subbasin and Crooked River Subbasin)

Effects of flow alterations resulting from operation of Reclamation facilities of the Deschutes and Crooked River Projects, along with operation of non-Federal water storage and diversion facilities, reduce inflows to the Deschutes River upstream from Pelton-Round Butte project; however, large spring inflows (augmented by irrigation groundwater recharge) restore or replace a substantial amount of the water that is stored or diverted upstream. These spring inflows to the Deschutes River above Lake Billy Chinook help ameliorate the effects of project-caused flow reductions in this reach of the river and dilute potential pollutants contained in irrigation surface return flows. Flows and water quality in this reach of the river appear to be adequate to support resident trout (e.g., bull trout and redband trout) as far upstream as Steelhead Falls (RM 128), a natural fish barrier, and also to provide fish access to lower Squaw Creek.

Storage and diversion of flows on the Deschutes and Crooked Rivers do not significantly affect the levels of Lake Billy Chinook. Operation of the Pelton-Round Butte Hydroelectric Project has the major influence relative to water quantity in Lake Billy Chinook and its tributary arms.

Return flows from irrigated project lands add nutrients, bacteria, and agricultural chemicals via the Deschutes and Crooked River inflows into Lake Billy Chinook. While these pollutants are diluted by large spring inflows, they do reduce the overall water quality of the lake, which often experiences seasonal algal blooms. There is no indication to date that water quality of Lake Billy Chinook is adversely affecting resident fish populations in the lake.

Operation of Prineville and Ochoco Reservoirs, pumping into the NUID canal from the Crooked River, and agricultural return flows have significantly reduced flows and impaired water quality in the lower Crooked River and its tributaries, adversely affecting fish habitat. However, at this time, Opal Springs Dam, a private facility, located immediately upstream from Lake Billy Chinook, blocks all upstream fish passage on the Crooked River. Opal Springs Dam is considered the upstream extent of Pacific salmon EFH.

9.4.2 Accessible/Current and Historic Habitat (Lower Deschutes Subbasin)

Reclamation's upper Deschutes River subbasin irrigation storage and withdrawals result in modeled net stream depletions in the lower Deschutes River as described in Chapter 6, and indirect and indiscernible effects on water quality. Changes in modeled streamflow at Madras in the "with Reclamation" scenario compared to "without Reclamation" flow conditions as described in Chapter 6, range from -14.5 percent in March to a +2.8 percent in August (Table 6-5). This is due to water storage during the winter and irrigation releases during the summer. However, Reclamation projects in the upper Deschutes subbasin have no effect on the current spring Chinook salmon spawning tributaries in the lower Deschutes River, e.g., Shitike Creek and the Warm Springs River, nor on accessible historic spawning tributaries, e.g., Trout Creek. Flow fluctuations and water quality effects in the lower Deschutes River are influenced by operation of the Pelton-Round Butte Hydroelectric Project and by downstream surface and groundwater inflows. Water temperature effects of Reclamation's operations on the lower Deschutes River are offset by cooler groundwater returns reducing in-river water temperatures (Appendix B). There are no easily discernible or quantifiable effects of Reclamation's operations on the thermal regimes of the lower Deschutes River.

As noted in Chapter 6, the lower Deschutes River has a relatively uniform and stable annual flow regime, although natural warming of the river occurs as it flows downstream. The Deschutes River water temperature meets the ODEQ water temperature criterion for anadromous salmonids of 17.8°C at Madras (Table 5-12), but exceeds this criterion in the summer at Moody (Aney et al. 1967). Nonetheless, some upper Columbia River adult salmon and steelhead use the lower Deschutes River seasonally as a thermal refugium during their upstream migration. Operations of the Pelton-Round Butte Hydroelectric Project mask for the most part any affect Reclamation's upper Deschutes River projects have on water temperature in the lower Deschutes River. It would be difficult if not impossible to separate out the effects of Reclamation's upper Deschutes River operations on water temperature in the lower Deschutes River.

Dissolved oxygen is decreased somewhat downstream from Lake Billy Chinook in the lower Deschutes River, in large part the result of the complex interaction of nutrient inputs, water temperature, other environmental conditions, and the subsequent production of algae in the lake and not by Reclamation operations. The seasonal decrease in dissolved oxygen has resulted in a portion of the lower Deschutes River being placed on the Oregon 303(d) list of impaired streams. The reach of the lower Deschutes River just downstream from the Pelton Reregulating Dam supports some salmonid spawning.

Some sedimentation occurs in the lower Deschutes River, but Reclamation has no projects on the tributary sources of sediment except in the White River, and much of that sediment contribution is of glacial origin upstream from the Wapinitia Project lands.

The relatively small amount of water storage and streamflow depletions from diversions to the Wapinitia Project lands in the White River subbasin (about -102 cfs in February but about +6 cfs during the irrigation season) do not substantially affect lower Deschutes River flows, especially considering the amount of carriage losses that are eventually returned to the adjacent streams. However, the sum total of all lower basin agricultural diversions and practices (both Federal and non-Federal) may significantly affect flows and water quality (e.g., dissolved oxygen and water temperature) during the irrigation season, especially in low water years.

9.5 EFFECTS CONCLUSION

This effects conclusion is limited to Chinook salmon EFH in the Deschutes River basin. Available scientific information indicates that the operation of Reclamation projects in the upper Deschutes River basin, in conjunction with the operation of non-Federal irrigation projects in the basin, may have an adverse affect on historical but presently unoccupied EFH, (i.e., the river basin upstream from the Pelton-Round Butte Hydroelectric Project), but has no adverse affect on currently accessible Chinook salmon EFH in the lower Deschutes River and no effect on EFH in Trout Creek. Spring Chinook salmon generally spawn and rear in westside tributaries, while summer/fall Chinook salmon predominantly spawn and rear in the main river.

The effects of Reclamation’s operations on environmental conditions and habitat in the lower Deschutes River are difficult to partition out from the effects that the Pelton-Round Butte Hydroelectric Project has downstream, except perhaps for the modeled hydrology with and without Reclamation as described in the accompanying biological assessment. The effects of operation of the Pelton-Round Butte Hydroelectric Project far outweigh the effects of Reclamation’s upper river operations on the lower Deschutes River.

Current Reclamation operations in the upper Deschutes River do not measurably degrade anadromous salmonid habitat of the lower Deschutes River. Table 6-6 and the accompanying discussion of the habitat indicators in Chapter 6 of the biological assessment, based on the NMFS habitat matrix of pathways and indicators, does not indicate degradation in habitat indicators in the lower Deschutes River from operation of Reclamation projects in the upper Deschutes River. Water temperatures at Madras meet the ODEQ water temperature criterion of 17.8°C for anadromous salmonids. Summertime warming of the river further downstream is the result of natural processes. The seasonal reduction in dissolved oxygen is the result of physical and biological processes operating in Lake Billy Chinook.

Reclamation's ongoing operations in the Deschutes River basin will not adversely affect currently occupied EFH for Chinook salmon in the lower Deschutes River.

CHAPTER 10.0 LITERATURE CITED

Allan, J. H. 1980. Life history notes on the Dolly Varden charr (Salvelinus malma) in the upper Clearwater River, Alberta. Alberta Energy and Natural Resources, Fish and Wildlife Division, Red Deer, Alberta, Canada.

Aney, W.W., M.L. Montgomery, and A.B. Lichens. 1967. Lower Deschutes River, Oregon; Discharge and the Fish Environment. Oregon State Game Commission, Portland, Oregon.

Batt, P.E. 1996. Governor Phillip E. Batt's *State of Idaho Bull Trout Conservation Plan*. Boise, Idaho. 20pp.

Bauman, Richard. 2002. Personal Communication. Environmental Specialist. Snake River Area Office, Bureau of Reclamation, Pacific Northwest Region.

Behnke, R.J. 1992. *Native Trout of Western North America*. American Fisheries Society Monograph 6. Bethesda, Maryland.

BLM (U.S. Bureau of Land Management). July 1992. *Lower Crooked River, Chimney Rock Segment, Management Plan and Environmental Assessment*. Prineville District, Oregon

BLM (U. S. Bureau of Land Management) and USFS (U.S. Forest Service). 2001. *Joint Aquatic and Terrestrial Programmatic Biological Assessment*, April 2001 - April 2003, for Federal Lands within the Deschutes Basin Administered by the Bureau of Land Management Prineville Office and for Federal Lands Administered by the Deschutes and Ochoco National Forests.

Block, D. G. 1955. Trout migration and spawning studies on the North Fork drainage of the Flathead River. University of Montana. MS Thesis.

Brun, C. 2003. Personal Communication. Fish Biologist. Confederated Tribes of the Warm Springs Indian Reservation.

Brun, C.V. and R.D. Dodson. 2000. *Bull Trout Distribution and Abundance in the Waters on and Bordering the Warm Springs Reservation, 2000 Annual Report*. Bonneville Power Administration, Portland, Oregon.

______________. 2001. *Bull Trout Distribution and Abundance in the Waters on and Bordering the Warm Springs Reservation, 2000 Annual Report*. Bonneville Power Administration, Portland, Oregon.

Buchanan, D. V., M. L. Hanson, and R. M. Hooton. 1997. *Status of Oregon's Bull Trout*. Oregon Department of Fish and Wildlife, Portland Oregon.

Burton, T. 1997. Personal Communication. Fish Biologist, Boise National Forest.

Busby, P.J., T.C. Wainwright, G.J. Bryant, L.J. Lierheimer, R.S. Waples, F.W. Waknitz, and I.V. Lagomarsino. 1996. *Status Review of West Coast Steelhead from Washington, Idaho, Oregon, and California*. U.S. Department of Commerce, NOAA Tech. Memo. NMFS-NWFSC-27, 261 p.

Caldwell, R.R. 1998. *Chemical study of regional ground-water flow and ground-water/surface-water interaction in the upper Deschutes Basin, Oregon*: U.S. Geological Survey Water-Resources Investigations Report 97-4233, 49 p.

Chilcote, M. W. January 1998. *Conservation Status of Steelhead in Oregon*. Oregon Department of Fish and Wildlife, Information Reports Number 98-3. Portland, Oregon.

______________. 1999. *Genetic Risks to Native, Wild Salmonids in the Imnaha River, Oregon, due to Hatchery Supplementation*. Affidavit to Federal District Court Regarding Hatchery Supplementation. 5 p.

Clowers, G. 2002. Prineville Reservoir Bald Eagle Habitat/Noxious Weed Survey, June – July 2002. Raven Research. West Madras, Oregon.

Cramer, S.P. and R.C.P. Beamesderfer. 2001. *Population Dynamics, Habitat Capacity, and a Like History Simulation Model for Steelhead in the Deschutes River, Oregon*. Draft. Prepared for Portland General Electric, Portland, Oregon. 151 p.

CTWSRO. 1999. (The Confederated Tribes of the Warm Springs Reservation of Oregon) and Warm Spring Power Enterprises. Pelton Project Final License Application (FERC License 2030). Warm Springs, Oregon. Four Volumes.

CTWSRO. (The Confederated Tribes of the Warm Springs Reservation of Oregon and Portland General Electric). September 14, 2000. Draft Joint Application Amendment for the Pelton-Round Butte Hydroelectric Project (FERC Project No. 2030 and No. 11832).

CTWSRO. (The Confederated Tribes of the Warm Springs Reservation of Oregon) and PGE (Portland General Electric). 2002. Joint Applicants' Response to FERC

Request for Additional Information, Pelton Round Butte Hydroelectric Project (FERC License No. 2030). Two Volumes.

Dean, B. 2002. Personal Communication. Prineville Area Office, Bureau of Land Management, Prineville, Oregon.

Dillon, Jeff. 2002. Personal Communication. U. S. Fish and Wildlife Service, Portland, Oregon.

DRC (Deschutes Resources Conservancy). 2003. http://www.deschutesrc.org/projects.htm

Elle, S., R. Thurow, and, T. Lamansky. 1994. *Rapid River Bull Trout Movement and Mortality Studies.* Idaho Department of Fish and Game, River and Stream Investigations: Subproject II, Study IV, Job Performance Report, Project F-73-R-17, Project 6. Boise, Idaho).

Fassnacht, H. and G.E. Grant. 1995. *Draft Literature Review on Downstream Effects of Dams on Alluvial Rivers: Applications to the Deschutes River, Oregon*. Oregon State University and USDA Forest Service, Corvallis, Oregon. 35 p.

Fassnacht, H., E. McClure, G.E. Grant, and P. Klingeman. 2002. *Downstream Effects of the Pelton-Round Butte Hydroelectric Project on Bedload Transport, Channel Morphology, and Channel-bed Texture, Lower Deschutes River, Oregon*.

Federal Register 55:26114-26194. 1990. *Endangered and Threatened Wildlife and Plants; Determination of Threatened Status for the Northern Spotted Owl*; Final Rule. U.S. Fish and Wildlife Service. June 26.

Federal Register 57:1796-1838. 1992. *Endangered and Threatened Wildlife and Plants; Determination of Critical Habitat for the Northern Spotted Owl*; Final Rule. U.S. Fish and Wildlife Service. January 15.

Federal Register 60:36000-36010. 1995. *Recovery Plan for the Pacific Bald Eagle*. U.S. Fish and Wildlife Service. July 12.

Federal Register 64:15417-14528. 1999. *Threatened Status for Two ESUs of Steelhead in Washington and Oregon*. National Marine Fisheries Service. March 25.

Federal Register 64:36454-36464. 1999. *Proposed Rule to Remove the Bald Eagle in the Lower 48 States From the List of Endangered and Wildlife*. U.S. Fish and Wildlife Service. July 6.

Federal Register 65:7764-7787. 2000. *Critical Habitat for 19 Evolutionary Significant Units of Salmon and Steelhead in Washington, Oregon, Idaho, and California*. National Marine Fisheries Service. February 16.

Federal Register 65:16052-16086. 2000. *Endangered and Threatened Wildlife and Plants; Determination of Threatened Status for the Contiguous U.S. Distinct Population Segment of the Canada Lynx*. U.S. Fish and Wildlife Service. March 24.

Feiger, M. 2002. Personal Communication. Hood River Ranger District, Mt. Hood National Forest, Hood River, Oregon.

Fies, T., J. Fortune, B. Lewis, M. Manion, and S. Marx. 1996a. *Upper Deschutes River Subbasin Fish Management Plan*. Oregon Department of Fish and Wildlife, Upper Deschutes Fish District, Bend, Oregon. October 1996.

Fies, T., B. Lewis, M. Manion, and S. Marx. 1996b. *Metolius River Subbasin Fish Management Plan*. Oregon Department of Fish and Wildlife, Upper Deschutes Fish District. December 1996.

Gannett, Marshall W., Kenneth E. Lite Jr., David S. Morgan, and Charles S. Collins. 2001. *Groundwater Hydrology of the Upper Deschutes Basin, Oregon*. U.S. Geological Survey, Water-Resources Investigations Report 00-4162, p 45.

__________________. p 73.

__________________. p 26.

Gilligan, J., M. Smith, D. Rogers, and A. Contreras (eds.). 1994. *Birds of Oregon, status and distribution*. Cinclus Publications, MCMinnville, Oregon.

Giorgi, A., M. Miller, and J. Stevenson. 2002. *Mainstem Passage Strategies In the Columbia River System: Transportation, Spill, and Flow Augmentation*. Prepared for Northwest Power Planning Council, Portland, OR. 86 p. plus appendices.

Gorman, K. 2002. Personal Communication. Regional Manager. Oregon Water Resources Department. Bend, Oregon.

Harmata, A. R. and B. Oakleaf. 1992. *Bald Eagles in the Greater Yellowstone Ecosystem: an Ecological Study with Emphasis on the Snake River, Wyoming*. Wyoming Game and Fish Dept., Cheyenne. 2 vol. 368pp.

Henshaw, F. F., J. H. Lewis, and E. J. McCaustland. 1914. *Deschutes River, Oregon, and its utilization*. U.S.G.S. Water Supply Paper 344.

Huntington, C., T. Hardin, and R. Raymond. 1999. Water Temperatures in the Lower Deschutes River, Oregon. Prepared for Portland General Electric Company, Portland, Oregon. 50 p.

Isaacs, F., S. Reed, R. Reed, and R. Anthony. 1992. *Habits of Bald Eagles Wintering in Northeastern Oregon and Adjacent Areas of Washington and Idaho*. Oregon CooperativeWildlife Research Unit, Oregon State University, Corvallis. 23pp. plus tables, figures, and appendices.

