RECLAMATION
Managing Water in the West

Biological Assessment for Bureau of Reclamation Operations and Maintenance in the Snake River Basin Above Brownlee Reservoir

Baker Project
Boise Project
Burnt River Project
Little Wood River Project
Lucky Peak Project
Mann Creek Project
Michaud Flats Project
Minidoka Project
Owyhee Project
Palisades Project
Ririe Project
Vale Project

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

November 2004

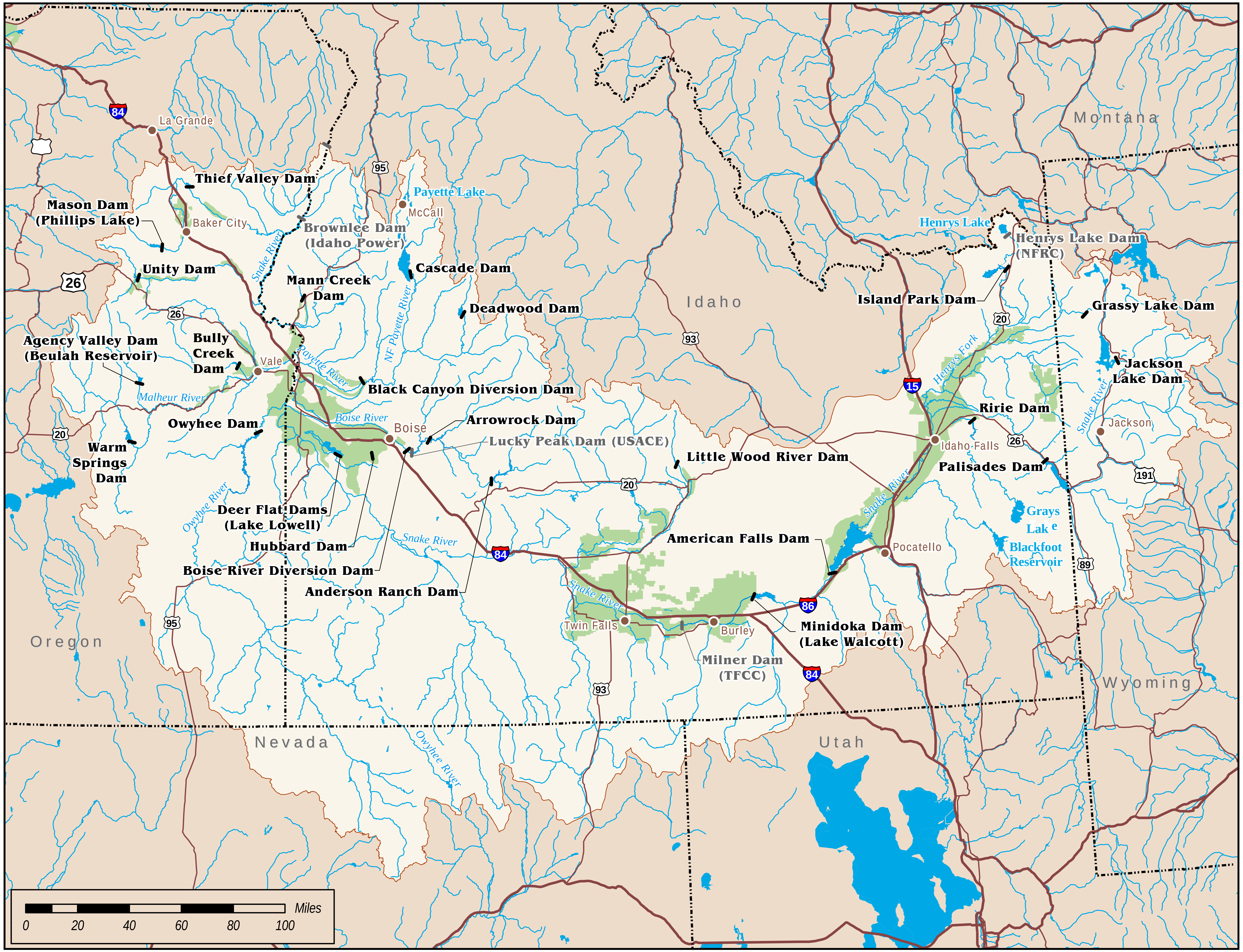
Acronyms and Abbreviations

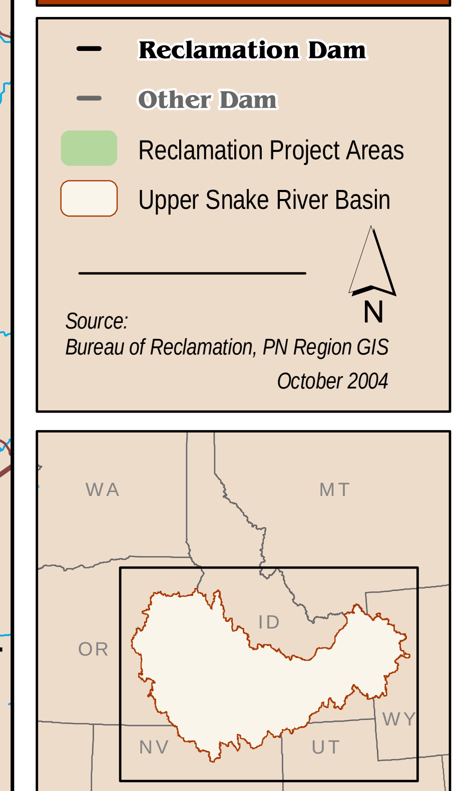
ALPI	Aleutian Low Pressure Index
BA	Biological Assessment
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BNF	Boise National Forest
BPA	Bonneville Power Administration
BRT	Biological Review Team
BRWG	Biological Requirements Work Group
CBFWA	Columbia Basin Fish and Wildlife Authority
cfs	Cubic feet per second
cm	Centimeter
CR	Conservation Recommendation
CRITFC	Columbia River Inter-Tribal Fish Commission
CWA	Clean Water Act
DDT	Dichlorodiphenyltrichloroethane
DO	Dissolved Oxygen
DPS	Distinct Population Segment
EA	Environmental Assessment
EBSM	Ecologically Based System Management
EFH	Essential Fish Habitat
ENSO	El Niño-Southern Oscillation
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESPA	Eastern Snake Plain Aquifer
ESU	Evolutionarily Significant Unit
FCRPS	Federal Columbia River Power System
FERC	Federal Energy Regulatory Commission
FONSI	Finding of No Significant Impact
FPC	Fish Passage Center
FR	Federal Register
GYA	Greater Yellowstone Area
GYBEWG	Greater Yellowstone Bald Eagle Working Group
HUC	Hydrologic Unit Code
IAC	Idaho Administrative Code
ICBTRT	Interior Columbia Basin Technical Recovery Team
IDEQ	Idaho Department of Environmental Quality
IDFG	Idaho Department of Fish and Game
IDHW	Idaho Department of Health and Welfare
IDWR	Idaho Department of Water Resources
IWRB	Idaho Water Resource Board
IWRRI	Idaho Water Resources Research Institute
km	Kilometer
kW	Kilowatt
m	Meter
M&I	Municipal and Industrial
mm	Millimeter
NAWQA	National Water Quality Assessment
NEPA	National Environmental Policy Act
NFRC	North Fork Reservoir Company
NOAA Fisheries	National Marine Fisheries Service
NPCC	Northwest Power and Conservation Council (also NPPC)
NTU	Nephelometer Turbidity Unit
ODEQ	Oregon Department of Environmental Quality
ODFW	Oregon Department of Fish and Wildlife
O&M	Operations and Maintenance
PBERP	Pacific Bald Eagle Recovery Plan
PCB	Polychlorinated biphenyl
PCI	Pacific Circulation Index
PFMC	Pacific Fishery Management Council
PDO	Pacific Decadal Oscillation
Reclamation	U.S. Bureau of Reclamation
RM	River Mile
RMP	Resource Management Plan
RPM	Reasonable and Prudent Measure
Services	USFWS and NOAA Fisheries
SST	Sea-surface Temperature
T&C	Terms and Conditions
TDG	Total Dissolved Gas
TFCC	Twin Falls Canal Company
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
USACE	U.S. Army Corps of Engineers
USBR	U.S. Bureau of Reclamation
USDOC	U.S. Department of Commerce
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VSP	Viable Salmonid Population
WDFW	Washington Department of Fish and Wildlife
WGFD	Wyoming Game and Fish Department
WLCTRT	Willamette Lower Columbia Technical Review Team
WOC	Washington-Oregon-California