Isaacs, F. B., R. Goggans, R. G. Anthony, and T. Bryan. 1993. *Habits of Bald Eagles Wintering Along the Crooked River, Oregon*. Northwest Science, 67 (2):55-62.

Issacs, F. 1997. Personal Communication. Oregon Eagle Foundation. Lakeview, Oregon.

Isaacs, F. and R. Anthony. 1999. *Bald Eagle Nest Locations and History of Use in Oregon and the Washington Portion of the Columbia River Recovery Zone, 1971 Through 1999*. Oregon Coop. Wildlife Research Unit, Oregon State University, Corvallis. 32pp. plus tables, figures and appendix.

______________. 2002. *Bald Eagle Nest Locations and History of Use in Oregon and the Washington Portion of the Columbia River Recovery Zone, 1971 Through 2002.* Oregon Coop. Wildlife Research Unit, Oregon State University, Corvallis. 21pp. 6 tables, 3 figures, 1 appendix (34 pages total).

Iwamoto, R. N. and J. G. Williams. 1993. *Juvenile salmonid passage and survival through turbines*. Report to U.S. Army Corps of Engineers, Portland, Oregon. Contract E86920049, 27 p. (Available from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, Washington 98112-2097.)

Jeffries, Shane. 2002. Personal Communication. Wildlife Biologist. Deschutes National Forest.

Knowles, C. J. and Robert G. Gumtow. 1996. *Saving the Bull Trout*. The Thoreau Institute, Oak Grove, Oregon. 21pp.

Krebs, Charles J. January, 2001. *What Drives the 10-Year Cycle of Snowshoe Hares?* BioScience [online]. American Institute of Biological Sciences. (@findarticles.com)

Kunkel, Clari. July 16, 2003. Personal Communication. Deschutes Watershed District Manager. Oregon Department of Fish and Wildlife.

LaMarche, J. 2001. Upper and Middle Deschutes Basin Surface Water Distribution Model. Surface Water Open File Report #SW02-001. Published by Oregon Water Resources Department.

Lewis, S.C. and R. Raymond. 2000. *Lower Deshutes River Dissolved Oxygen Study, 1999*. Prepared for Portland General Electric Company, Portland, Oregon. 18 p. plus appendices.

Lichatowich, J., R. Williams, and J.H. Nathan. 1998. *A Conceptual Foundation for the Management of Native Salmonids in the Deschutes River*. Prepared for Portland General Electric Company, Portland, Oregon. 170 p.

Marx, Steven. July 31, 2000. Personal Communication. District Fish Biologist, Oregon Department of Fish and Wildlife, Bend, Oregon.

______________. April 2003. Personal Communication. District Fish Biologist, Oregon. Department of Fish and Wildlife. Bend, Oregon.

McClure, M., B. Sanderson, E. Holmes, C. Jordan, P. Kareiva, and P. Levin. 2000. Revised Appendix B of standardized quantitative analysis of the risks faced by salmonids in the Columbia River basin. National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington. September.

Minear, P. J. 1999. *Historical Riparian Conditions and Large In-Channel Wood, Deschutes River, Oregon*. Prepared for Portland General Electric, Portland, Oregon. 88 p. plus appendices.

Morehead, Carol. March 30, 1999. Personal Communication. Biologist. Deschutes National Forest, Bend , Oregon.

Muir, W. D., S.G. Smith, K. W. McIntyre, and B. P. Sandford. 1998. *Project survival of juvenile salmonids passing through the bypass system, turbines, and spillways with and without flow deflectors at Little Goose Dam, 1997*. Report to U.S. Army Corps of Engineers, Portland, Oregon. Contract E86970085, 47 p. (Available from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, Washington 98112-2097.)

Nehlsen, W. 1995. *Historical Salmon and Steelhead Runs of the Upper Deshutes River and Their Environments*. Prepared for Portland General Electric Company, Portland, Oregon. 65 p. plus references and two appendices.

Newton, J.A. and S. Pribyl. 1994. *Bull Trout Population Summary: Lower Deschutes River Subbasin*. Oregon Department of Fish and Wildlife, The Dalles, Oregon.

NMFS (National Marine Fisheries Service). August 1996. *Factors for Decline*. A Supplement to the Notice of Determination for West Coast Steelhead Under the Endangered Species Act. Portland, Oregon and Long Beach, California. 83 p.

NMFS (National Marine Fisheries Service). 1999. *Biological Opinion on Artificial Propagation in the Columbia River Basin.* National Marine Fisheries Service, Northwest Region, Seattle,Washington. 177 p.

NMFS (National Marine Fisheries Service). 2000a. *A Standardized Quantitative Analysis of Risks Faced by Salmonids in the Columbia River Basin*. Cumulative Risk Initiative. 123 p. plus appendix and tables.

NMFS (National Marine Fisheries Service). 2000b. *Passage of Juvenile and Adult Salmonids Past Columbia and Snake River Dams*. White Paper. Northwest Fisheries Science Center, Seattle, Washinton 38 p.

NMFS (National Marine Fisheries Service). March 28, 2000c. *NMFS Finding that Bureau of Reclamation Existing Environmental Review Procedures for Federal Projects Meet EFH Consultation Requirements*. Memorandum to Mr. J. William McDonald, Regional Director, Pacific Northwest Region. From William Stelle, Jr., Regional Administrator, NMFS, Seattle, Washington.

NMFS (National Marine Fisheries Service). March 9, 2001. Letter - Re: Updated Species List Request for Species Which May Be Affected by Bureau of Reclamation Reservoir Operations in the Deschutes River Basin, OR. Chief, Oregon State Branch, Habitat Conservation Division, Portland, Oregon.

NPPC (Northwest Power Planning Council). 1990. *Salmon and Steelhead Production Plan, Deschutes River Subbasin*. 146 p.

O'Connor, J. E., G. E. Grant, J. H. Curran, and H. Fassnacht. 1999. *Geomorphology of the Deschutes River below the Pelton Round Butte Dam Complex, Oregon*. Prepared for Portland General Electric, Portland, Oregon. 102 p. Draft.

O'Connor, J.E., G.E. Grant, and T.L. Haluska. 2002. *Overview of Geology, Hydrology, Geomorphology, and Sediment Budget of the Deschutes River Basin, Oregon*. Draft. USGS and US Forest Service. 41 p.

ODFW (Oregon Department of Fish and Wildlife). 1997. *Lower Deschutes River Subbasin Management Plan.* Mid-Columiba Fish District. July 1997.

ODFW (Oregon Department of Fish and Wildlife). 2002. District Annual Report, Mid Columbia Fish District.

ODFW (Oregon Department of Fish and Wildlife). 2003. *Middle Columbia and Snake Basin ESUs*. (<http://www.dfw.state.or.us/ODFWhtml/FishText/SteelheadWeb/Part10.html>)

ONHIC (Oregon Natural Heritage Information Center). Canada Lynx. Data Set. 2002a.

ONHIC (Oregon Natural Heritage Information Center). Northern Spotted Owl. Data Set. 2002b.

Oregon, State of. 1998. Oregon Plan for Salmon and Watershed. www.oregon-plan.org

OWEB (Oregon Water Enhancement Board). 2003. (http://www.oweb.state.or.us/SmallGrant/smallgrant.shtml

OWRD (Oregon Water Resources Department). 1999. *Allocation of Conserved Water Program.* (http://www.wrd.state.or.us/programs/stewardship/conserved.shtml

OWRD (Oregon Water Resources Department). 2002. Deschutes Basin Mitigation Bank and Mitigation Credit Rules. Oregon Administrative Rules 690-521-0100 through 690-521-0600.

PFMC (Pacific Fishery Management Council). August 1999. Appendix A – *Identification and Description of Essential Fish Habitat, Adverse Impacts and Recommended Conservation Measures for Salmon*. Amendment 14 to the Pacific Coast Salmon Plan. Portland, Oregon.

Peery, C.A., and T.C. Bjornn. 2002. *Water Temperatures and Passage of Adult Salmon and Steelhead in the Lower Snake River*. U.S. Geological Survey, Moscow, Idaho. Technical Report 02-1. Prepared for U.S. Army Corps of Engineers, Walla Walla, Washington. 80p.

Ploskey, G., T. Poe., A. Giorgi, and G. Johnson. 2001. *Synthesis of Radio Telemetry, Hydroacoustic, and Survival Studies of Juvenile Salmon at The Dalles Dam (1982-2000)*. Prepared for the U.S. Army Corps of Engineers, Portland, Oregon. Contract Number DACW57-00-D-0009, Task Order Case No. 3.

PGE (Portland General Electric). 2002. Response to FERC Request for Additional Information. Pelton Round Butte Hydroelectric Project, FERC No. 2030, AIR 11.

Pribyl, Steve. April 27, 2000. Personal Communication. District Fish Biologist, Oregon Department of Fish and Wildlife, The Dalles, Oregon.

Pribyl, Steve. July 13, 2002. Personal Communication. District Fish Biologist, Oregon Department of Fish and Wildlife, The Dalles, Oregon.

Pribyl, Steve. April 30, 2003. Personal Communication. District Fish Biologist, Oregon Department of Fish and Wildlife, The Dalles, Oregon.

Pribyl, Steve. September 3, 2003. Personal Communication. District Fish Biologist, Oregon Department of Fish and Wildlife, The Dalles, Oregon.

Ratliff, D.E., and P.J. Howell. 1992 *The Status of Bull Trout Populations in Oregon*. In Proceedings of the Gearhart Mountain Workshop, Oregon Chapter of AFS, 1992. American Fisheries Society. Corvallis, Oregon

Ratliff, D.E., S.L. Thiesfield., W.G. Weber,. A. Stuart, M.D. Riehle, D.V. Buchanan. 1996. *Distribution, life history, abundance, harvest, habitat, and limiting factors of bull trout in the Metolious River and Lake Billy Chinook, Orego*n, 1983-94. 44 pp. Fish Division. Oregon Department of Fish and Wildlife. Portland, Oregon.

Ratliff, Don. April 19, 2001. Personal Communication. Fishery Biologist. Portland General Electric. Madras, Oregon.

______________. September 17, 2002. Personal Communication. Fishery Biologist, Portland General Electric, Madras, Oregon.

Raymond, R.B., J.M. Eilers, J.A. Bernert, and K.B. Vache. 1998. *Lower Deschutes River Studies Water Quality and Biota 1997 Final Report*. Pelton Round Butte Hydroelectric Project, FERC Number 2030. 26 p.

Reclamation (U.S. Bureau of Reclamation). September 1992. *Environmental Assessment and Prineville Reservoir Resource Management Plan*, Pacific Northwest Region, Boise, Idaho.

Reclamation (U.S. Bureau of Reclamation). November 1993. *Draft Environmental Assessment - Ochoco Safety of Dams Project, Crooked River Project, Oregon*. Pacific Northwest Region, Boise, Idaho.

Reclamation (U.S. Bureau of Reclamation) and OWRD (Oregon Water Resources Department). 1997. *Upper Deschutes River Basin Water Conservation Study – Special Report*, Crook, Deschutes, and Jefferson Counties, Oregon.

Reclamation (U.S. Bureau of Reclamation). July 1999. *Finding of No Significant Impact and Final Environmental Assessment, Wasco Dam Safety of Dams Project*, Wapinitia Project, Oregon. Lower Columbia Area Office, Portland, Oregon.

Reclamation (U.S. Bureau of Reclamation). 2003a. *Operations Description of the Deschutes River Basin Projects*. Pacific Northwest Region, Boise, Idaho.

Reclamation (U.S. Bureau of Reclamation). 2003b. *Prineville Reservoir Resource Management Plan and Master Plan: Finding of No Significant Impact and Final Environmental Assessment.* Pacific Northwest Reg ion, Lower Columbia Area Office, Portland, Oregon.

Reisenbichler, R.R. 1996. *Effects of supplementation with hatchery fish on carrying capacity and productivity of naturally spawning populations of steelhead*. Pages 81-92 *in* G.E. Johnson, D.A. Neitzel, and W.V. Mavros [eds.] Proceedings from a Workshop on Ecological Carrying Capacity of Salmonids in the Columbia Basin: Measure 7.1A of the Northwest Power Planning Council's 1994 Fish and Wildlife Program. Report 3 and 4. Bonneville Power Administration. Portland, Oregon.

Riehle, M., D. Wilcox, and Chris Brun. 1997. An assessment of watershed condition and risk to bull trout in response to proposed timber harvest and salvage in the Metolious River basin. USFS Sisters Ranger District, Sisters, Oregon.

Rieman, B. E. and J. D. McIntyre. 1993. *Demographic and Habitat Requirements of Bull Trout*. United States Forest Service, Intermountain Research Station, General Technical Report INT-302. Boise, Idaho.

Russell, I. C. 1905. Preliminary Report on the geology and Water Resources of Central Oregon. U.S. Geological Survey Bulletin 252. 138 p.

Schriever, Ed. July 24, 2002. Personal Communication. Idaho Department of Fish and Game. Lewiston, Idaho.

Soules, Gary. June 23, 1999. Personal Communication. Biologist. Oregon Department of Fish and Wildlife.

Stillwater, L. 2003. *MODSIM Simulation of Deschutes River Basin Projects Operations Modeling Results, Model Version October 31, 2002*. Available on CD from U.S. Bureau of Reclamation, Pacific Northwest Regional Office, PN-6200, 1150 N. Curtis Road, Boise, Idaho 83706-1234.

Stone, Steve. May 28, 2002. Personal Communication. Email to Monte McClendon (USBR). National Marine Fisheries Service. Portland, Oregon.

Stuart, A.M., S.T. Thiesfeld, T.K. Nelson, and T.M. Schrader. 1996. *Crooked River Basin Plan, Ochoco Fish District*. Oregon Department of Fish and Wildlife. Portland, Oregon.

Thiesfield, S.L., A.M. Stuart, D.E. Ratliff and B.D. Lampman. 1996. Migration patterns of adult bull trout in the Metolious River and Lake Billy Chinook, Oregon. Pp. 17 Fish Division, Oregon Department of Fish and Wildlife.

Tuchmann, E. Thomas, Kent P. Connaughton, Lisa E. Freedman, and Clarence B. Moriwaki. 1996. *The Northwest Forest Plan: A Report to the President and Congress*. U.S. Department of Agriculture, Office of Forestry and Economic Assistance. Martha H. Brookes, Editor.

USDA (U.S. Department of Agriculture) and (U.S. Department of Interior). 2000. *Interior Columbia Basin Final Environmental Impact Statement*. Walla Walla, Washington and Boise, Idaho.

USFS (U.S. Forest Service). July 1996. *Upper Deschutes Wild and Scenic River and State Scenic Waterway, Comprehensive Management Plan*. Deschutes National Forest, Bend, Oregon.

USFS (U. S. Forest Service). February 2002. List of Bald Eagle Nest Sites (and Bald Eagle Managment Plans) Within the Crane Prairie and Wickiup Reservoir Areas and Along the Deschutes River Below these Reservoirs. Bend & Ft. Rock Ranger Districts, Bend, Oregon.

USFWS (U.S. Fish and Wildlife Service). 1986. *Recovery Plan for the Pacific Bald Eagle*. U.S. Fish and Wildlife Service, Portland, Oregon. 160pp.

USFWS (U.S. Fish and Wildlife Service). 1994. *Biological Opinion for Lake Roosevelt Bald Eagles--Salmon Flow Augmentation.* U.S. Fish and Wildlife Service, Idaho State Office, Boise, Idaho. 16pp.

USFWS (U. S. Fish and Wildlife Service). June 5, 1998. News Release: Fish and Wildlife Service Lists Two Bull Trout Populations. Portland, Oregon.

USFWS (U.S. Fish and Wildlife Service) and NMFS (National Marine Fisheries Service). 1998. *Endangered Species Consultation Handbook – Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Act*.

USFWS (U.S. Fish and Wildlife Service). October, 2000a. *Biological Opinion of the Effects of National Forest Land and Resource Management Plans and Bureau of Land Management Land Use Plans on Canada Lynx*. Available at url: fs.fed.us/r1/planning/lynx/lynx.html.

USFWS (U. S. Fish and Wildlife Service). December, 2000b. *Biological Opinion: Effects to Listed Species from Operations of the Federal Columbia River Power System*. Regions 1 and 6.

USFWS (U. S. Fish and Wildlife Service). March 14, 2001. Letter providing updated lists of species for the Deschutes River Basin Projects (1-7-01-SP-285A-E). State Supervisor, Portland, Oregon.

USFWS (U.S. Fish and Wildlife Service). May 5, 2003. Memorandum: "Informal Consultation on the Final Environmental Assessment for the Prineville Reservoir Resource Management Plan." State Supervisor, Portland, Oregon.

Verts, B.J., and L.N. Caraway. 1998. *Land Mammals of Oregon*. University of California Press; Berkley, California

Zabel, R.W., S.G. Smith, W.D. Muir, D.M. Marsh, J.G. Williams, and J.R. Skalski. 2001. *Survival Estimates for the Passage of Spring-Migrating Juvenile Salmonids Through Snake and Columbia River Dams and Reservoirs, 2001*. Prepared for U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife, contract DE-AI79-93BP10891, Project 93-29. 95 p.

Zakrajsek, L. 2002. Preliminary Meeting Notes (July 9, 2002): Eagle Habitat Use in Prineville Reservoir and Adjacent land. Bureau of Reclamation, Bend, Oregon. (Preliminary results of study by Raven Research).

Zimmerman, C.E. and G.H. Reeves. 1998. *Steelhead and Rainbow Trout: Early Life History and Habitat Use in the Deschutes River, Oregon*. 1997 Annual Report. Prepared for Portland General Electric Company, Portland, Oregon. 21 p.

_______________. 2000. Population structure of sympatric anadromous and nonanadromous Oncorhynchus mykiss: evidence from spawning surveys and otolith microchemistry. Can. J. Fish. Aquat. Sci. 57:2152-2162.

— APPENDICES —

— APPENDIX A—

Updated Species List from NMFS and USFWS

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
525 NE Oregon Street
PORTLAND, OREGON 97232-2737

Refer to:
OHB2002-0159-SL

July 3, 2002

Mr. Ronald J. Eggers
U.S. Department of the Interior
Bureau of Reclamation
Pacific Northwest Region
Lower Columbia Area Office
825 NE Multnomah Street, Suite 1110
Portland, Oregon 97232-2135

Re: Updated Species List Request for Species Which May Be Affected by Bureau of Reclamation Reservoir Operations in the Deschutes River Basin, Oregon.

Dear Mr. Eggers:

The National Marine Fisheries Service (NMFS) received your June 5, 2002, letter requesting an updated list of threatened and endangered anadromous fish species which may be affected by Bureau of Reclamation (BOR) reservoir operations in the Deschutes River Basin, Oregon. We have enclosed a list of those anadromous fish species that are listed as endangered or threatened under the Endangered Species Act (ESA), those that are proposed for listing, and those that are candidates for listing. This inventory only includes species under NMFS' jurisdiction that occur in the Pacific Northwest. The U.S. Fish and Wildlife Service should be contacted regarding the presence of species falling under its jurisdiction.

Available information indicates that ten anadromous fish species listed under the ESA are known to be present within or downstream from the proposed action area. Middle Columbia River (MCR) steelhead (*Oncorhynchus mykiss*) which NMFS listed as threatened (March 25, 1999, 64 FR 14517) are known to spawn and rear in the Deschutes River and its tributaries downstream from Pelton Dam. Snake River (SR) fall, SR spring/summer, and Upper Columbia River (UCR) spring chinook salmon (*O. tshawytcha*); SR sockeye salmon (*O. nerka*); and SR and UCR steelhead (*O. mykiss*) migrate past the mouth of the Deschutes River in the Columbia, and sometimes enter the lower Deschutes for brief periods before continuing their migration up the Columbia River. Lower Columbia River (LCR) chinook salmon, LCR steelhead and Columbia River chum salmon (*O. keta*) occur in the Columbia River, and certain tributaries downstream from Hood River.

Furthermore, habitat in and along the length of the Columbia River has been designated as critical habitat for SR fall chinook salmon, SR spring/summer chinook salmon, and SR sockeye salmon. Additional information on listed species' distribution, copies of Federal Register documents designating listed species status, and links to various ESA consultation policies and tools may be found on our web site at: www.nwr.noaa.gov. For information on the ESA section 7 consultation process, please refer to the ESA section 7 implementing regulations, 50 CFR Part 402.

In addition, the Pacific Fisheries Management Council (PFMC), which was established under the Magnuson-Stevens Act, has described and identified essential fish habitat (EFH) in each of its fisheries management plans. EFH includes "those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity." All habitat, excluding areas upstream of longstanding, naturally-impassible barriers, in the Upper Deschutes watershed (HUC 17070301), Lower Crooked River watershed (HUC 17070305), and Trout Creek watershed (HUC 17070307) is designated as EFH for chinook salmon. All habitat, excluding areas upstream of longstanding, naturally-impassible barriers, in the Lower Deschutes watershed (HUC 17070306) is designated as EFH for chinook salmon and coho salmon. Additional information addressing EFH may be found on our web site cited above.

Questions regarding this letter should be directed to Scott Hoefer of my staff at 503.231.6938.

Sincerely,

Michael Tehan
Chief, Oregon State Branch
Habitat Conservation Division

Enclosure:
Endangered, Threatened, Proposed, and Candidate Species That Occur under National Marine Fisheries Service Jurisdiction in Oregon

cc: Ellen Berggren, BOR
Peter Lickwar, USFWS

Enclosure

Endangered, Threatened, Proposed, and Candidate Species That Occur under National Marine Fisheries Service Jurisdiction in Oregon
(T=threatened, E=endangered, CH=critical habitat)

<u>Listed Species</u>:

Coho Salmon (*Oncorhynchus kisutch*)
- -S. Oregon/N. California Coasts Evolutionarily Significant Unit(ESU)(T)
- -Oregon Coast ESU (T)

Chinook Salmon (*O. tshawytscha*)
- -Snake River fall-run ESU (T)(CH)
- -Snake River spring/Summer-run ESU (T)(CH)
- Lower Columbia River ESU (T)
- Upper Willamette River ESU (T)
- Upper Columbia River Spring-run ESU (E)

Chum Salmon (*O. keta*)
- -Columbia River ESU (T)

Sockeye Salmon (*O. nerka*)
- -Snake River ESU (E)(CH)

Steelhead (*O. mykiss*)
- -Upper Columbia River ESU (E)
- -Snake River Basin ESU (T)
- -Lower Columbia River ESU (T)
- -Upper Willamette River ESU (T)
- -Middle Columbia River ESU (T)

<u>Proposed for Listing</u>:

-None

<u>Candidates for Listing</u>:

-Coho Salmon (*O. kisutch*)
- Lower Columbia River/SW Washington ESU

-Steelhead (*O. mykiss*)
- Oregon Coast ESU

Ellen Berggren

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Oregon Fish and Wildlife Office
2600 S.E. 98th Avenue, Suite 100
Portland, Oregon 97266
(503) 231-6179 FAX: (503) 231-6195

Reply To: 8330.7401(02)
File Name: Sp740.wpd
TS Number: 02-5889

June 28, 2002

Ronald J. Eggers
U.S. Bureau of Reclamation
825 NE Multnomah Street, Suite 1110
Portland, OR 97232-2135

Subject: Deschutes River Basin Projects
USFWS Reference # (1-7-02-SP-740)

Dear Mr. Eggers:

This is in response to your letter, dated May 28, 2002, requesting information on listed and proposed endangered and threatened species that may be present within the area of the Deschutes River Basin Projects in Deschutes County. The U.S. Fish and Wildlife Service (Service) received your correspondence on May 28, 2002.

We have attached a list (Attachment A) of threatened and endangered species that may occur within the area of the Deschutes River Basin Projects. The list fulfills the requirement of the Service under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*). U.S. Bureau of Reclamation (BR)requirements under the Act are outlined in Attachment B.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems on which they depend may be conserved. Under section 7(a)(1) and 7(a)(2) of the Act and pursuant to 50 CFR 402 *et seq.*, BR is required to utilize their authorities to carry out programs which further species conservation and to determine whether projects may affect threatened and endangered species, and/or critical habitat. A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) which are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (NEPA) (42 U.S.C. 4332 (2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to the Biological Assessment be prepared to determine whether they may affect listed and proposed species. Recommended contents of a Biological Assessment are described in Attachment B, as well as 50 CFR 402.12.

If BR determines, based on the Biological Assessment or evaluation, that threatened and endangered species and/or critical habitat may be affected by the project, BR is required to consult with the Service following the requirements of 50 CFR 402 which implement the Act.

Attachment A includes a list of candidate species under review for listing. The list reflects changes to the candidate species list published October 30, 2001, in the Federal Register (Vol. 66, No. 210, 54808) and the addition of "species of concern." Candidate species have no protection under the Act but are included for consideration as it is possible candidates could be listed prior to project completion. Species of concern are those taxa whose conservation status is of concern to the Service (many previously known as Category 2 candidates), but for which further information is still needed.

If a proposed project may affect only candidate species or species of concern, BR is not required to perform a Biological Assessment or evaluation or consult with the Service. However, the Service recommends addressing potential impacts to these species in order to prevent future conflicts. Therefore, if early evaluation of the project indicates that it is likely to adversely impact a candidate species or species of concern, BR may wish to request technical assistance from this office.

Your interest in endangered species is appreciated. The Service encourages BR to investigate opportunities for incorporating conservation of threatened and endangered species into project planning processes as a means of complying with the Act. If you have questions regarding your responsibilities under the Act, please contact Stacy Sroufe at (503) 231-6179. All correspondence should include the above referenced file number. For questions regarding salmon and steelhead trout, please contact National Marine Fisheries Service, 525 NE Oregon Street, Suite 500, Portland, Oregon 97232, (503) 230-5400.

Sincerely,

for Kemper M. McMaster
State Supervisor

Attachments
1-7-02-SP-740

cc: OFWO-ES
ODFW (nongame)

ATTACHMENT A

FEDERALLY LISTED AND PROPOSED ENDANGERED AND THREATENED SPECIES, CANDIDATE SPECIES AND SPECIES OF CONCERN THAT MAY OCCUR WITHIN THE AREA OF THE DESCHUTES RIVER BASIN PROJECTS
1-7-02-SP-740

LISTED SPECIES[1/]

Mammals		
Canada lynx[2/]	*Lynx canadensis*	T
Birds		
Bald eagle[3/]	*Haliaeetus leucocephalus*	T
Northern spotted owl[4/]	*Strix occidentalis caurina*	CH ~~T~~
Fish		
Steelhead (Middle Columbia River)[5/]	*Oncorhynchus mykiss*	**T
Bull trout (Columbia River pop)[6/]	*Salvelinus confluentus*	T

PROPOSED SPECIES

None

CANDIDATE SPECIES[7/]

Birds	
Yellow-billed cuckoo[8/]	*Coccyzus americanus*
Amphibians and Reptiles	
Columbia spotted frog	*Rana luteiventris*
Oregon spotted frog	*Rana pretiosa*

SPECIES OF CONCERN

Mammals	
Pygmy rabbit	*Brachylagus idahoensis*
Pale western big-eared bat	*Corynorhinus (=Plecotus) townsendii pallescens*
California wolverine	*Gulo gulo luteus*
Silver-haired bat	*Lasionycteris noctivagans*
Pacific fisher	*Martes pennanti pacifica*
Small-footed myotis (bat)	*Myotis ciliolabrum*
Long-eared myotis (bat)	*Myotis evotis*
Fringed myotis (bat)	*Myotis thysanodes*
Long-legged myotis (bat)	*Myotis volans*
Yuma myotis (bat)	*Myotis yumanensis*
California bighorn sheep	*Ovis canadensis californiana*
Preble's shrew	*Sorex preblei*

<u>Birds</u>	
Northern goshawk	*Accipiter gentilis*
Tricolored blackbird	*Agelaius tricolor*
Western burrowing owl	*Athene cunicularia hypugea*
Ferruginous hawk	*Buteo regalis*
Band-tailed pigeon	*Columba fasciata*
Greater sage-grouse	*Centrocercus urophasianus*
Black tern	*Chlidonias niger*
Olive-sided flycatcher	*Contopus cooperi (=borealis)*
Willow flycatcher	*Empidonax trailli adastus*
Harlequin duck	*Histrionicus histrionicus*
Yellow-breasted chat	*Icteria virens*
Lewis' woodpecker	*Melanerpes lewis*
Mountain quail	*Oreortyx pictus*
White-headed woodpecker	*Picoides albolarvatus*
<u>Amphibians and Reptiles</u>	
Coastal tailed frog	*Ascaphus truei*
Oregon slender salamander	*Batrachoseps wrighti*
Northern red-legged frog	*Rana aurora aurora*
Cascades frog	*Rana cascadae*
Northern sagebrush lizard	*Sceloporus graciosus graciosus*
<u>Fish</u>	
Pacific lamprey	*Lampetra tridentata*
Interior redband trout	*Oncorhynchus mykiss gibbsi*
<u>Invertebrates</u>	
Beller's ground beetle	*Agonum belleri*
California floater (mussel)	*Anodonta californiensis*
Cascades apatanian caddisfly	*Apatania (=Radema) tavala*
Mt. Hood farulan caddisfly	*Farula jewetti*
Great Columbia River spire snail	*Fluminicola columbianus*
One-spot rhyacophilan caddisfly	*Rhyacophila unipunctata*
<u>Plants</u>	
Wallowa ricegrass	*Achnatherum wallowaensis*
Peck's milk-vetch	*Astragalus peckii*
Crenulate grape-fern	*Botrychium crenulatum*
Disappearing monkeyflower	*Mimulus evanescens*
Little mousetail	*Myosurus minimus* ssp. *apus* (= var. *sessiliflorus*)
Lichen	*Texosporum sancti-jacobi*

(E) - Listed Endangered *(T) - Listed Threatened* *(CH) - Critical Habitat has been designated for this species*
(PE) - Proposed Endangered *(PT) - Proposed Threatened* *(PCH) - Critical Habitat has been proposed for this species*
(S) - Suspected *(D) - Documented*

Species of Concern - Taxa whose conservation status is of concern to the Service (many previously known as Category 2 candidates), but for which further information is still needed.

[1] *U. S. Department of Interior, Fish and Wildlife Service, October 31, 2000, Endangered and Threatened Wildlife and Plants, 50 CFR 17.11 and 17.12*

[2] *Federal Register Vol. 65, No. 58, Mar 24, 2000, Final Rule-Canada lynx*

[3] *Federal Register Vol. 60, No. 133, July 12, 1995 - Final Rule - Bald Eagle*

[4] *Federal Register Vol. 57, No. 10, January 15, 1992, Final Rule-Critical Habitat for the Northern Spotted Owl*

[5] *Federal Register Vol. 64, No. 57, March 25, 1999, Final Rule - Middle Columbia and Upper Willamette River Steelhead*

[6] *Federal Register Vol. 63, No. 111, June 10, 1998, Final Rule-Columbia River and Klamath River Bull Trout*

[7] *Federal Register Vol. 66, No. 210, October 30, 2001, Notice of Review - Candidate or Proposed Animals and Plants*

[8] *Federal Register Vol. 66, No. 143, July 25, 2001, 12-Month Finding for a Petition To List the Yellow-billed Cuckoo*

ATTACHMENT B

FEDERAL AGENCIES RESPONSIBILITIES UNDER SECTION 7(a) and (c) OF THE ENDANGERED SPECIES ACT

SECTION 7(a)-Consultation/Conference

Requires:

1) Federal agencies to utilize their authorities to carry out programs to conserve endangered and threatened species;
2) Consultation with FWS when a Federal action may affect a listed endangered or threatened species to insure that any action authorized, funded or carried out by a Federal agency is not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of Critical Habitat. The process is initiated by the Federal agency after they have determined if their action may affect (adversely or beneficially) a listed species; and
3) Conference with FWS when a Federal action is likely to jeopardize the continued existence of a proposed species or result in destruction or adverse modification of proposed Critical Habitat.

SECTION 7(c)-Biological Assessment for Major Construction Projects[1]

Requires Federal agencies or their designees to prepare a Biological Assessment (BA) for construction projects only. The purpose of the BA is to identify proposed and/or listed species which are/is likely to be affected by a construction project. The process is initiated by a Federal agency in requesting a list of proposed and listed threatened and endangered species (list attached). The BA should be completed within 180 days after its initiation (or within such a time period as is mutually agreeable). If the BA is not initiated within 90 days of receipt of the species list, the accuracy of the species list should be informally verified with our Service. No irreversible commitment of resources is to be made during the BA process which would foreclose reasonable and prudent alternatives to protect endangered species. Planning, design, and administrative actions may be taken; however, no construction may begin.