On the cover: Sun setting at Palisades Reservoir on the South Fork of the Snake River.

Features and Facilities for Bureau of Reclamation Projects

in the Snake River Basin above Brownlee Reservoir





Federal storage facilities included in the proposed actions.

Storage Facility [1]	Stream and River Mile	Active Capacity [2] (acre-feet)	Powerplant Owner	Operating and Maintaining Entity
Minidoka Project				
Jackson Lake Dam	Snake River 988.9	847,000	No powerplant	Reclamation
Grassy Lake Dam	Grassy Creek 0.5	15,200	No powerplant	Fremont-Madison Irrigation District
Island Park Dam	Henry Fork 91.7	135,205	Non-Federal	Fremont-Madison Irrigation District
American Falls Dam	Snake River 714.0	1,672,590	Non-Federal	Reclamation
Minidoka Dam	Snake River 674.5	95,200	Reclamation	Reclamation
Palisades Project				
Palisades Dam	Snake River 901.6	1,200,000	Reclamation	Reclamation
Ririe Project				
Ririe Dam	Willow Creek 20.5	80,541	No powerplant	Reclamation
Little Wood River Project				
Little Wood River Dam [3]	Little Wood River 78.8	30,000	Non-Federal	Little Wood River Irrigation District
Owyhee Project				
Owyhee Dam	Owyhee River 28.5	715,000	Non-Federal	Owyhee Irrigation District
Boise Project				
Anderson Ranch Dam	S.F. Boise River 43.5	413,074	Reclamation	Reclamation
Arrowrock Dam	Boise River 75.4	272,224	No powerplant	Reclamation
Hubbard Dam	New York Canal	1,177	No powerplant	Boise Project Board of Control
Deer Flat Dams	New York Canal	159,365	No powerplant	Boise Project Board of Control
Deadwood Dam	Deadwood River 18.0	153,992	No powerplant	Reclamation
Cascade Dam	N.F. Payette River 38.6	646,461	Non-Federal	Reclamation
Lucky Peak Project				
Lucky Peak Dam [4]	Boise River 64.0	264,371	Non-Federal	Army Corps of Engineers
Vale Project				
Warm Springs Dam [5]	Malheur River 114.0	169,714	No powerplant	Warmsprings Irrigation District
Agency Valley Dam	N.F. Malheur River 15.0	59,212	No powerplant	Vale Oregon Irrigation District
Bully Creek Dam	Bully Creek 12.5	23,676	No powerplant	Vale Oregon Irrigation District
Mann Creek Project				
Mann Creek Dam	Mann Creek 13.2	10,900	No powerplant	Mann Creek Irrigation District
Burnt River Project				
Unity Dam	Burnt River 63.6	24,970	No powerplant	Burnt River Irrigation District
Baker Project				
Mason Dam	Powder River 122.0	90,540	No powerplant	Baker Valley Irrigation District
Thief Valley Dam	Powder River 70.0	13,307	No powerplant	Lower Powder River Irrigation District

1 Reclamation owns all facilities unless otherwise indicated.
2 Active capacity is the volume of storage space that can be filled and released for specific purposes.
3 The Little Wood River Irrigation District owns the Little Wood River Dam.
4 The Army Corps of Engineers owns Lucky Peak Dam; Reclamation administers water service and repayment contracts for irrigation.
5 Reclamation has a one-half interest in Warm Springs Reservoir and associated storage.

Federal diversion facilities included in the proposed actions.

Diversion Facility	Stream	Owner	Operating and Maintaining Entity
Minidoka Project			
Cascade Creek Diversion Dam	Cascade Creek	United States	Fremont-Madison Irrigation District
Minidoka Northside Headworks	Snake River	United States	Minidoka Irrigation District
Minidoka Southside Headworks	Snake River	United States	Burley Irrigation District
Unit A Pumping Plant	Snake River	United States	A & B Irrigation District
Milner-Gooding Canal Headworks	Snake River	United States	American Falls Reservoir District No. 2
Michaud Flats Project			
Falls Irrigation Pumping Plant	Snake River	United States	Falls Irrigation District
Owyhee Project			
Tunnel No. 1	Owyhee River	United States	Owyhee Irrigation District
Dead Ox Pumping Plant	Snake River	United States	Owyhee Irrigation District
Ontario-Nyssa Pumping Plant	Snake River	United States	Ontario-Nyssa and Owyhee Irrigation Districts
Gem Pumping Plants #1 and #2	Snake River	United States	Gem Irrigation District
Boise Project			
Boise River Diversion Dam	Boise River	United States	Boise Project Board of Control [1]
Black Canyon Diversion Dam	Payette River	United States	Reclamation
Vale Project			
Harper Diversion Dam	Malheur River	United States	Vale Oregon Irrigation District
Bully Creek Diversion Dam	Bully Creek	United States	Vale Oregon Irrigation District
Mann Creek Project			
Mann Creek Dam Outlet	Mann Creek	United States	Mann Creek Irrigation District
Baker Project			
Savely Dam and Lilley Pumping Plant	Powder River	United States	Lower Powder River Irrigation District

1 The Boise Project Board of Control operates and maintains the dam. Reclamation operates and maintains the powerplant.

Federal powerplants included in the proposed actions.