To complete the BA, your agency or its designee should: (1) conduct an on-site inspection of the area to be affected by the proposal which may include a detailed survey of the area to determine if the species is present and whether suitable habitat exists for either expanding the existing population or for potential reintroduction of the species; (2) review literature and scientific data to determine species distribution, habitat needs, and other biological requirements; (3) interview experts including those within FWS, National Marine Fisheries Service, State conservation departments, universities, and others who may have data not yet published in scientific literature; (4) review and analyze the effects of the proposal on the species in terms of individuals and populations, including consideration of cumulative effects of the proposal on the species and its habitat; (5) analyze alternative actions that may provide conservation measures and (6) prepare a report documenting the results, including a discussion of study methods used, any problems encountered, and other relevant information. The BA should conclude whether or not a listed species will be affected. Upon completion, the report should be forwarded to our Portland Office.

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[1] A construction project (or other undertaking having similar physical impacts) which is a major Federal action significantly affecting the quality of the human environment as referred to in NEPA (42 U.S.C. 4332. (2)c). On projects other that construction, it is suggested that a biological evaluation similar to the biological assessment be undertaken to conserve species influenced by the Endangered Species Act.

— APPENDIX B—

Water Quality Report

DESCHUTES RIVER BASIN BIOLOGICAL ASSESSMENT - WATER QUALITY

INTRODUCTION

Water quality in the Deschutes River basin is managed by the state of Oregon under a framework provided in the Clean Water Act (CWA). The state of Oregon promulgates water quality standards in the Deschutes River Basin for specific physical and chemical parameters in order to provide suitable conditions for support of recognized beneficial uses (Table 1).

On March 31, 2003, U.S. District Court Judge Ancer Haggerty ordered the EPA to void its earlier approval of Oregon's water temperature standards. Oregon has initiated rulemaking and is working in concert with the Oregon Department of Fish and Wildlife, EPA, NMFS, and U.S. Fish and Wildlife Service to develop new temperature criteria. For water quality discussions in this BA, Reclamation will use Oregon's existing temperature criteria for comparison purposes.

Section 303(d) of the CWA requires states to identify and develop a list of waters for which water quality is inadequate to fully support beneficial uses. The states then use the list to develop and implement water quality management plans, including pollutant load allocations. These water quality management plans and pollutant load allocations, commonly called Total Maximum Daily Load (TMDL), are scheduled for completion in 2005 for the Upper Deschutes subbasin, the Lower and Upper Crooked subbasins, and the Lower Deschutes subbasin. Water bodies, or stream reaches, that are potentially influenced by Reclamation projects in the Deschutes River basin that have been identified as not supporting beneficial uses and the pollutant causing the impairment are listed in Table 2.

Table 1. Recognized Beneficial Uses for the Deschutes Basin
(Source: State of Oregon ,Oregon Administrative Rules, Table 9, 2002)

Beneficial Uses	Columbia River (RM 203 to 218)	Deschutes River Main Stem from Mouth to Pelton Regulating Dam	Deschutes River Main Stem from Pelton Regulating Dam to Bend Diversion Dam and for the Crooked River Main Stem	Deschutes River Main Stem above Bend Diversion Dam and for the Metolius River Main Stem	All Other Basin Streams
Public Domestic Water Supply [1]	X	X	X	X	X
Private Domestic Water Supply [1]	X	X	X	X	X
Industrial Water Supply	X	X	X	X	X
Irrigation	X	X	X	X	X
Livestock Watering	X	X	X	X	X
Anadromous Fish Passage	X	X	X	X	X
Salmonid Fish Rearing	X	X	X	X	X
Salmonid Fish Spawning		X	X	X	X
Resident Fish and Aquatic Life	X	X	X	X	X
Wildlife and Hunting	X	X	X	X	X
Fishing	X	X	X	X	X
Boating	X	X	X	X	X
Water Contact Recreation	X	X	X	X	X
Aesthetic Quality	X	X	X	X	X
Hydro Power	X		X		
Commercial Navigation and Transportation	X				

1. With adequate pretreatment (filtration and disinfection) and natural quality to meet drinking water standards.

Table 2. 303(d) Listed Waters in the Deschutes River Basin

(Source: Oregon Department of Environmental Quality 2002, Oregon's Final 1998 Water Quality Limited Streams - 303(d) List)

Waterbody or Stream Reach	Impairment Parameter	Criteria
Crooked River: Mouth to Baldwin Dam	1. Temperature - Summer 2. Bacteria - Summer 3. pH - year around 4. Flow Modification	1. Rearing 64°F (17.8°C) 2. Water Contact Recreation - fecal coliform 400 cfu/100mL (listing based on the 1996 standard) 3. 6.5 - 8.5 4. No Criteria
Crooked River: Baldwin Dam to Prineville Reservoir	Total Dissolved Gas	110%
Ochoco Creek: Mouth to Camp Branch	Temperature - Summer	Rearing 64°F (17.8°C)
Clear Creek: Mouth to headwaters	Temperature - Summer	Rearing 64°F (17.8°C)
Deschutes River: Mouth to White River	1. pH 2. Temperature - Summer	1. 6.5 - 8.5 2. Rearing 64°F (17.8°C)
Deschutes River: White River to Reregulating Dam	1. Dissolved Oxygen - Oct - July 2. Temperature - Summer	1. Salmonid Spawning 11 mg/L 2. Oregon Bull Trout 50°F (10°C)
Wapinitia Creek: Mouth to Headwaters	Temperature - Summer	Rearing 64°F (17.8°C)
White River: Mouth to Rock Creek	Temperature - Summer	Rearing 64°F (17.8°C)
Deschutes River: Lake Billy Chinook to Steelhead Falls	pH - May - Sep	6.5 - 8.5
Deschutes River: Steelhead Falls to North Unit Main Canal	1. pH - May - Sep 2. Temperature - Summer 3. Flow Modification	1. 6.5 - 8.5 2. Rearing 64°F (17.8°C) 3. No Criteria

Waterbody or Stream Reach	Impairment Parameter	Criteria
Deschutes River: North Unit Canal to Central Oregon Canal	pH - Summer	6.5 - 8.5
Deschutes River: Central Oregon Canal to Little Deschutes	1. Dissolved Oxygen - Oct - July 2. Sedimentation 3. Turbidity - Spring/Summer 4. Flow Modification 5. Habitat Modification	1. Salmonid Spawning 11 mg/L 2. Formation of appreciable bottom deposits deleterious to fish is not allowed 3. No more than a 10% cumulative increase in natural stream turbidities 4. No Criteria 5. No Criteria
Deschutes River: Little Deschutes to Wickiup Reservoir	1. Dissolved Oxygen - Oct - July 2. Sedimentation 3. Turbidity - Spring/Summer 4. Flow Modification 5. Habitat Modification	1. Salmonid Spawning 11 mg/L 2. Formation of appreciable bottom deposits deleterious to fish is not allowed 3. No more than a 10% cumulative increase in natural stream turbidities 4. No Criteria 5. No Criteria
Deschutes River: Wickiup Reservoir to Crane Prairie Reservoir	Temperature - Summer	Rearing 64^{o}F (17.8^{o}C)
Lake Billy Chinook	1. Chlorophyll a - Spring/Summer/Fall 2. pH - Summer	1. 0.015 mg/L 2. 6.5 - 8.5
Squaw Creek: Alder Springs to Maxwell Ditch	1. Temperature - Summer 2. Flow Modification	1. Rearing 64^{o}F (17.8^{o}C) 2. No Criteria

^{o}C = Degrees Celsius ^{o}F = Degrees Fahrenheit mg/L = Milligrams per liter or parts per million cfu/100mL = Colony forming unit per milliliter

CROOKED RIVER PROJECT

Prineville Reservoir

Water quality in Prineville Reservoir is generally good and is suitable for all beneficial uses as identified by the state of Oregon. Surface water quality data collected by Reclamation (1978-1995) indicates that the water quality criteria are met under most conditions.

Prineville Reservoir surface water temperatures during July and August often exceed the cold water aquatic life temperature standard (17.8^{o}C). Reservoir profile data collected during July and August of 1985 and 1995 show that there are temperatures less than 17.8^{o}C in the lower 50 percent of the reservoir. The temperature cycle in the reservoir is typical of reservoirs in Oregon. During the spring, the reservoir has a relatively uniform vertical temperature profile. During the summer, the epilimnion is generally warm, turbulent, and well mixed. The hypolimnion is cold and relatively undisturbed. As the surface water cools during the fall, the reservoir turns over, returning to a near uniform temperature profile.

Increased turbidity in the reservoir is from two major sources: the reservoir proper and the watershed. Camp Creek, Bear Creek, Eagle Creek, Lost Creek, Klootchman Creek, Newsome Creek, and the Upper Crooked River were all shown to contain a high amount of suspended montmorillonite clays (OSU 1976). Since 1960, the estimated average annual rate of reservoir capacity lost to sediment accumulation is 122.3 acre-feet. This represents a 2.96 percent loss in reservoir volume (Reclamation 1999). Upstream land use practices including logging, road building, and livestock grazing contribute to erosion in the watershed. Wind induced waves and boat wakes also contribute to increased reservoir and down stream turbidity by eroding and resuspending shoreline sediments.

Nutrients (nitrogen and phosphorus) are available in sufficient quantities to support plant growth in the reservoir indicating a potential for algal blooms and eutrophic conditions. It is suspected that turbid conditions in the reservoir reduce light penetration to the extent that photosynthethic activity and plant growth are limited. This is supported by the low concentrations of chlorophyll a and minimal dissolved oxygen depletion in the lower levels of the reservoir during the summer months (ODFW 1996). Dissolved oxygen levels in the reservoir decrease somewhat during July and August, but not to the levels that would be indicative of eutrophic conditions.

Crooked River below Arthur R. Bowman Dam

Water released through Bowman Dam is of suitable quality to support beneficial uses. On occasion during periods of high flow, total dissolved gas levels rise above 110 percent and may cause some gas bubble disease in the rainbow trout population in the Crooked River below Bowman Dam. Total dissolved gas below Bowman Dam will be addressed through Oregon's TMDL process in 2005.

Turbidity in Prineville Reservoir is noticeable downstream of Bowman Dam, especially when irrigation releases begin in the spring. Primary sources of turbidity and sedimentation include land management activities upstream of Prineville Reservoir and wave action within the reservoir. The stream flow regime is sufficient to transport the undesirable finer sediment through the Crooked River system. Turbidity levels decline as the irrigation season progresses.

Large diversions from the Crooked River lead to low flow in the river during the irrigation season. This reduced flow along with high air temperature and lack of riparian vegetation results in elevated stream temperature below the Prineville valley. Sedimentation, streambank erosion, and nutrient loading in the lower stretches of the Crooked River result from land practices and agricultural return flows. Nutrient concentrations in the Lower Crooked River near Terrebonne are sufficient to allow excessive algal growth to occur. Opal Springs provides dilution flows to the Crooked River upstream from its confluence with Lake Billy Chinook.

Ochoco Reservoir

Water quality in Ochoco Reservoir is suitable to support the beneficial uses identified by the state of Oregon. Historical data show thermal stratification and some dissolved oxygen depletion in Ochoco Reservoir during the summer months. Generally the reservoir fully mixes in the fall, resulting in uniform temperature and dissolved oxygen concentrations through the reservoir profile. During low flow years, the reservoir may be drafted to low levels to meet irrigation demands thus reducing the amount of cool water in the hypolimnion.

Ochoco Creek below Ochoco Dam

Ochoco Dam release temperature increases in the late summer when the reservoir is at low levels. In most years, except dry water years, release temperatures meet the Oregon temperature standard for salmonid rearing. Crooked River basin streams monitored for temperature between 1997 and 1998 as part of the Regional Environmental Monitoring and Assessment Program (REMAP) project showed elevated temperatures. Additional monitoring and correlation work is needed to identify specific causes of the elevated stream temperatures downstream of Ochoco Dam.

DESCHUTES PROJECT

Crane Prairie Reservoir

Crane Prairie Reservoir water quality currently supports the beneficial uses as identified by the state of Oregon. Limited water quality data for Crane Prairie Reservoir indicate that the reservoir exhibits weak thermal stratification with minimal dissolved oxygen depletion. Some data suggest eutrophic conditions, while others suggest a healthy reservoir system. When the reservoir is drafted to low levels during the summer, often during low water years, release temperatures often exceed 17.8°C.

Average loss due to seepage between 1939 and 1950 at Crane Prairie Reservoir is approximately 60,000 acre-feet per year or 83 cfs. Depending on the stage of the reservoir, the rate of loss ranges from 30 to 135 cfs. USGS estimates that some of the seepage returns to the Deschutes River through springs three to four miles downstream of Crane Prairie Dam along what is now an arm of Wickiup Reservoir. Some of the seepage loss may contribute to the regional groundwater flow system and likely benefits downstream water quality.

Wickiup Reservoir

The primary water supply to Wickiup Reservoir is Crane Prairie Reservoir and springs. Historical water quality data indicate that mild algal growth may occur in the reservoir during the later part of summer. Water quality within Wickiup Reservoir currently supports beneficial uses identified by the state of Oregon.

Deschutes River below Wickiup Dam

The segment of the Deschutes River from below Wickiup Dam to the Central Oregon Canal is included on Oregon's 303(d) list for turbidity, sedimentation, and dissolved oxygen. Increases in turbidity occur when irrigation water deliveries from Wickiup Dam begin in the spring and decrease as the irrigation season progresses. These spring irrigation releases tend to erode the loose soil in the bed and banks of the stream resulting in increased turbidity level. These loose soils are caused by frost heave conditions during the winter months. Turbidity in the mid-summer to fall is likely from algae blooms in Wickiup Reservoir. Potential sources of pollutants to the Deschutes River include residential and commercial development, failing septic systems, recreation, and forestry and agricultural land use practices.

Some reduced dissolved oxygen levels have been observed in the Deschutes River (RM 191.7, ODEQ Site 402363) between October and July. A minimum concentration of 7.3 mg/L was detected between water year 1985 and 1995. A concentration of 11.0 mg/L has been identified by the state of Oregon for protection of salmonid spawning. Sedimentation (collection of fines in spawning gravels that limit embryo survival rates for trout), has been identified as an impairment in the Deschutes River below Wickiup Dam to Central Oregon Canal.

In the reaches of the Deschutes River just upstream of Lake Billy Chinook, flows are greatly influenced by groundwater. A USGS Water-Resources Investigations Report (WRI 97-4233) describes the stream flow in the lower reaches of the Deschutes and Crooked Rivers above Lake Billy Chinook to be dominated by groundwater discharge from April through November (Caldwell 1998). The groundwater inflow affects the water chemistry of the Deschutes River. The USGS concluded that, based on specific conductance, the initial gains in the Deschutes River flow (RM 138 to 134) are probably due to groundwater flowing from the southeast or east, whereas the most significant gains (RM 134 to 123) are dominated by the discharge of groundwater with lower dissolved solids concentrations flowing from the south or west (Caldwell 1998). The primary sources of this groundwater flow are Deschutes River losses in the upper reaches, canal seepage, and deep percolation of water applied to irrigated lands.

Water quality in the Pelton-Round Butte Project reservoirs is generally good, even though natural phosphorous and silicon levels from local geology and introduced nitrogen from upstream activities create seasonal algal blooms that some what degrade reservoir water quality. The reservoirs act as a nutrient sink for the upper and middle Deschutes River subbasins and the Crooked River subbasin. Natural phosphorus is associated with the geology of the watershed, especially in the Metolius River subbasin. Although upstream uses adversely influence the quality of water in the middle Deschutes and lower Crooked Rivers, these subbasins contribute generally fair to good water quality to Lake Billy Chinook because of groundwater recharge upstream of the lake in both subbasins.

Water quality of the inflows, Deschutes, Metolius, and Crooked Rivers, to Lake Billy Chinook is altered before being released to the lower Deschutes River by impoundment and the operation of the Pelton-Round Butte Project Dams. Water quality below Lake Billy Chinook is driven by operation of the dams in the Pelton Round Butte Project. The river immediately below the Pelton-Round Butte Project experiences low dissolved oxygen concentrations and modified temperature because of the hydroelectric project operations and influence of its reservoirs. Higher summer water temperatures are also influenced by ambient air temperatures in the river canyon. Sediment sources in the lower channel are limited to channel beds and banks and tributary inflows. The Deschutes River below the White River confluence is limited in pH and temperature.

Haystack Reservoir

Haystack Reservoir serves as a reregulating reservoir for the lower part of the Deschutes Project. Water quality within the reservoir is suitable for the agricultural uses and the rainbow trout that are stocked annually in the reservoir.

WAPINITIA PROJECT

Clear Lake and Clear Creek below Wasco Dam

Source water for Clear Lake is snow melt from Mount Hood. Generally the water quality is good, but runoff from Mt. Hood carries a large sediment load. Reservoirs in this area collect the phosphorus and store a portion of this natural phosphorus within the consolidated sediments, thus acting as a phosphorus sink. Water quality in the tributaries and the lower Deschutes River is good.

Water provided to the Wapinitia Project from Clear Lake usually uses the entire amount of storage available each year. Water quality effects of this water delivery on the lower Deschutes River is minimal considering water delivered is reused or collected in a pond at the lower end of the project and pumped back for reuse. Minimal pollutants from agriculture and private land use in the Wapinitia Project area affect the water quality in the lower Deschutes River.

PROJECT EFFECTS

Introduction

The proposed action for this biological assessment is the continuance of operation and maintenance of Reclamation project facilities in the Deschutes River basin. For comparison purposes, modeled hydrology was completed to show modeled flows in the Deschutes River basin at specific points under current operations (with Reclamation) and without Reclamation operations, but with the facilities still in place (without).

Reclamation Storage Reservoirs

The general operation of the Reclamation storage facilities in the Deschutes River and Crooked River basins include storage, delivery, and flood control (formal and informal). Specific operation of the Reclamation projects in the Deschutes River and Crooked River basins are described in the *Operations Description of the Deschutes River Basin Projects* report (USBR 2003). Crane Prairie, Wickiup, and Prineville Reservoirs provide most of the flow regulation on the Deschutes and Crooked Rivers. Water quality within the reservoirs is determined, in part, by the timing of storage and release operations resulting in changes in reservoir elevations. The other component of the reservoir water quality is inflow and land use practices in the watershed draining into the reservoirs.

Crane Prairie and Wickiup Reservoirs

Crane Prairie and Wickiup Reservoirs are operated jointly. Water quality of the inflows to these reservoirs is of relatively high quality and providing suitable water quality within the reservoirs. Over the summer period when the reservoirs are drafted, the thermal stratification in both reservoirs becomes less defined. The average water temperature in the water column becomes warmer as the reservoir elevation drops. During the fall or under windy conditions, the reservoir will mix from top to bottom resulting in a near uniform temperature in the water column. Under certain conditions, natural phosphorus entering the reservoirs and limited nitrogen introduced into the system will result in late season algal blooms. The intensity of these blooms is low and likely do not cause depleted dissolved oxygen conditions from decaying algae or under ice conditions.

Deschutes River below Wickiup Dam (Upper and Middle Deschutes Rivers)

Water quality in the upper and middle reaches of the Deschutes River is affected by urbanization, dam operations, private land use practices, groundwater returns, and Federal and non-Federal irrigation diversions and returns. The state of Oregon has identified temperature, turbidity, and sedimentation as water quality problems in these two reaches. A 1997 report completed as part of the Pelton Round Butte Limnology Study (project number 2030) provides a substantial amount of discussion concerning the effects of the major tributaries on the limnology of Lake Billy Chinook, Lake Simtustus, and the water quality of the water being released to the lower Deschutes River (see Raymond and Eilers 1997). The major tributaries to Lake Billy Chinook are the Crooked River, the Deschutes River, and the Metolius River. The report presents an interpretation of data collected from July 1994 through October 1996 and associated conclusions.

Turbidity and sedimentation increases in the Deschutes River between Wickiup Dam and Bend are primarily associated with private land use activities and elevated runoff associated with snow melt and storm events. Without Reclamation, river flows in the upper and middle Deschutes reaches would be higher during snow melt and storm events. These elevated flows would carry more sediment in the water column and result in a larger sediment load to the Pelton Round Butte Complex. Store and release operations at Reclamation reservoirs in the upper reaches of the Deschutes River capture sediment and reduce downstream loads. Under the proposed action, reduced flows due to storage operations are not effective in flushing sediment that enters the Deschutes River below the Reclamation reservoirs through the Deschutes River system. When irrigation releases are made during the early spring, some of the sediment that accumulates in the Deschutes River below Reclamation dams during storage operations is transported further downstream.

Water temperature in the upper and middle reaches of the Deschutes River is primarily affected by ambient air temperature and flow. Temperature data gathered (1997 - 2002) from gages in the Deschutes River below Wickiup Dam, Benham Falls, and Bend were correlated with mean daily flow (cfs) and maximum daily air temperature at Madras, Oregon (Figure A). Variability in daily maximum water temperature in the Deschutes River below Wickiup Dam is accounted for, nearly equally, by flow (r = 0.84) and air temperature (r = 0.83). Periods of high flow below Wickiup Dam primarily occur during the irrigation season, when air temperature is at the highest for the year, thus resulting in a similar, positive relationship. Daily maximum water temperature below Wickiup Dam between 1997 and 2002 reached 19.4°C (67°F) during the summer months.

Without Reclamation, flow and temperature patterns at the upper Deschutes River gage below Wickiup would be much different than under the proposed action hydrograph, which is defined by store and release operations. Temperature of the release water is dependent upon the elevation of the outlets, ambient air temperature at the monitoring location, and thermal stratification within the reservoir. Under the proposed action, flows are higher during the irrigation season (May through September). This additional flow increases the time it takes for the water temperature to warm to an equilibrium condition with the ambient air temperature during the summer months.

Flow in the Deschutes River between Bend and Steelhead Falls is reduced by upstream diversions during the irrigation season. With this large reduction in flow, water temperature in this reach is strongly correlated with air temperature (r = 0.91) (Figure A). Limited riparian shading along with reduced flow in this reach (Bend to Steelhead Falls) likely intensifies the diel temperature pattern. However, groundwater recharge to the Deschutes River (below RM 136) provides additional flow and rapid cooling before the water enters Lake Billy Chinook.

Effects of Upstream Deschutes River Activities on Lake Billy Chinook and Lower Deschutes

Study of the thermal regimes in Lake Billy Chinook and Lake Simtustus, along with flow and mixing studies, were completed as part of the Pelton-Round Butte Complex FERC relicensing project. This 1997 report (Raymond and Eilers 1997) on the limnology of Lake Billy Chinook and Lake Simtustus clearly explains the thermal and chemical processes occurring in the two lakes, how flow from the tributaries mix, and how the temperature and quality of the releases to the lower Deschutes River are affected.

Depletion of dissolved oxygen in Lake Billy Chinook occurs on a seasonal basis, mostly during the summer months. This depletion occurs mostly in the deeper water as the result of algae respiration in the hypolimnion of Lake Billy Chinook. Because the major tributaries to Lake Billy Chinook are well oxygenated, the effects of respiration in the hypolimnion of Lake Billy Chinook is mitigated by the infusion at depth of the cooler tributary water. The short residence time of Lake Simtustus does not allow enough time for oxygen depletion in the hypolimnion to occur (Raymond and Eilers 1997). The 1998 303(d) dissolved oxygen listing in the lower

Deschutes River between the Reregulating Dam to the White River is based on 6 of 21 dissolved oxygen measurements between October and June (water years 1986 - 1995) were below Oregon's 11.0 mg/L or 95 percent saturation salmonid spawning criteria. The minimum dissolved oxygen value measured in that period was 8.9 mg/L (86 percent saturation).

Nutrients (phosphorus and nitrogen) are supplied to Lake Billy Chinook and Lake Simtustus by the tributaries in concentrations that are sufficient for plant growth in both lakes. A comparison of phosphorus loads between the major tributaries to Lake Billy Chinook indicated that most of the phosphorus appears to be of natural origin. Lake Simtustus has more algal growth due to the shallow epilimnion and a large amount of nitrogen load from Willow Creek. One conclusion from this study is that both lakes retain water from the most nutrient rich tributaries, the Crooked and Deschutes Rivers, in the epilimnion during the summer and discharge cooler, lower nutrient water (Raymond and Eilers 1997).

Historical water temperature data collected at various locations in the Deschutes River were used to look at annual water temperature patterns in the Deschutes River. Maximum daily water temperature data collected over multiple years were sorted by Julian day then averaged to get an average daily maximum temperature (Figures C and D). This information is used to show the effects of Reclamation storage, release, and diversion operations in the middle and upper Deschutes River and resulting impacts on the lower Deschutes River.

In 2001, the Oregon Department of Environmental Quality (ODEQ) contracted Watershed Sciences for thermal infrared remote (TIR) sensing to map and assess stream temperatures in the Deschutes River basin. The data presented in Figure B is the median, water surface temperature of the Deschutes River collected on July 25 and 26, 2001. Although stream temperature changes that occur during the course of the temperature survey are not reflected in the longitudinal temperature profile, general stream temperature warming and cooling trends are reflected in Figure B. An overall warming trend is apparent between RM 167 (near Bend) and 139 (just upstream of Odin Falls) with some small cooling stretches. A large drop in surface water temperature occurs upstream of Lake Billy Chinook between RM 133 (Lower Bridge) and 128 (just downstream of Steelhead Falls). ODEQ measured 16 cold water inputs (springs and tributaries) between RM 132 and the inlet of Lake Billy Chinook (approximately 14.4 miles).

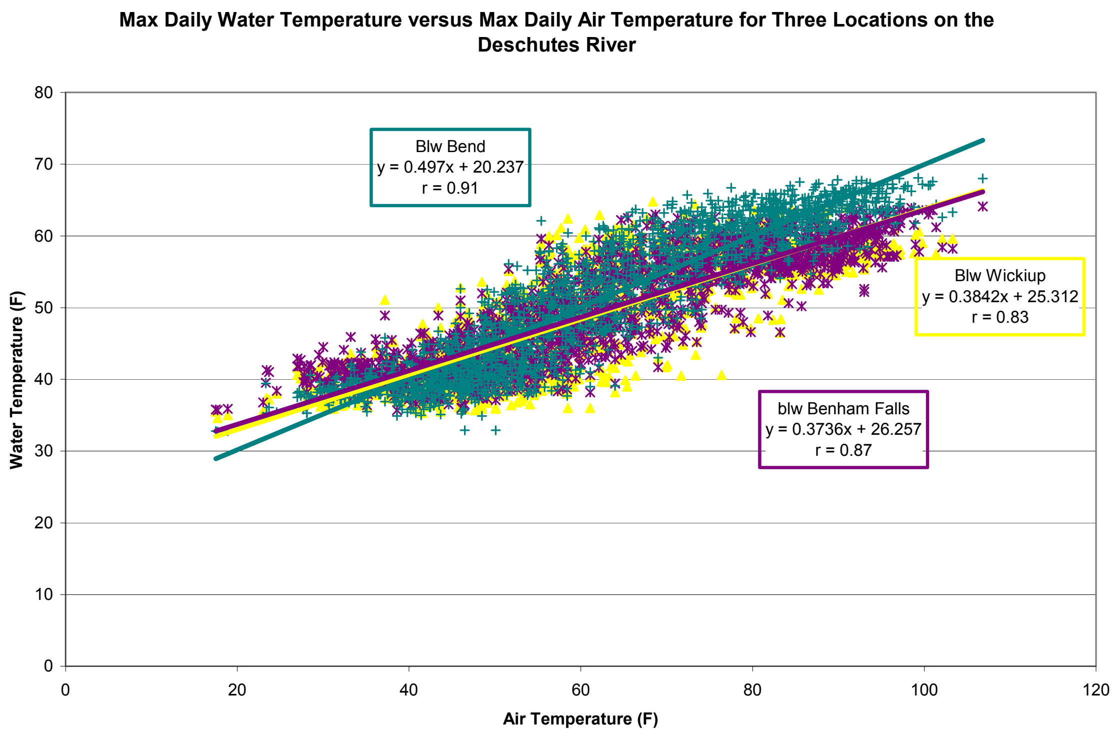

Max Daily Water Temperature versus Max Daily Air Temperature for Three Locations on the Deschutes River
Blw Bend
y = 0.497x + 20.237
r = 0.91
Blw Wickiup
y = 0.3842x + 25.312
r = 0.83
blw Benham Falls
y = 0.3736x + 26.257
r = 0.87
Water Temperature (F)
Air Temperature (F)
0
10
20
30
40
50
60
70
80
0
20
40
60
80
100
120

Figure A

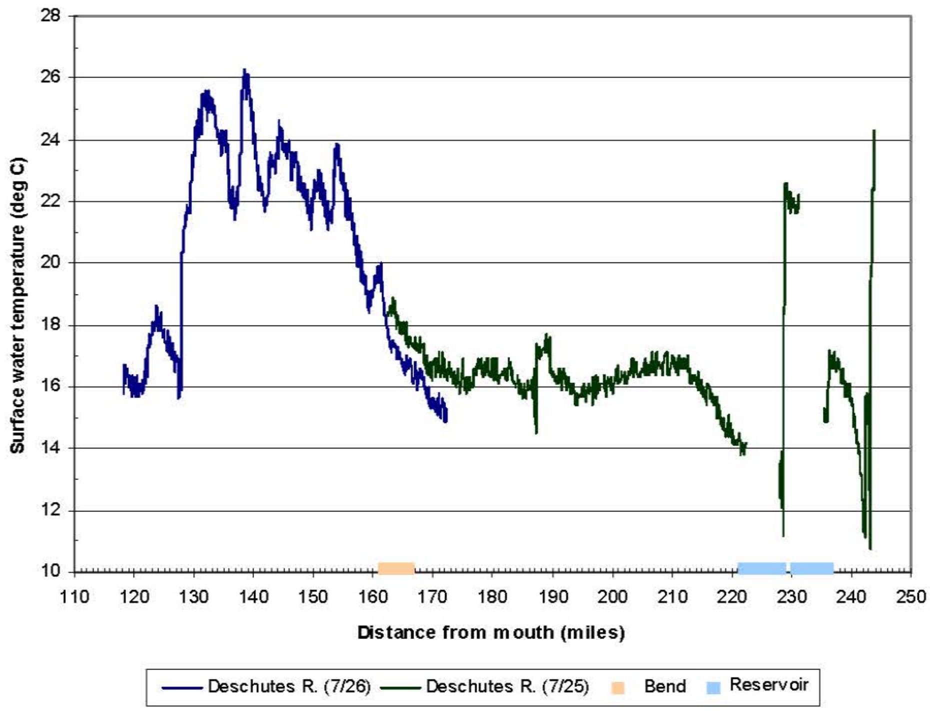


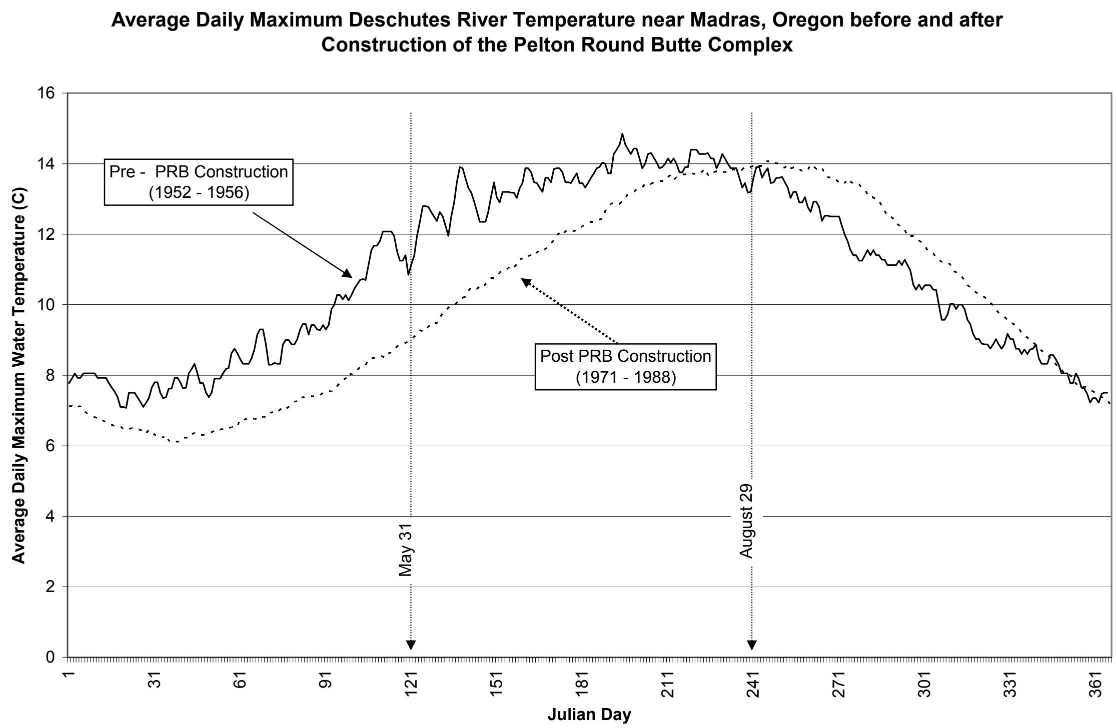
Figure B. Median channel temperature versus river mile for the Deschutes River, OR from Lake Billy Chinook to the headwaters at Little Lava Lake (7/25/01 – 7/26/01).