Powerplant	Stream	Impoundment	Nameplate Rating
Palisades Powerplant	Snake River	Palisades Dam	176,600 kW
Inman and Minidoka Powerplants	Snake River	Minidoka Dam	28,500 kW
Anderson Ranch Powerplant	South Fork Boise River	Anderson Ranch Dam	40,000 kW
Boise River Diversion Powerplant	Boise River	Boise River Diversion Dam	1,500 kW
Black Canyon Powerplant	Payette River	Black Canyon Diversion Dam	8,000 kW

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The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to tribes.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

How to Read This Document

To read this biological assessment more effectively, carefully study this page. We have designed and written this biological assessment to:

- Document analysis of the effects of the proposed actions on Endangered Species Act listed species and designated critical habitat.
- Request concurrence for "not likely to adversely affect" conclusions.
- Request formal consultation for "likely to adversely affect" conclusions.
- Present the effects on essential fish habitat (EFH) as required under the Magnuson-Stevens Fishery Conservation and Management Act.

This **introductory section** contains a list of acronyms and abbreviations, the frontispiece, and the table of contents. Each chapter contains its own list of **literature cited**.

Part I contains information relevant to both the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NOAA Fisheries).

> **Chapter 1** provides the preliminary information and background on this ESA Section 7 consultation that is helpful in reading the rest of the document.
>
> **Chapter 2** describes the proposed actions and action areas.
>
> **Chapter 3** contains an overview of the upper Snake River basin, a description of past hydrologic conditions, and a description of the model Reclamation used to simulate hydrologic conditions of the 11 proposed actions.

Part II contains the chapters relevant to only the USFWS.

> **Chapters 4 through 8** provide information and analysis on aquatic snails, bald eagle, bull trout, gray wolf, and Ute ladies'-tresses.

Part III contains the chapters relevant to only NOAA Fisheries.

> **Chapter 9** provides information and analysis on listed salmon and steelhead Evolutionarily Significant Units (ESUs).
>
> **Chapter 10** provides information and analysis on essential fish habitat for the salmon and steelhead ESUs.

Part IV contains the biological assessment's **appendices**.

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PART I

INTRODUCTION AND THE PROPOSED ACTIONS

Chapter 1 OVERVIEW

1.1 Purpose of the Biological Assessment

The U.S. Bureau of Reclamation (Reclamation) submits this biological assessment to the Fish and Wildlife Service, U.S. Department of the Interior (USFWS), and the National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce (NOAA Fisheries), (collectively, the Services) in compliance with Section 7 of the Endangered Species Act (ESA), the implementing regulations for Sections 7(a) – (d) of the ESA found at 50 C.F.R. 402 (ESA regulations), and the Magnuson-Stevens Fishery Conservation and Management Act. Reclamation also referred to *The Endangered Species Consultation Handbook: Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Act* (Endangered Species Consultation Handbook), published jointly by the Services (1998), in determining what to include in this biological assessment.

Reclamation proposes to undertake 11 separate Federal actions in the Snake River basin upstream from Brownlee Reservoir (upper Snake River basin) involving future operation and routine maintenance (O&M) activities for 12 Federal reclamation projects. Reclamation is reinitiating consultation because existing biological opinions for current O&M activities will be expiring before the start of the 2005 irrigation season, and some components of the proposed actions differ from the actions consulted upon in the last consultations.

While not required by the ESA or the ESA regulations, Reclamation has chosen, as a matter of administrative convenience, to address all proposed actions in a single biological assessment. In turn, Reclamation is requesting each of the Services, as permitted by 50 C.F.R. 402.14(c), to enter into a single consultation and issue a single biological opinion regarding all 11 proposed actions to the extent formal consultation is required by law.

Section 7(c) of the ESA and the ESA regulations require that a biological assessment be prepared only for Federal actions which are "major construction activities" (see 50 C.F.R. 402.12(b)). None of the 11 proposed actions is such an activity. However, as Figure 3-1 in the Endangered Species Consultation Handbook illustrates, a biological assessment is an optional route an agency may use for actions that do not involve major construction to determine if formal consultation is required pursuant to 50 C.F.R. 402.13 and 402.14.

Accordingly, Reclamation has chosen to submit this biological assessment to document its analysis of the effects of the proposed actions on ESA-listed species and designated critical habitat, to request concurrence for its "not likely to adversely affect" conclusions, and to request formal consultation for its "likely to adversely affect" conclusions. For those species for which formal consultation is required, this biological assessment fulfills the requirements of 50 C.F.R. 402.14(c), and Reclamation requests the issuance of biological opinions by the Services. If the Services concur in Reclamation's "not likely to adversely affect" conclusions for certain listed species, then the informal consultation process will be terminated as to those species, and no further action by Reclamation will be necessary (see 50 C.F.R. 402.13(a)).

1.2 Proposed Actions

This biological assessment documents 11 proposed actions. The proposed actions all describe Reclamation's future operations and routine maintenance at features and facilities that are a part of 12 Federal projects (the Baker, Boise, Burnt River, Little Wood River, Lucky Peak, Mann Creek, Michaud Flats, Minidoka, Owyhee, Palisades, Ririe, and Vale Projects), some of which consist of multiple divisions on separate rivers. Reclamation does not coordinate operation among all 12 projects, but rather operates divisions, projects, or groups of projects independently of each other. Therefore, some actions reflect the operation of only a single project, some reflect the independent operation of different divisions within a single project, and other actions encompass the integrated operation of multiple divisions of a project or multiple projects. These 11 proposed actions are:

- Future O&M in the Snake River system above Milner Dam (Michaud Flats, Minidoka, Palisades, and Ririe Projects).
- Future operations in the Little Wood River system (Little Wood River Project).
- Future O&M in the Owyhee River system (Owyhee Project).
- Future O&M in the Boise River system (Arrowrock Division of the Boise Project and the Lucky Peak Project).
- Future O&M in the Payette River system (Payette Division of the Boise Project).
- Future O&M in the Malheur River system (Vale Project).
- Future O&M in the Mann Creek system (Mann Creek Project).

- Future O&M in the Burnt River system (Burnt River Project).
- Future O&M in the upper Powder River system (Upper Division of the Baker Project).
- Future O&M in the lower Powder River system (Lower Division of the Baker Project).
- Future provision of salmon flow augmentation from the rental or acquisition of natural flow rights.