The water temperature of the Deschutes River above Lake Billy Chinook has a pronounced seasonal variation, with the highest temperatures occurring in July and August and the coolest temperatures in January. The seasonal trend of water temperature measured just downstream from Bend, Oregon closely reflects the seasonality of the air temperature. Maximum water temperature just downstream from Bend, Oregon approaches 20°C during the summer period, but the inflow of groundwater near Culver reduces the summer maximum water temperature, on average, by approximately 3.5°C. Water temperatures near Culver rarely exceed 15°C during the peak summer months.

Reduced flow near Bend due to diversions may allow water temperatures between Bend and Culver to come to equilibrium with the ambient air temperature at a faster rate, but also improves the effectiveness of the returning groundwater to cool the flow. If higher flows existed during the summer months between Bend and Culver, the resulting temperatures after mixing with groundwater returns would likely be warmer due to dilution of cool groundwater returns. Groundwater inflow determines the temperature of the Deschutes River immediately upstream from Lake Billy Chinook thus the smaller the amount of warm water mixing with the cool groundwater, the cooler the Deschutes will be when entering Lake Billy Chinook.

The Deschutes River temperature immediately below the Pelton Round Butte Complex is primarily driven by the operation of the Pelton Round Butte Complex. Historical data indicate changes in the timing of annual temperature extremes in the Lower Deschutes River but show little change in the magnitude of the extremes (Huntington et al. 1999) (Figure C). Considering the travel time in Lake Billy Chinook and Lake Simtustus, 66 to 83 days depending on the amount of thermal stratification, warm Deschutes River water that enters Lake Billy Chinook during the hottest period of the summer does not reach the lower Deschutes until 66 to 83 days later. Even when the warmest water is released into the lower Deschutes reach, between late August and early October, the amount of natural warming that occurs during a day is reduced, thus daily maximums are lower.

Examination of available water temperature data above and below the Pelton Round Butte Complex, indicates that the Deschutes River water temperature between Bend and Culver approaches equilibrium with the ambient air temperature quickly due to reduced flow, but groundwater returns near Culver provide beneficial cool flows that reduce the Deschutes River temperature to levels (around 14°C) that are generally suitable for salmonids before it enters Lake Billy Chinook. Water temperature immediately below the Pelton Round Butte Complex is usually suitable for salmonids. The thermal pattern of water temperature for the Deschutes River at Culver and at Madras are similar but maximum and minimum water temperatures occur at different times of the year due to the hydraulic resident time of the Pelton Round Butte Complex (Figure D).



Average Daily Maximum Deschutes River Temperature near Madras, Oregon before and after
Construction of the Pelton Round Butte Complex
Average Daily Maximum Water Temperature (C)
Julian Day
Pre - PRB Construction
(1952 - 1956)
Post PRB Construction
(1971 - 1988)
May 31
August 29
16
14
12
10
8
6
4
2
0
1
31
61
91
121
151
181
211
241
271
301
331
361

Figure C

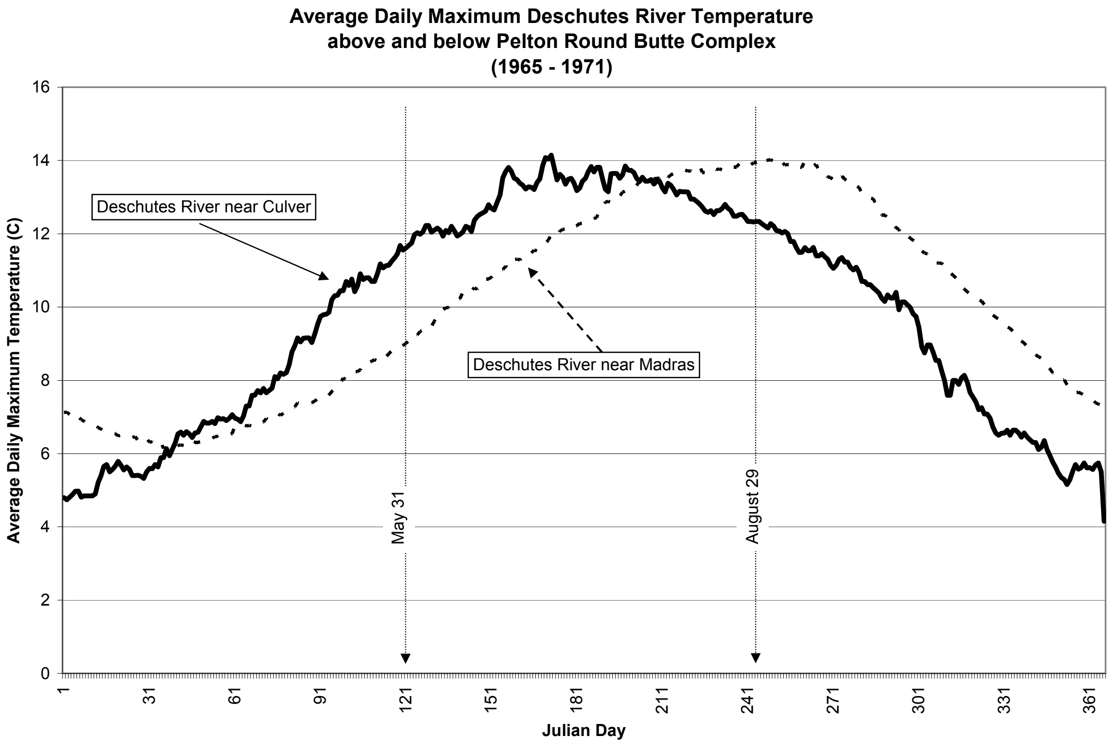


Figure D

Below the Pelton Round Butte Complex, the Deschutes River water temperature is cooler during peak summer months than it would likely be without the Pelton Round Butte Complex. The thermal effects in the lower Deschutes River of the proposed action and other water and land use activities on water temperature upstream from the Pelton Round Butte Complex are buffered by the groundwater flow above Lake Billy Chinook and operation of the Pelton Round Butte Complex. The effects, if any, of Reclamation activities occurring upstream from the Pelton Round Butte Complex on the thermal regimes in the lower Deschutes River are not apparent.

Water Quality Bibliography

Anderson, C.W. 2000. *Framework for the Regional, Coordinated Monitoring in the Middle and Upper Deschutes River Basin, Oregon*. USGS Open-File Report 00-386. U.S. Geological Survey, Portland OR.

BLM (Bureau of Land Management) and Reclamation (Bureau of Reclamation). 1992. *Lower Crooked River Wild and Scenic River (Chimney Rock Segment) Management Plan*. October 1992. Prineville OR.

Breithaupt, S., T. Khangaonkar, Z. Yang, and C. DeGaspari. 2001. *Water Quality Model of the Lower Deschutes River.* Foster Wheeler Environmental Corporation.

Caldwell, R.R. 1998. *Chemical Study of Regional Ground-Water Flow and Ground-Water/Surface-Water Interaction in the Upper Deschutes Basin, Oregon.* USGS Water-Resources Investigations Report 97-4233. U.S. Geological Survey, Portland OR.

Caldwell, R.R. and M. Truini. 1997. *Ground-Water and Water-Chemistry Data for the Upper Deschutes Basin, Oregon*. USGS Open-File Report 97-197. U.S. Geological Survey, Portland OR.

Confederated Tribes of the Warm Springs Reservation of Oregon and Portland General Electric. June. *Final Joint Application Amendment for The Pelton-Round Butte Hydroelectric Project*. June 2001. FERC Project Nos. 2030 and 11832. Portland OR.

Crooked River Watershed Council. 2002. *Crooked River Watershed Assessment*. July 2002.

Gannett, M.W., K.E. Lite Jr., D.S. Morgan, and C.A. Collins. 2001. *Ground-Water Hydrology of the Upper Deschutes Basin, Oregon.* USGS Water-Resources Investigations Report 00-4162. U.S. Geological Survey, Portland OR.

Huntington, C., Hardin, T., and R. Raymond. 1999. *Water Temperatures in the Deschutes River, Oregon*. Final Report.

Khangaonkar, T., Yang, Z., DeGasperi, C., Johnson, P., and C. Sweeney. (ENSR). 1999. *Preliminary Temperature and Hydrodynamic Modeling of Lake Billy Chinook - Pelton/Round Butte Hydroelectric Project.*

Oregon Department of Environmental Quality. 1998. *1997 - 98 Upper Deschutes R-EMAP Temperature Summary*. D.G. Mochan. Technical Report Number BIO98-02. Portland OR.

Hubler, S. 1999. *Upper Deschutes River basin R-EMAP, 1997 - 1998 Water Chemistry Summary*. Technical Report BIO99-04. Oregon Department of Environmental Quality, Portland OR.

Oregon Department of Environmental Quality. 2002. *Final 1998 Water Quality Limited Streams 303(d) List.*

Oregon Department of Environmental Quality. 2002. *Final 2002 Water Quality Limited Streams 303(d) List.* Not Approved by the EPA as of March 9, 2003.

Oregon Department of Environmental Quality. 2002. *DRAFT Upper and Middle Deschutes River Basins Watershed Characterization*.

Oregon Department of Fish and Wildlife. 1996. *Crooked River Fish Plan.* Prineville, Oregon.

Oregon State University. Agricultural Experiment Station. 1976. *Soil and Watershed Characteristics in Relation to Turbidity of the Prineville Reservoir.* Special Report 453. February1976. Corvallis, Oregon.

Hubler, S. 2000. *Upper Deschutes River Basin REMAP, 1998-98 Vertebrate Summary*. Technical Report BIO00-0008. Oregon Department of Environmental Quality, Portland OR.

Raymond, R.B. and J.M. Eilers. 1997. *Final Report on the Limnology of Lake Billy Chinook and Lake Simtustus, Oregon, Pelton Round Butte Limnology Study*. E&S Environmental Chemistry. Corvallis, Oregon.

Raymond, R.B., and J.M. Eilers. 1999. *Lower Deschutes River Water Quality Studies.*

Raymond, R.B., Eilers, J., Bernert, J., and K. Vache. 1998. *Lower Deschutes River Studies Water Quality and Biota - 1997 Final Report.* April 1998.

Reclamation (U.S. Bureau of Reclamation). 1980? *Ochoco Reservoir Temperature Study*.

Reclamation (U.S. Bureau of Reclamation). 1981. *Lower Deschutes Basin, Oregon; Appraisal: Volume I Supporting Data: Water Quality*. September 1981. Salem OR.

Reclamation (U. S. Bureau of Reclamation). 1993. *Upper Deschutes River Basin Water Conservation Project, Oregon. Surface Water Quality Study Report*. November 1993. Denver CO.

Reclamation (U.S. Bureau of Reclamation). 1999. *Prineville Reservoir, 1998 Sedimentation Survey.* March 1999. Denver CO.

Reclamation (U.S. Bureau of Reclamation). 2003. *Operations Description of the Deschutes River Basin Projects.* Pacific Northwest Region, Boise, Idaho.

Reclamation (U.S. Bureau of Reclamation) and Oregon Water Resources Department. 1997. *Special Report: Upper Deschutes River Basin Water Conservation Study*. April 1997. Crook, Deschutes, and Jefferson Counties OR.

State of Oregon. 2002. *Oregon Administrative Rules*. Division 41. Accessed May 14, 2002.

State of Oregon. 2002. *Second Unified State Position Pelton- Round Butte Hydroelectric Project, Oregon State License Nos. 217 and 222, Federal License No. 2030*. March 2002.

U.S. Forest Service (Deschutes National Forest), Oregon State Parks, and National Wild and Scenic Rivers System. 1996. *Upper Deschutes Wild and Scenic River and State Scenic Waterway Comprehensive Management Plan*. July 1996.

U.S. Forest Service (Deschutes National Forest), Oregon State Parks, and National Wild and Scenic Rivers System. 1995. *Upper Deschutes Wild and Scenic River Management Plan and Draft Environmental Impact Statement*. September 1995.

Watershed Sciences. 2002. *Aerial Surveys in the Deschutes River Basin, Thermal Infrared and Color Videography.* Report to the Oregon Department of Environmental Quality. February 11, 2002.

Yang, Z., T. Khangaonkar, C. DeGaspari, and S. Breithaupt. ???? *Water Quality Model of Lake Simtustus.* Foster Wheeler Environmental Corporation.

— APPENDIX C—

Extended Deschutes Surface Water Distribution Model – Users Manual Version October 31, 2002

Extended Deschutes Surface Water Distribution Model: Development and Assumptions

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1. BACKGROUND

The Extended Deschutes Surface Water Distribution Model (Extended Model) was created to analyze flow scenarios for the Deschutes River Basin BA. The Extended Model combined the products of three separate models and studies: 1) The Upper and Middle Deschutes Basin Surface Water Distribution Model, 2) The Crooked River Surface Water Distribution Model, and 3) a spreadsheet analysis of the White River. Model output reflects the October 31, 2002 version of the model.

The Upper and Middle Deschutes Basin Surface Water Distribution Model was developed by the Oregon Water Resources Department (OWRD). The scope of this model extends from the headwaters of the Deschutes and Little Deschutes Rivers to the Deschutes River Below Bend (RM 164.3). Diversions and creek inflows as far downstream as Tumalo Creek (RM 160.2) are also provided in the model. Documentation for this model is found in the *Upper and Middle Deschutes Basin Surface Water Distribution Model.*[1] This model was extended by Reclamation to the Deschutes River near Madras (RM 100.1).

The Crooked River Surface Water Distribution Model was developed by Reclamation from 1997 through 2001. The scope of the model is from the Crooked River above Prineville Dam (RM 70.5) and from Ochoco Creek above Ochoco Dam (RM 10.6) to the Crooked River Near Terrebonne gage (RM 27.7). Modeled Terrebonne flows were incorporated into the Extended Deschutes Model. Documentation for this model is included in Section 2, "Crooked River Surface Water Distribution Model."

A White River spreadsheet analysis determined effects from the operation of the Wapinitia Project. A discussion of this analysis is contained in *Effects of Wasco Dam Storage on White River Flows.*[2]

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[1] La Marche, J. 2001. *Upper and Middle Deschutes Basin Surface Water Distribution Model*. Surface Water Open File Report #SW02-001. Oregon Water Resources Department. Available in PDF.
[2] Mellema, M. 2002. *Effects of Wasco Dam Storage on White River Flows.* Unpublished Report. U.S. Bureau of Reclamation, Pacific Northwest Regional office.

Flow effects at the Deschutes River at Moody (RM 1.4) were determined by applying the calculated flow effects due to the Wapinitia Project and the modeled flow effects at the Deschutes River Near Madras to historic (observed) flows Near Moody.

2. CROOKED RIVER SURFACE WATER DISTRIBUTION MODEL

The model was constructed using Modsim.[1] The model was developed to demonstrate Prineville and Ochoco Reservoir contents, irrigation deliveries, and Crooked River flows that would be likely to occur under alternate allocation and distribution scenarios. Historic monthly inflows to Prineville and Ochoco Reservoirs for the years 1962-1999 enter the reservoirs and are distributed according to defined operations criteria.

Due to the lack of diversion data, modeled requests for diversions are based on estimated crop irrigation requirements and distribution and delivery efficiencies. If adequate flow is not available or if the diverter does not have a storage or natural flow right to that water, the full request can not be diverted, and a shortage occurs.

The Crooked River Surface Water Distribution Model was used to determine surface water and groundwater contributions from the Crooked River into Lake Billy Chinook. The modeled contributions were incorporated as gains and losses into the Extended Deschutes Basin Surface Water Distribution Model.

The following discussion describes the assumptions used in developing the Crooked River Surface Water Distribution Model and in extending the Upper and Middle Deschutes Surf ace Water Model.

Model Scope

The most upstream nodes of the model include inflow to Prineville and Ochoco Reservoirs. The most downstream node of the model is the Terrebonne gage (RM 27.7).

Gains Data Set and Calibration

Gains above Prineville Reservoir: The monthly gains (reservoir inflows) for water years 1962 through 1999 were estimated from a balance around the reservoir, so that:

$$gains = S(f) - S(i) + Rel + evap \quad [AF/mo]$$

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[1] Modsim is a general, multi-purpose, multi-reservoir water allocation and simulation tool originally developed by Dr. John Labadie at Colorado State University, and since 1994 developed cooperatively with the Bureau of Reclamation. Documentation and the model can be downloaded from http://modsim.engr.colostate.edu.

where S(f) and S(i) are final and initial end-of-month storage values, Rel is the total monthly release, and evap is the total monthly evaporation.

Gains above Ochoco Reservoir: Gains above Ochoco Reservoir were calculated using a balance around the reservoir, similar to the calculation for gains above Prineville Reservoir. Missing gains (when all the data necessary for a balance were not available) were developed by using gains from similar water supply years.

Post-dam Historic Regulated Flows for the Crooked River Near Terrebonne: Flows at Terrebonne were required to calibrate the model and to develop the gains to the Crooked River below the Crooked River Feed Canal and gains to the Ochoco Feed Canal.

Estimated and observed historic flows at Terrebonne were developed using the following approaches:

- Water Years (WY) 1968-1973 and WY 1994-2001: Observed flows
- WY 1962-1967 and WY 1974-1993: Monthly flows at Terrebonne were estimated using a linear correlation to the Crooked River below Opal Springs.

Gains below the Crooked River Feed Canal and Gains to the Ochoco Feed Canal: A calibration model was used to determine the gains below the Crooked River Feed Canal and the gains to the Ochoco Feed Canal so that observed and estimated flows at Terrebonne were perfectly met. The modeled gains represent the additional reach flow required to satisfy nearly all the diversion demands (based on estimated diversion rates for a dry year) while meeting historic reservoir target contents and the observed and estimated historic flows at Terrebonne.

Originally, gains were calculated by subtracting observed Terrebonne flows (WY 1968-1973 and WY 1994-2001) from the flows below Bowman Dam and the flows in Ochoco Creek, and then attempting to correlate these gains to the gains above Prineville Reservoir. The correlation was poor. Since only 10 years of observed Terrebonne flows were available, a better approach was to model the gains in this reach.

Calibration: Although diversion data are not available and downstream flow data at Terrebonne are sparse, a calibration model was constructed using the gains described above. Modeled reservoir end-of-month contents compared favorably to historic values. Flows below the Crooked River Feed Canal and Ochoco Creek were consistent with anecdotal information. Flows at Terrebonne, due to the nature of their construction, calibrate successfully with existing Terrebonne flow data.

Natural Flow Rights and Reservoir Accrual

Prineville Reservoir is allowed to accrue with a 1914 water right up to a seasonal capacity of 148,633 acre-feet. Ochoco Reservoir is allowed to accrue with a 1914 water right up to a seasonal capacity of 45,200 acre-feet.

Natural flow rights to the Crooked River Feed Canal, Rice Baldwin, Peoples, Central, Low Line, and Rye Grass Canals are modeled as senior to Prineville and Ochoco Reservoirs' accrual rights. North Unit Irrigation District (NUID) is allowed to pump Crooked River water as supplemental water for Deschutes lands with a 1955 water right and as water for Crooked River lands with a 1968 water right. The following table shows the modeled natural flow rights.

Modeled Natural Flow Rights (in cubic feet per second (cfs))

Crooked River Feed Canal	400 cfs (limited by 160 cfs canal capacity)
Rice Baldwin Canal	7 cfs
Peoples Canal	19 cfs
Central Canal	7 cfs
Low Line Canal	5.5 cfs
Rye Grass	8 cfs
NUID pumps	200 cfs (two rights, limited by historic pumping rates)

Diversion Requirements

Measured flow data which could be used to determine diversion rates for OID and other Ochoco Creek and Crooked River irrigators do not exist. Measured diversions at the Crooked River Feed Canal reflect the need to maintain head at Barnes Butte Pumping Plant, so these flows include spills to Ochoco Creek and subsequent diversion to Rye Grass Canal. In addition, water wasted to McKay and Lytle Creeks, which had been measured at the Crooked River Feed Canal diversion, is credited back to Ochoco Irrigation District's (OID) Prineville Reservoir storage account. For these reasons, measured flows at the Crooked River Feed Canal do not reflect actual irrigation and diversion requirements or reservoir duty. Therefore, the diversion requirements for irrigated lands were calculated by estimating the acres irrigated and assuming irrigation requirements, distribution efficiencies, and application efficiencies. The following section describes the process used to develop the diversion requirements.

Acres Irrigated
Total irrigated acres were determined from the primary, supplemental, and natural flow-served lands on the Project Proof Survey,[2] and verified by comparison to the allowable acres and duty in the contracts; comparison to the natural flow rights; comparison to earlier estimates in the *Draft Ochoco Irrigation District Water Management/Conservation Plan*[3] (Draft Water Conservation Plan); and conversations with OWRD (Bob Main, former Regional Manager and Kyle Gorman, Regional Manager) and OID (Hugh Moore, former Manager). OID was determined to irrigate 20,148 acres in an average year. Other irrigators, including other spaceholders in Prineville Reservoir and those served by natural flow rights, were determined to irrigate an additional 3,221 acres.

Once irrigated lands were identified and incorporated into the calibration model for the Crooked River Model, it was demonstrated that modeled flows at the Crooked River Feed Canal successfully simulated Crooked River Feed Canal observed flows; modeled flows at Barnes Butte Pumping Plant successfully simulated anecdotal pumping rates; and modeled spills from the Barnes Butte Pumping Plant in Ochoco Creek successfully simulated anecdotal flows.

Irrigation Requirement
An annual irrigation requirement (IR) of 1.945 acre-feet/acre for a crop mixture of primarily mint, alfalfa, hay, and grass pasture was used.[4,5] The irrigation requirement is the crop evapo-transpiration less the effective precipitation. The irrigation requirement is not the diversion requirement, but is just one component of the diversion requirement. A monthly distribution of the annual irrigation requirement per acre was applied as shown in the following table[6].

Monthly Irrigation Requirement (acre-feet/acre)

Oct	*Nov*	*Dec*	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*WY*
.035	0	0	0	0	0	.084	.276	.409	.602	.332	.205	1.945

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[2] U.S. Bureau of Reclamation. 1980. Project Proof Survey Maps.

[3] H&R Engineering. 1999. *Draft Ochoco Irrigation District Water Management/Conservation Plan.* Prepared for OID. Cover letter dated March 30, 1999.

[4] Ibid.

[5] Ross, Elwin. 1998. Facsimile dated August 18, 1998. H&R Engineering, Redmond, Oregon.

[6] Ibid.

The diversion required to satisfy the irrigation requirement also includes deep percolation to groundwater, surface runoff, evaporation, and distribution losses. Modeled diversion requirements are based on data collected from the 1992-1997 irrigation seasons and summarized in the Draft Water Conservation Plan (H&R Engineering 1999). Although the analysis was performed using data for OID lands, the assumptions were assumed to apply project-wide.

The following table summarizes the delivery analysis from the Draft Water Conservation Plan.

Delivery Analysis from Draft Water Conservation Plan

Flows (Average from 1992-1997)		**Comments**
Diversion (from records)	83,742 AF	
Spill	27,960 AF	Spill occurs at Barnes Butte Pumping Plant and is not considered 'diverted' water.
Adjusted Diversion (diversion - spill)	55,782 AF	
Delivery (from records)	43,000 AF	
Distribution Losses (adjusted diversion - delivery)	12,782 AF	
Distribution Efficiency	77 percent	Distribution efficiency is (1.0 - distribution losses / adjusted diversion).
Crop Water Use, IR (based on 20,306 acres irrigated)	39,495 AF	The value of 20,148 used in the model is a more recent estimate, although the difference is insignificant.
On-farm Losses (delivery - IR)	3,505 AF	
On-farm Efficiency	92 percent	On-farm efficiency is (1.0 - on-farm losses / delivery)

Given the above efficiencies, for every 1.0 acre-feet of irrigation requirement, 1.41 acre-feet is required for diversion in an average water supply year:

$$1.0 /(.77 * .92) = 1.41.$$

Diversion requests are aggregated in the model based on points of delivery and application. The diversion request (DIV) for each block of aggregated diversions for an average water supply year is then:

$$DIV = 1.41 \cdot IR \cdot ACRES$$

where DIV is the monthly required diversion, IR is the monthly irrigation requirement in acre-feet/acre, and ACRES is the estimated acres of land irrigated. In the model, the diversion required is adjusted up or down based on water supply year type.

Estimated Distribution of Losses

	Surface Irrigation	Sprinkler Irrigation	Sprinkler + Surface
Acres->	2015	18135	**20150**
Percent of delivery that goes to:			
Deep Percolation	25.0	20.0	**20.5**
Runoff	25.0		**2.5**
Evaporation		15.0	**13.5**
(1-sum)	50.0	65.0	**63.5**

Calculation of Diversions and Returns Based on IR

Multiply diversion by ...	x	y	to get……	to get……
Diversion (calculated)	1.000		55782	141.3
Distribution Loss	0.229		12782	32.4
Delivery to Farm	0.771		43000	108.9
Used for IR (given)	0.771	0.918	39495	100.0
Deep Percolation	0.771	0.205	8815	22.3
Runoff	0.771	0.025	1075	2.7
Evaporation	0.771	0.135	5805	14.7

Estimated Distribution of Returns

% of DIV which returns in……				
	Current Month	***Next 2 Months***	***Never***	***Total***
	*x*y*	*X*y*	*x*y*	
Diversion				
Distribution Loss	0.229			
Delivery to Farm				
Used for IR				
Deep Percolation		0.158		
Runoff	0.019			
Evaporation			0.104	
Sum->	0.248	0.158	0.104	0.511
	0.487	0.310	0.204	

Return Flows and Spills

For the purposes of this study, "return flows" refer to that portion of water diverted from the Crooked River which returns to the river via surface and subsurface pathways. This includes some channel loss, surface runoff, infiltration and seepage from irrigated lands, drainage, and spill (with the exception of Barnes Butte Pumping Plant spill) which occur after the water has been diverted. Return flows are made available downstream as natural flow.

Crooked River Feed Canal diversions in excess of the capacity of the Barnes Butte Pumping Plant (spills) are modeled to return to the Crooked River immediately and are then made available downstream as natural flow.

Total return flows are assumed to be very nearly the diversion minus the irrigation requirement and evaporation losses. Modeled return flows are distributed over a three month period by the heuristic: 33 percent of the diversion returns in the first month after diversion, 16 percent in the second month after diversion, and 7 percent in the third month after diversion. These diversion returns were used in model calibration.

OID provided measured return flows for the 1994-1997 irrigation seasons. Assuming the measurements captured return flows from the Crooked River Feed, Ochoco Feed, and Rye Grass Canals and returns occurred over a three month period, these measured returns accounted for 22 percent of diversions (minus the spills at Barnes Butte Pumping Plant). OWRD (Kyle Gorman and Bob Main) estimated return flows to be about 35 percent. However, in calibrating to the few years of data available for the Terrebonne gage (1968-73 and 1994-1997), the best calibration was achieved when 56 percent of all diversions returned upstream of the gage, lagged over 3 months (33 percent in the first month after diversion, 16 percent in the second month, 7 percent in the third month). This value is consistent with the Draft Water Conservation Plan if the total diversion minus irrigation requirement and evaporation is assumed to return over a three month period. This is the "high end" of the return flow estimate.

Dry River contributes runoff from Central Oregon Irrigation District above the Terrebonne gage. This is not measured and was not estimated for the model. Flows entering the Crooked River from Dry River would be accounted as return flows from Crooked River diversions in the return flow calculations described above, introducing unknown error.

Minimum Instream Flows

The model requests a 75 cfs minimum instream flow below Prineville Reservoir throughout the year, with the exception that 35 cfs is requested in very dry water supply years. If water is not already flowing in the reach to meet downstream demands and if natural flow is not available to increase flows to 75 cfs, releases are made from Prineville Reservoir to meet the minimum streamflow target.

Downstream at the NUID's Crooked River pumps, the model requires a 10 cfs minimum streamflow to pass the pumps so that the Crooked River is not dried up.

Spaceholder's Contracts

Current contracted space and uncontracted space in Prineville Reservoir is modeled as follows:

OID contracted space	57,893 acre-feet
Other contracted space	10,389 acre-feet
Total contracted space	68,282 acre-feet
Uncontracted space	80,351 acre-feet
Total active storage	148,633 acre-feet

NUID Crooked River Pumping Requests

Modeled requests for Crooked River pumping by NUID uses historic measured values for 1977 through 1997. For years where historic data does not exist (1942-1976), modeled pumping rates are the average of the historic values. NUID relies on its natural flow right of 200 cfs (priority dates of 1955 and 1968), but is limited by a 150 cfs pumping capacity.

Channel Losses

Channel losses in the Crooked River between Bowman Dam and the Crooked River Feed Canal diversion were modeled as 8.5 percent. Channel losses in the Crooked River below the Crooked River Feed Canal diversion were modeled as zero. [7]

Rule Curves and Flood Space

Section 7 flood control rule curves for Prineville Reservoir are applied in the model. Rule curves dictate target end-of-month contents based on current reservoir contents and forecast inflow. In the model, forecast inflow is a "perfect" forecast, because the model knows the inflow which occurred following each historic month of record.

Recreation Targets

Prineville Reservoir September end-of-month storage contents of about 100,000 acre-feet was selected as the recreation target.[10] This volume maintains boat access at Prineville Reservoir State Park. The historic 1961-1997 average September contents for Prineville Reservoir are 92,116 acre-feet and maximum contents are 118,400 acre-feet.

Special Modeling Considerations

Crooked River Feed Canal Diversions

OID's preferred operation is to divert 160 cfs from the Crooked River into the Crooked River Feed Canal at all times to keep the pumps at Barnes Butte Pumping Plant running efficiently. OID uses a 400 cfs senior natural flow right and stored water to maintain this flow. The modeling goal is to divert 160 cfs when it is available in right and divert less when water is not available. This is accomplished by using a flow-through demand node which draws water from the Crooked River with two distinct rights. The first right is a very senior 400 cfs natural flow right. Once this water flows through to the head of the feed canal, it is distributed in the natural flow step to demands which are served with natural flow links with Unit Costs of -1.

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[7] OWRD. 1991. Memo from OWRD to Prineville Reservoir Users Re: Crooked River Losses. August 16, 1991.

[10] Moore, Hugh. 1997. Personal Communication. Former Manager, Ochoco Irrigation District.

If the natural flow right is not enough to meet the 160 cfs request, another link ("force 160cfs") draws water out of Prineville Reservoir with a Unit Cost of -90,000 during the storage step (the Stg Flow Only flag is set to 1, so the link only opens during the storage step). Although the water which flows through the "force 160cfs" link is not debited from a storage account *here*, once it flows through to the head of the feed canal, it is distributed through storage ownership links serving the demand nodes on the canal and then debited from the appropriate accounts.

Return Flow Credits from the Crooked River Feed Canal
Although the Crooked River Feed Canal requests 160 cfs to keep the pumps operating efficiently, the capacity of the pumps is only 140 cfs (and the requests for water in this portion of the system might be even less), so water spills into Ochoco Creek and eventually back to the Crooked River. OWRD and OID have agreed to credit this stored water back to OID's account. In the model, the water spills back to Ochoco Creek via the link "BarnesBPP spill." Although spilled, this water is still considered Prineville Reservoir storage water.