It is Reclamation's view that the ESA regulations apply to Reclamation's actions only to the extent that Reclamation has discretionary involvement in or control of them. However, as a matter of practicality in this biological assessment, Reclamation has chosen not to differentiate between the discretionary and non-discretionary components of any proposed action. Thus, while many aspects of the proposed actions are, pursuant to state water law, Federal reclamation law, and contracts with water users, non-discretionary on Reclamation's part, this biological assessment analyzes the effects resulting from both the discretionary and non-discretionary components of each proposed action.

During the formal consultation process, it will be important to address the limitations on Reclamation's authority and discretion in implementing the proposed actions. In this regard, Reclamation will work closely with the Services in assuring that: 1) any reasonable and prudent alternatives to the proposed actions, if required, are consistent with the intended purposes of the proposed actions and accurately reflect the limits of Reclamation's statutory and contractual authority and discretion, as well as being economically and technically feasible (see 50 C.F.R. 402.02, definition of "reasonable and prudent alternatives"); and 2) any reasonable and prudent measures (including terms and conditions) in incidental take statements do not alter the basic design or scope of the proposed actions (50 C.F.R. 402.14(i)(2)).

1.3 Action Areas

The analyses of ESA-listed species, designated critical habitat, and essential fish habitat focus on the aquatic and terrestrial environments that Reclamation may affect under the proposed actions. Each proposed action has a distinct action area that begins at the location of that proposed action's farthest upstream effect (e.g., the uppermost extent of the storage reservoir or point of diversion) and continues to the location of its farthest downstream effect (the Columbia River estuary for these proposed actions). Figure 1-1 shows a consolidated view of all the action areas in this consultation. The proposed action descriptions in Chapter 2 show the action area for each proposed action.

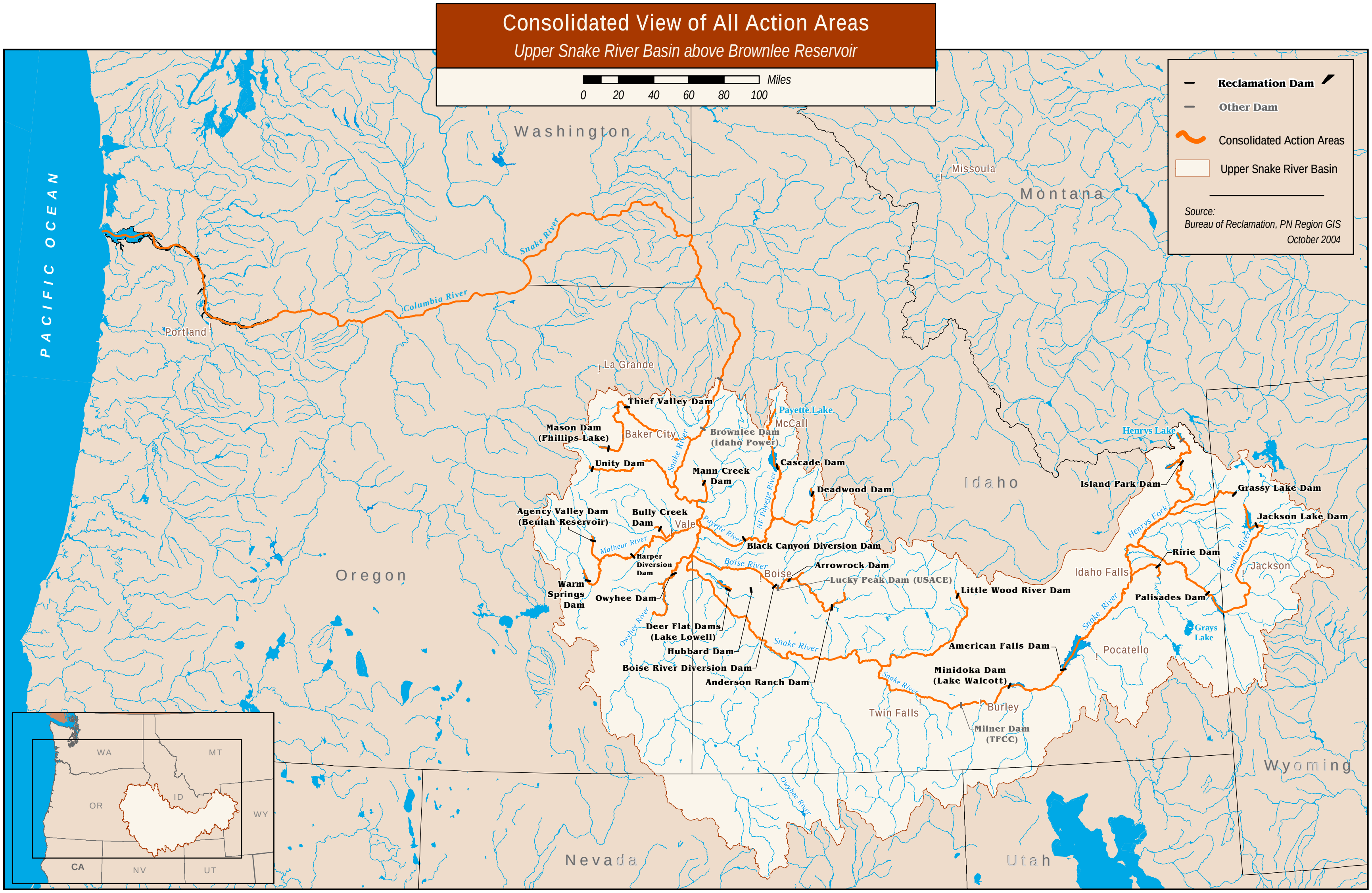

Figure 1-1. Consolidated action areas for Reclamation's 11 proposed actions.

The features and facilities of the 12 Federal projects included in the proposed actions all exist upstream from Brownlee Dam, an Idaho Power Company (Idaho Power) facility on the Snake River at river mile (RM) 285. Beginning at Brownlee Reservoir, the action areas for the separate proposed actions share the Snake River corridor to its confluence with the Columbia River, and then downstream in the Columbia River corridor to its estuary; in other words, any combined effects of the separate actions aggregate at Brownlee Reservoir and extend downstream to the Columbia River estuary.

Reclamation's proposed actions do not affect any animal or plant that is not found in or near the aquatic environment. The ESA-listed species included in this assessment occur within affected river corridors and reservoirs.