Several demand nodes on Ochoco Creek and the Rye Grass Canal receive Prineville Reservoir water only by utilizing this spill, but also have access to Ochoco Reservoir water. When a storage ownership link opens up during the storage step, it pulls water from the reservoirs according to the reservoir priorities. So it is possible for the Prineville ownership links which serve these demands to draw water from Ochoco Reservoir while debiting that water (in the accounting) from Prineville Reservoir. Therefore, the Prineville storage ownership links to the Ochoco Creek and Rye Grass Canal demand nodes are limited by the spill. This is accomplished by constructing the "P2spill" network which watches the spill. The net result is that the total of the flows through the Prineville storage ownership links serving the demand nodes on Ochoco Creek and the Rye Grass Canal can not exceed the spill from the pumping plant.

3. EXTENDED DESCHUTES BASIN SURFACE WATER DISTRIBUTION MODEL

The Upper and Middle Deschutes Basin Surface Water Distribution Model was extended from its original termination point below Bend so that Deschutes River flows as far downstream as Madras could be modeled. This was achieved by combining output from the Crooked River Surface Water Distribution Model described earlier and the observed flows from the Metolius River and other contributing tributaries to the Upper and Middle Deschutes Basin Surface Water Distribution Model.

Groundwater Gains

Diversions above the gage at the Deschutes River below Bend (14070500, Hydromet station code DEBO), contribute to the groundwater gains to the Deschutes River below Bend, the Crooked River below Terrebonne, and Lake Billy Chinook. However, groundwater gains to that region developed from observed data do not appropriately represent gains which would occur if modeled diversions above DEBO differ significantly from observed diversions. The Deschutes River basin BA studies required simulating current conditions (the "with Reclamation" scenario) as well as removing Reclamation operations (the "without Reclamation" scenario). Since diversions above DEBO differ from observed diversions in both scenarios, the model needed to respond by adjusting groundwater gains accordingly.

The best approach for determining groundwater returns due to diversions above DEBO would be to develop response functions based on the information compiled by the U.S. Geological Survey (USGS).[8] Budget and time constraints did not allow for this arrangement. Reclamation examined two potential approaches.

The first approach was developed by OWRD, with input from the USGS, to adjust groundwater gains to the Lake Billy Chinook region when modeled diversions differ from observed diversions. The OWRD method takes half of the difference between the modeled and observed diversions, applies a 5-year running average, and returns those averages as positive or negative groundwater gains to the Lake Billy Chinook region. The calculation of the difference in diversions and the change in groundwater gains is performed outside the model. This approach produces a very flat distribution.

The second approach models half of the flow diverted above DEBO to return as groundwater gains to locations above and below the Deschutes River Near Culver gage, to Opal Springs on the Crooked River, and to Lake Billy Chinook. This value is lagged to return to the river throughout the next 10 months in 10 percent increments. This method results in groundwater gains more closely reflecting anecdotal information about gains expected from irrigation diversions above DEBO. This "10 month flat lag" approach was used in the Extended Deschutes Model. However, this method may be conservative in estimating the positive effects of Reclamation activities on late summer flows.

Groundwater gains due to diversions above DEBO return to the river at several locations above Madras. Because model output was required at the Deschutes River Near Culver (RM 120.0), it was necessary to determine what percentage of those gains return above and what percentage below the Culver gage. To determine this percentage, a calibration run was performed, allowing the model to select the return location based on the need to perfectly achieve historic flows at Culver. In general, it appeared that about 84 percent of the groundwater gains due to diversions above DEBO return *above* the Culver gage. The remaining 16 percent was allowed to return below the Culver gage to the Crooked River and Lake Billy Chinook.

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[8] Gannett, Marshall, Kenneth E. Lite Jr., David S, Morgan, and Charles S. Collins. 2001. *Ground-Water Hydrology of the Upper Deschutes Basin, Oregon.* USGS, Water-Resources Investigations Report 00-4162.

Gannett, Marshall. 2001. Personal Communications. USGS.

In addition to the gains already developed for the Upper and Middle Deschutes Surface Water Distribution Model, gains and losses for the extended model were developed from the observed flows at:

The Deschutes River Near Culver (RM 120.0)
The Metolius River confluence (RM 111.3)
The Crooked River Below Opal Springs (RM 6.7)
The Deschutes River Near Madras (RM 100.1)

Contributions from the Crooked River

Inflows to Lake Billy Chinook from the Crooked River were determined by a run of the Crooked River model (described in Section 2, *Crooked River Surface Water Distribution Model*). The Crooked River model extends only to the Crooked River at Terrebonne (RM 27.7). Below Terrebonne, significant groundwater gains from the Deschutes River basin enter the Crooked River at Opal Springs.

However, it is not necessary to model flows between Terrebonne and the Crooked River below Opal Springs (RM 6.7, near where the Crooked River enters Lake Billy Chinook), as long as the change in the contributions from the Crooked River to Lake Billy Chinook can be determined. Consider the water budget equations for historic and modeled scenarios:

$$opal_{HIST} = terre_{HIST} + GW_{HIST} + other$$
$$opal_{MODEL} = terre_{MODEL} + GW_{MODEL} + other$$

where terre represents Crooked River flows at Terrebonne, opal represents Crooked River flows below Opal Springs, GW represents the groundwater gains to the Crooked River due to diversions above DEBO, and other represents all other groundwater and surface water gains and losses. The subscripts $_{HIST}$ and $_{MODEL}$ refer to historic observed or modeled flows. other is assumed not to change from scenario to scenario.

Combining and rearranging:

$$opal_{MODEL} = opal_{HIST} + Terre_{MODEL} - Terre_{HIST} + GW_{HIST} - GW_{MODEL}$$

The model handles differences between groundwater gains due to irrigation ($GW_{HIST} - GW_{MODEL}$) as part of the 16 percent of gains which return below Culver as described earlier in the "Groundwater Gains" section. The remaining values to complete the contributions from the Crooked River, $opal_{MODEL}$, are historic and modeled flows at Terrebonne. Modeled Terrebonne flows are determined by the Crooked River Surface Water Distribution Model described in section 2.

Pelton-Round Butte Operations

In the model, Pelton-Round Butte was operated by targets which reflect historic average elevations. Pelton-Round Butte operations attempt to release the minimum of either (1) the required minimum flow at Madras or (2) reservoir inflow. The July through February required minimum flow at Madras is 3000 cubic feet per second (cfs); the March through June required minimum flow is 3500 cfs.

Calibration

The Extended Deschutes Model was calibrated to available historic (observed) flows, diversions, and reservoir contents. Calibration results indicate that the model successfully represents water supply and system operations.

— APPENDIX D—

Effects of Wasco Dam Storage on White River Flows

EFFECTS OF WASCO DAM STORAGE ON WHITE RIVER FLOWS

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The White River is a tributary to the Deschutes River and enters downstream from Pelton Dam at river mile (RM) 46.4. The White River drainage is approximately 417 square miles and has its headwaters near Mt. Hood. White River Falls is a natural barrier in the basin and is 2.1 miles upstream from the confluence with the Deschutes River.

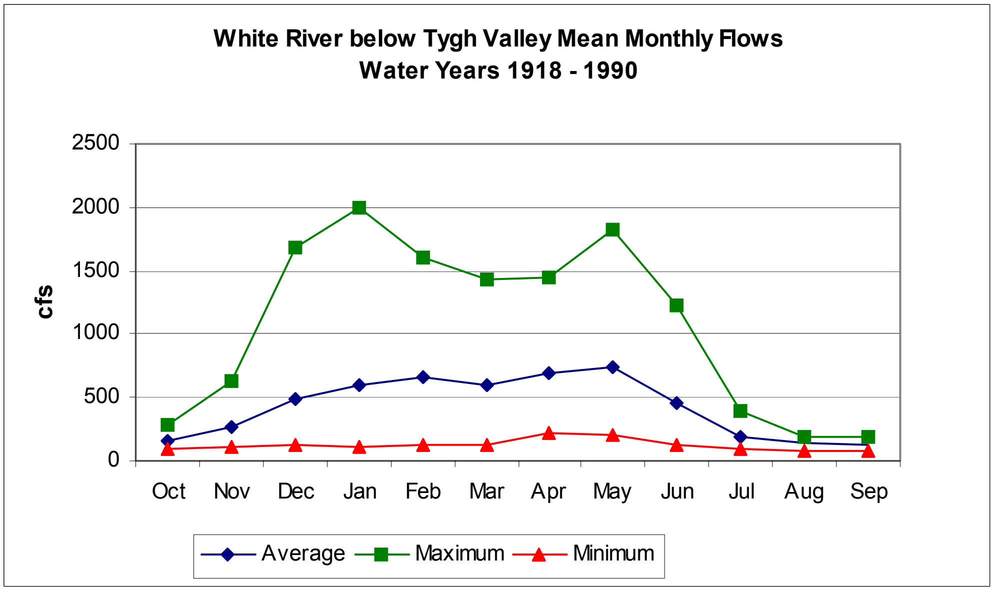
The Wapinitia Project consists of approximately 2,100 acres in the White River basin. Wasco Dam storage is used to supplement the irrigation flows on the project when the natural flows begin to decrease in July during wet years and as early as April in dry years. The total amount of water diverted from natural streamflow and storage for the Wapinitia Project is 5,000 acre-feet (AF) annually.

There are three private irrigation districts in the White River basin that also affect the flow in the White River. These private diversions divert more water than the Wapinitia Project, diverting flow to approximately 7,160 acres for a total amount of 21,490 AF annually[1]. The diversions occur primarily during the summer months. The effect of Wasco Dam storage on White River flows is small when compared to the other irrigation projects in the White River basin.

Wasco Dam storage effects on White River flows was analyzed by using daily flow data from the U.S. Geological Survey (USGS) gage below Tygh Valley and calculating how dam operations affected those flows. The Tygh Valley gage was located near the mouth of the White River downstream from White River Falls and approximately 2 miles upstream from the confluence with the Deschutes River. Data were available for water years 1918 through 1990. Mean monthly flows were computed and the average, maximum, and minimum flows were plotted in Figure 1. The monthly flows ranged from 2,000 cubic feet per second (cfs) maximum during a January winter rain event to a minimum of 80 cfs during a base flow period in August. The average monthly flows ranged from roughly 130 cfs in August and September to 730 cfs in May.

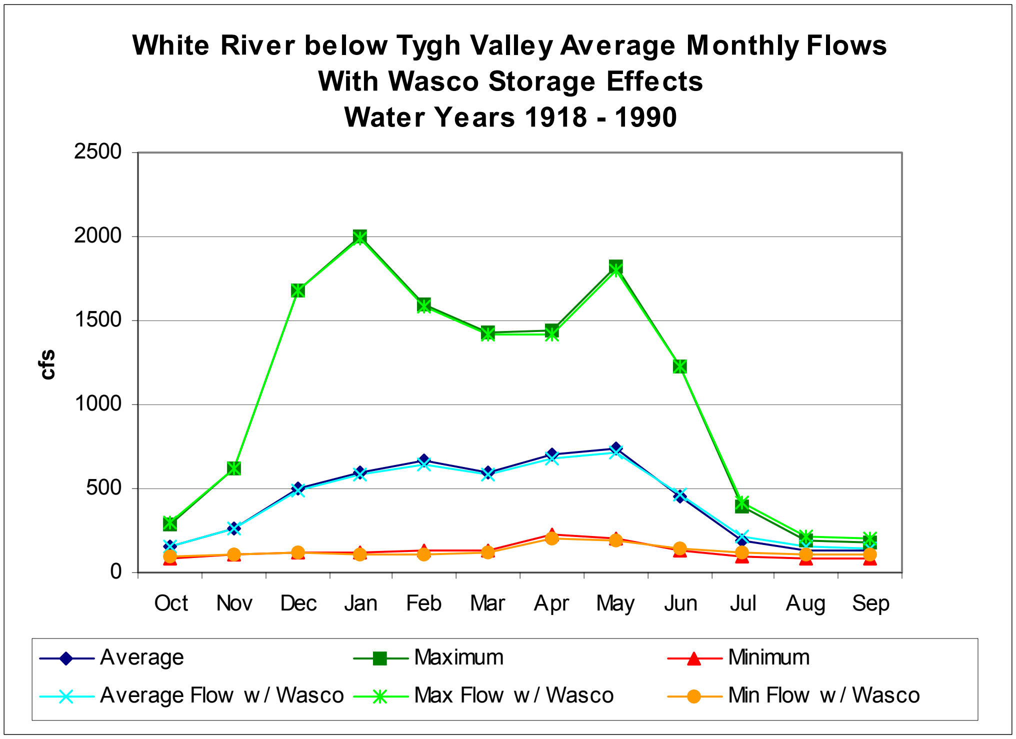
[1] Toll, Larry. 2002. Personal Communication. Watermaster, Oregon Department of Water Resources.

Figure 1. White River below Tygh Valley
Mean Monthly Flows for Period 1918 – 1990



Effects from Wasco Dam operations on White River flow were analyzed using reservoir storage data. Daily storage data for the period 1984 through 2000 were available from the Bureau of Reclamation's historic data set. During this period there were two years when data was not available and some months were missing within a few other years. End-of-month storage was tabulated for each year and the change in storage for each month was calculated. The change in monthly storage was averaged and converted to change in flow. The maximum, minimum, and average change in monthly flow is shown in Figure 2.

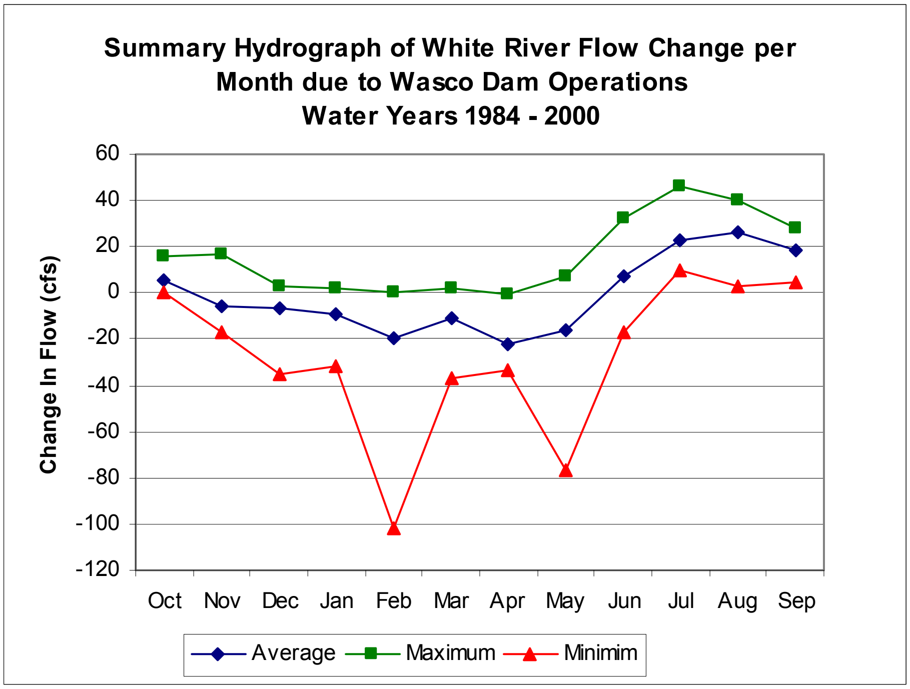
Figure 2. Flow Change per Month due to Wasco Dam Operations



The change in monthly flow ranged from an increase of 46 cfs to a decrease of 102 cfs. The average change was +6 cfs during the irrigation season. The monthly flow change is positive when the water is released from storage into the river; when the flow change is negative the water is going into storage and not flowing down the river. Negative flow changes occur in the winter months during storage and in the spring months during periods of high runoff from rain and snowmelt events. Positive flow changes occur during the June through September period when natural runoff is low and irrigation demands are high, because storage is released to supply irrigation water. These flow trends are applicable to the White River and the Deschutes River below its confluence with the White River.

The Wasco Dam storage changes and the total White River flow were compared in Figure 3. This figure illustrates the magnitude of impacts of the average monthly amount of water stored and released from Wasco Dam on the White River. For all three categories, minimum, average and maximum flows, the effect of the change in flow from Wasco Dam are very small when compared to the total White River flow.

Figure 3. White River below Tygh Valley, Average Monthly Flows with Seasonal Effects of Storing and Releasing Water from Wasco Dam.



The effects of Wasco storage is almost negligible when compared to the total flow near the mouth of the White River and on the lower Deschutes River. Private irrigation projects, which collectively divert more water in the White River basin, most likely have a greater effect on the flow of the White River than the Wapinitia Project.