1.4 Basis for "May Affect" Determinations

The purpose of a biological assessment is, among other things, to determine whether a Federal agency must enter into formal consultation pursuant to the ESA regulations. In this regard, the ESA regulations require a Federal agency "…to determine whether any action may affect listed species or critical habitat" (see 50 C.F.R. 402.14(a)). If an agency determines that a proposed action "may affect" a listed species or its critical habitat, then it must enter into formal consultation unless it determines, and the Service(s) concur, that the proposed action may affect, but "…is not likely to adversely affect…," such species or habitat (see 50 C.F.R. 402.13(a) and 402.14(b)(1)). The ESA regulations (50 C.F.R. 402.14(c)(4)), in describing the information to be submitted to the Services for formal consultation, state only that an agency is to provide "a description of the manner in which the action may affect any listed species or critical habitat and an analysis of cumulative effects…," with "cumulative effects" defined in 50 C.F.R. 402.02.

In determining whether the proposed actions "may affect" listed species or critical habitat, Reclamation considered the range of effects resulting from its proposed actions in accordance with the regulatory definition of "effects of the action" (50 C.F.R. 402.02). Thus, the hydrologic analyses and associated species analyses contained in this biological assessment address the combined effects of storing and releasing project water from project reservoirs, of diverting project water at downstream points of delivery, and of return flows.

A method for determining effects from the implementation of future O&M activities is not clearly established in either the ESA regulations or the Endangered Species Consultation Handbook. In particular, the ESA regulations do not specify whether the "may effect" determination is to be made by comparing the effects of an action to the "environmental baseline" (as defined by 50 C.F.R. 402.02) or to some other "base" condition.

Since Reclamation is still working with the Services to identify the proper environmental baseline for these consultations, Reclamation elected to base its "may effect" determinations on the Endangered Species Consultation Handbook's definitions of the terms "may affect," "is not likely to adversely affect," and "is likely to adversely affect." These terms are not specifically defined in the ESA regulations but are defined at pages xv and xvi of the Endangered Species Consultation Handbook Glossary as follows:

> **May affect** – the appropriate conclusion when a proposed action may pose any effects on listed species or designated critical habitat. When the Federal agency proposing the action determines that a "may affect" situation exists, then they must either initiate formal consultation or seek written concurrence from the Services that the action "is not likely to adversely affect" listed species.
>
> **Is not likely to adversely affect** – the appropriate conclusion when 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.
>
> **Is likely to adversely affect** – the appropriate finding in a biological assessment (or conclusion during informal consultation) if any adverse effect to listed species 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 (see definition of "is not likely to adversely affect"). 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. An "is likely to adversely affect" determination requires the initiation of formal section 7 consultation.

1.4.1 Characterizing Effects from the Implementation of Future O&M Activities

As used in this biological assessment for the purpose of making the required "may effect" determinations, "effects" means conditions or consequences traceable to identified causes. In this context, future operation of a water project may result in two types of effects to listed species and critical habitat that are particularly important to making a "may affect" determination. These may be thought of as continuing effects and new effects.

Continuing effects are physical or biological effects that have occurred in the past, are occurring at present, and will continue to occur in the future. Such effects typically are related to annual diversions, storage, releases, and other annual or periodic O&M activities. These activities can result in annual or periodic increases or decreases in habitat quantity or quality; such habitat changes can in turn result in annual or periodic increases or decreases in species population numbers, distribution, or related parameters. In this biological assessment, the continuing effects of the proposed actions (storing, releasing, and diversion of project water, and routine maintenance), were taken into account in making “may affect” determinations. However, such continuing effects will be part of the environmental baseline for the purposes of the jeopardy analyses to be performed by the Services.

In ecosystems that are still changing in response to existing project operations (e.g., riverine systems that have not yet reached a new equilibrium in response to recurring diversions, storage, releases, and related activities), the implementation of future O&M activities may result in or contribute to changes in existing conditions. These changes may be thought of as “new effects” and were also taken into account in making the “may affect” determination.

1.4.2 Subsequent Steps in the Consultation Process

While Federal agencies proposing an action are to describe the manner in which the action “may affect” listed species or critical habitat, the Services are, among other things, to evaluate “the effects of the action and cumulative effects on the listed species or critical habitat” and formulate their “biological opinion as to whether the action, taken together with cumulative effects, is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat” (50 C.F.R. 402.14(g)). Furthermore, 50 C.F.R. 402.14(h) states that a biological opinion shall include a “detailed discussion of the effects of the action on listed species or critical habitat….”

Reclamation, in making the “may affect” determinations set forth in this biological assessment, draws no conclusions as to whether the proposed actions are or are not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of designated critical habitat. Rather, the sole purpose of the “may affect” determinations is to determine whether or not formal consultation is required. Reclamation will not reach a decision as to whether the proposed actions that are the subject of this biological assessment comply with the requirements of Section 7(a)(2) of the ESA until it receives and considers the biological opinions to be rendered by the Services.

Furthermore, as noted above, Reclamation is still working with the Services to determine the proper environmental baseline for these consultations. Reclamation will work with the Services as formal consultation proceeds to develop and provide additional information, if necessary, to reach agreement on the environmental baseline.

1.5 Summary of Species Effects

Appendix A contains a complete list of the fifteen species the USFWS has listed in the action areas and the thirteen salmon and steelhead Evolutionarily Significant Units (ESUs) that NOAA Fisheries has listed or proposed for listing in the action areas. Three ESUs have designated critical habitat in the action areas.

Reclamation is submitting this biological assessment to the USFWS and NOAA Fisheries as part of the interagency consultation process for two purposes:

- Reclamation seeks the Services' concurrence for those species that Reclamation has determined the proposed actions are not likely to adversely affect.
- Reclamation seeks the Services' issuance of biological opinions for those species that Reclamation has determined the proposed actions are likely to adversely affect.

1.5.1 Species within the Jurisdiction of the USFWS

Reclamation has determined that the proposed actions will have no effect on Banbury Springs lanx, Bruneau hot springsnail, Canada lynx, grizzly bear, MacFarlane's four o'clock, northern Idaho ground squirrel, and water howellia (see Appendix A).

Reclamation has determined that the proposed actions may affect but are not likely to adversely affect the bald eagle, Bliss Rapids snail, gray wolf, Idaho springsnail, and Snake River physa. Reclamation requests written concurrence from the USFWS for this determination.

Reclamation has also determined that the proposed actions are likely to adversely affect bull trout, the Utah valvata snail, and Ute ladies'-tresses. Reclamation submits this biological assessment to request formal consultation with the USFWS.

1.5.2 Species within the Jurisdiction of NOAA Fisheries

Reclamation has determined that the proposed actions may affect but are not likely to adversely affect nine salmon and steelhead ESUs: Lower Columbia River, Upper Columbia River, and Upper Willamette River Chinook salmon ESUs; Columbia River chum salmon ESU; Lower Columbia River coho salmon ESU (currently proposed for listing); and Lower Columbia River, Middle Columbia River, Upper Columbia River, and Upper Willamette River steelhead ESUs. Reclamation requests written concurrence from NOAA Fisheries for this determination.

Reclamation has also determined that the proposed actions are likely to adversely affect four salmon and steelhead ESUs: Snake River spring/summer and Snake River fall Chinook salmon ESUs, the Snake River sockeye salmon ESU, and the Snake River Basin steelhead ESU. Reclamation has also determined that the proposed actions are likely to adversely affect designated critical habitat for Snake River spring/summer Chinook salmon, Snake River sockeye salmon, and Snake River fall Chinook salmon. Reclamation submits this biological assessment to request formal consultation with NOAA Fisheries.

In compliance with the Magnuson-Stevens Fishery Conservation and Management Act, Reclamation has determined that the proposed actions will not adversely affect essential fish habitat for Upper Columbia River spring Chinook salmon, Middle Columbia River spring Chinook salmon, Upper Columbia River summer/fall Chinook, Deschutes River summer/fall Chinook salmon, Lower Columbia River Chinook salmon, Upper Willamette River Chinook salmon, Lower Columbia River coho salmon, and Southwest Washington coho salmon. Reclamation has determined that the proposed actions will adversely affect essential fish habitat for Snake River fall Chinook salmon and Snake River spring/summer Chinook salmon. Reclamation submits this biological assessment to request that NOAA Fisheries recommend conservation measures to offset potential adverse effects to EFH pursuant Section 305(b)(4)(A) of the Magnuson-Stevens Fishery Conservation and Management Act.

1.6 Literature Cited

Parenthetical Reference	Bibliographic Citation
NOAA Fisheries and USFWS 1998	National Marine Fisheries Service and the U.S. Fish and Wildlife Service. 1998. *The Endangered Species Consultation Handbook: Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Act.*

Chapter 2 DESCRIPTION OF THE PROPOSED ACTIONS

2.1 Introduction

The 11 proposed actions described here are authorized, funded, or carried out by Reclamation by virtue of Congressional or Secretarial authorizations, Congressional appropriations, contracts with Reclamation, and facility ownership. Proposed actions include one or more of the following activities:

- Future storage of water in reservoirs and its release from dams that the United States owns and constructed for authorized purposes. Storage and releases occur in accordance with authorized project purposes, Reclamation contracts, Federal law, and State water rights.
- Future diversion or pumping of water into facilities that Reclamation owns or operates.
- Future hydropower generation at Reclamation powerplants.
- Future routine maintenance activities at dams, reservoirs, on-stream diversion structures and pumping plants, and Reclamation hydropower plants, regardless of whether the operation and maintenance responsibility has been transferred to another entity.
- Future provision of salmon flow augmentation by acquiring water through rental pools and leasing or acquiring natural flow rights. The total volume of flow augmentation per year from all proposed actions would not exceed 487,000 acre-feet. Reclamation's provision of flow augmentation is consistent with the proposed Nez Perce water rights settlement (Nez Perce Tribe et al. 2004). Reclamation's ability to provide salmon flow augmentation is contingent on State legislation.

The frontispiece shows the locations of facilities in the upper Snake River basin associated with the proposed actions; on the back of the frontispiece, three tables present summary information on the Federal storage, diversion, and power facilities included in the 11 proposed actions. These features and facilities are part of 12 Federal projects (Baker, Boise, Burnt River, Little Wood River, Lucky Peak, Mann Creek, Michaud Flats, Minidoka, Owyhee, Palisades, Ririe, and Vale Projects).

Reclamation's *Operations Description for Bureau of Reclamation Projects in the Snake River Basin above Brownlee Reservoir* (2004b) and the Operations and

Maintenance Addendum (see Appendix B) comprehensively describe the authorities, future operations, and routine maintenance for the proposed actions.

Although some of these 11 proposed actions involve the operation of federally owned powerplants whose capacity and energy are marketed by the Bonneville Power Administration, all 11 actions are wholly independent of each other and of the action of operating any other Reclamation or Army Corps of Engineers' projects in the Columbia River basin, including the 14 Federal dams and powerplants below Brownlee Reservoir that are operated as an integrated system for flood control and hydroelectric power generation. These 14 facilities are referred to as the Federal Columbia River Power System (FCRPS) in consultations that have taken and are taking place separately from the consultations that are being initiated with the submittal of this biological assessment. The operations of the federally owned powerplants involved in some of the 11 actions described in this biological assessment are not coordinated with the operations of other reservoirs in the FCRPS. Rather, the federally owned powerplants at the projects involved in this assessment are operated incidental to water releases made to serve the authorized purposes of the projects. These powerplants are operated without regard to how the FCRPS powerplants are operated.

2.2 Duration of Proposed Actions

The duration of all 11 proposed actions is 30 years (2005 through December 31, 2034). This is the period contemplated by Section III (the Snake River Flow Component) of the April 2004 Nez Perce Term Sheet (Term Sheet) for the proposed settlement of the Federal water right claims of the Nez Perce Tribe in the Snake River Basin Adjudication (Nez Perce Tribe et al. 2004). The Term Sheet applies, in part, to those actions involving the operation of the Reclamation projects located in Idaho but not those in Oregon.

In order to implement the settlement, a number of steps, including the passage of Federal and State legislation, Tribal approval, Snake River Basin Adjudication court approval, and the negotiation and execution of a number of legal documents, will need to be taken. As of the date of this biological assessment, none of these has been accomplished.

Notwithstanding this fact, Reclamation's proposed actions, to the extent that they involve the operation and maintenance of Reclamation projects located in Idaho, reflect the terms in the Snake River Flow Component of the Term Sheet. This assumes either that the settlement will be finalized in accordance with the Term Sheet insofar as it applies to the projects in Idaho or, if the settlement is not consummated, that the State of Idaho and Idaho water users will still take the steps that are needed so that Reclamation can obtain water for flow augmentation, commencing in 2005, to the extent and with the degree of reliability described in this biological assessment. If this proves not to be the case and Reclamation has to deviate from any of the proposed actions described herein, then consultation will be reinitiated on such action(s) in accordance with 50 C.F.R. 402.16 if required.

It is NOAA Fisheries' expectation that responsibility for temperature improvements in the mainstem of the Snake River in reaches occupied by listed anadromous fish species above the reservoir pool created by the Corps of Engineers' Lower Granite Dam will be resolved in discussions that will occur outside the scope of the Snake River Basin Adjudication and the implementation of the Term Sheet (NOAA Fisheries 2004). Accordingly, Reclamation has agreed with NOAA Fisheries that, after 2010, it may be necessary to reinitiate consultation on the proposed actions that are the subject of this biological assessment depending upon the status of actions to address water temperature (USBR 2004a).

2.3 Limitations on Reclamation's Discretion

It is Reclamation's view that the ESA regulations for this consultation apply to Reclamation's actions only to the extent that Reclamation has discretionary involvement in or control of them. However, as a matter of convenience in this biological assessment, Reclamation has chosen not to differentiate between the discretionary and non-discretionary components of any proposed action. Thus, while many aspects of the proposed actions are, pursuant to State water law, Federal reclamation law, and contracts with water users, non-discretionary on Reclamation's part, this biological assessment analyzes the effects resulting from both the discretionary and non-discretionary components of each proposed action. This section provides a brief (but not comprehensive) overview of the general limitations on Reclamation's discretion regarding the 11 proposed actions.

2.3.1 Project Authorizations

Reclamation received authorization for each of its projects from either Congress or the Secretary of the Interior, who had authority under the 1902 Reclamation Act to approve construction after a finding of feasibility. The Congressional and Secretarial authorizations state the purposes to be served by each project. Most of the projects are authorized for the primary purpose of irrigation. The Army Corps of Engineers constructed the Ririe and Lucky Peak Projects, which are authorized for local flood control and irrigation. Other specific legislation authorizes some storage facilities to be used for various combinations of local flood control, hydropower generation, recreation, and fish and wildlife purposes (see USBR 2004b for project-specific authorizations).

2.3.2 State Water Law and Water Rights

Reclamation secures state water rights for its projects that are consistent with the authorized project purposes. Section 8 of the Reclamation Act of 1902 requires the Secretary to proceed in conformity with state water laws in carrying out the provisions of Reclamation law. 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. Any changes in water use from those described in the water right must generally be authorized by the state through an approval of a transfer of a water right. Watermasters as officers of the state 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 in accordance with the project water rights and contracts between Reclamation and its contractors.

2.3.3 Contracts

In accordance with Federal reclamation law, a party who wishes to receive project water from a Reclamation project for irrigation or municipal and industrial (M&I) purposes must first enter into a contract with the United States pursuant to which they agree, among other things, to pay to the United States the costs of project construction that are allocable to irrigation and/or M&I purposes. In addition, project water users are generally required to bear all costs of annual O&M in the year in which those costs are incurred.

In consideration of this repayment obligation, the United States agrees to deliver project water to contractors in accordance with the terms and conditions set forth in the contract. While the contracts associated with the proposed actions that are the subject of this biological assessment are not identical to each other, they all impose on the United States a legally binding obligation to make deliveries of project water. Thus, Reclamation's discretion in carrying out the proposed actions is substantially circumscribed by virtue of its contractual obligations.

2.3.4 Tribal Interests

The United States has entered into numerous treaties and agreements with tribes in the region. The proposed actions are consistent with these treaties and agreements (for example, the 1990 Fort Hall Indian Water Rights Agreement with the Shoshone-Bannock Tribes of the Fort Hall Reservation and the proposed Nez Perce water rights settlement).

2.4 Future O&M in the Snake River System above Milner Dam

2.4.1 Proposed Action

Future O&M in the Snake River system above Milner Dam includes:

- Storage in and release of water from Jackson Dam and Lake, Palisades Dam and Reservoir, Grassy Lake Dam and Lake, Island Park Dam and Reservoir, Ririe Dam and Reservoir, American Falls Dam and Reservoir, and Minidoka Dam and Lake Walcott.
- Diversion of water at Cascade Creek Diversion Dam, Falls Irrigation Pumping Plant, Minidoka Northside Headworks, Minidoka Southside Headworks, Unit A Pumping Plant, and Milner-Gooding Headworks.
- Power generation at Minidoka, Inman, and Palisades Powerplants.
- Routine maintenance (as described in Appendix B) at the above facilities.
- Provision of salmon flow augmentation water to Brownlee Reservoir (as described in Appendix B) from uncontracted reservoir space in Jackson Lake, American Falls, and Palisades Reservoirs; leased storage from the Shoshone-Bannock Tribal water bank; annually rented storage from the Water District 01 rental pool; and use of powerhead space in Palisades Reservoir (as described in Appendix B.1.2).

The above features and facilities are part of the Michaud Flats, Minidoka, Palisades, and Ririe Projects. Project lands are located discontinuously along the Snake River from the town of Ashton, Idaho, on the Henrys Fork and on the Snake River below Palisades Reservoir to about 300 miles downstream near the town of Bliss in south-central Idaho. The Michaud Flats project is authorized for irrigation. The Minidoka Project is authorized for irrigation and power. The Palisades Project is authorized for irrigation, power, local flood control, and fish and wildlife. The Ririe Project is authorized for local flood control, irrigation, municipal water supply, and recreation.

2.4.2 Action Area

The action area associated with this proposed action includes these reservoir and river corridors (see Figure 2-1):

- Henrys Lake and the Henrys Fork from Henrys Lake downstream to its confluence with the Snake River (Henrys Lake is not part of the proposed action, but its operations are coordinated with Reclamation facilities).
- Cascade Creek downstream from Cascade Creek Diversion Dam to its confluence with Grassy Creek.
- Grassy Lake and Grassy Creek from Grassy Lake Dam downstream to its confluence with the Falls River, and the Falls River downstream to its confluence with the Henrys Fork.
- Ririe Reservoir and Willow Creek from Ririe Dam to its confluence with the Snake River.
- Jackson Lake and the Snake River from Jackson Lake downstream to its confluence with the Columbia River.
- The Columbia River from its confluence with the Snake River to the Columbia River estuary.

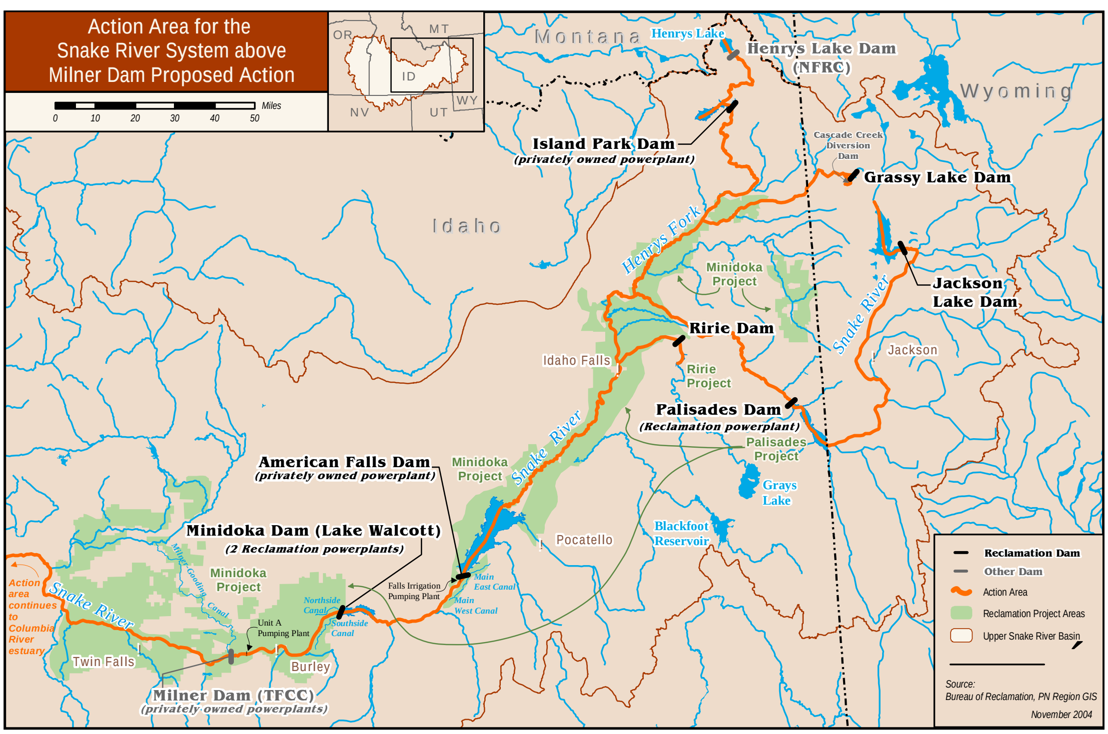

Figure 2-1. Action area and features and facilities for the proposed action in the Snake River system above Milner Dam.

2.5 Future Operations in the Little Wood River System

2.5.1 Proposed Action

Future operations in the Little Wood River system include storage in and release of water from Little Wood River Dam and Reservoir. These features and facilities are a part of the Little Wood River Project; they are authorized for irrigation, local flood control, minimal recreation facilities, and fish and wildlife measures.

2.5.2 Action Area

The action area associated with this proposed action includes these river and reservoir corridors (see Figure 2-2):

- Little Wood River Reservoir and the Little Wood River from the Little Wood River Dam downstream to its confluence with the Snake River.
- The Snake River from its confluence with the Little Wood River downstream to its confluence with the Columbia River.
- The Columbia River from its confluence with the Snake River to the Columbia River estuary.

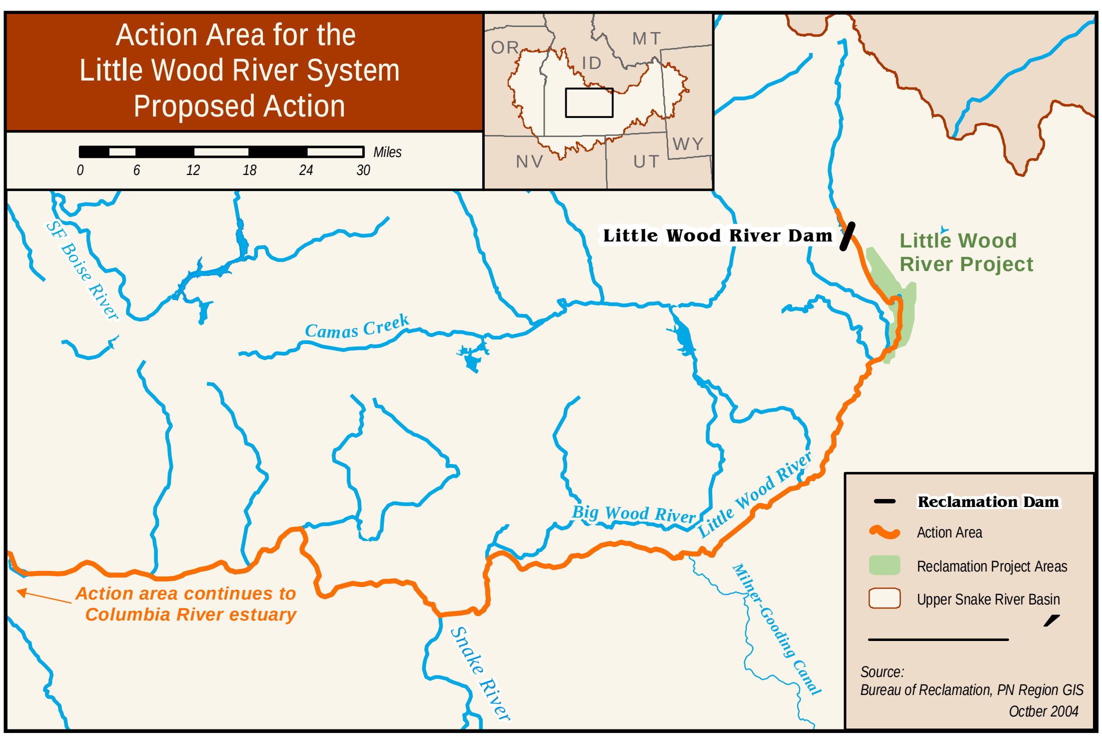

Figure 2-2. Action area and features and facilities for the proposed action in the Little Wood River system.

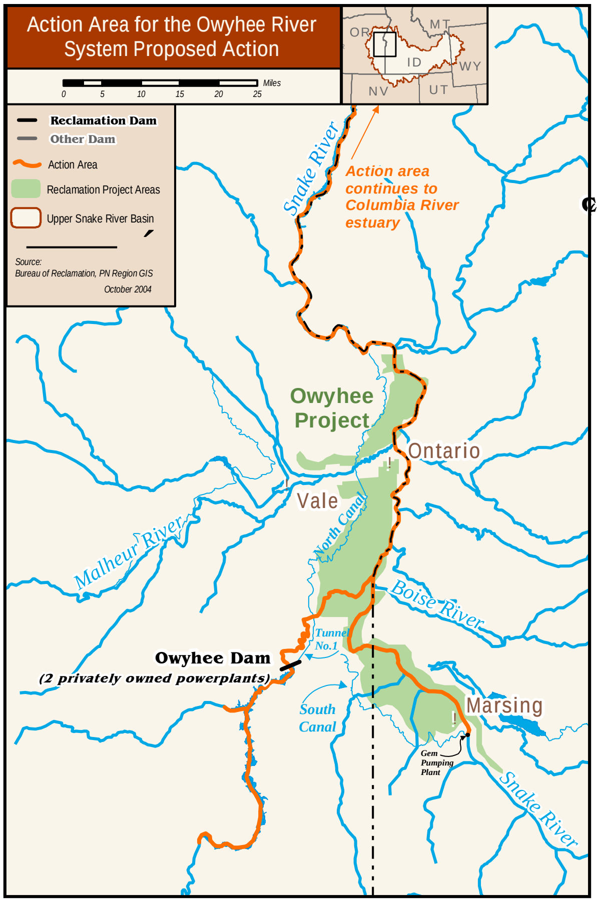

Figure 2-3. Action area and features and facilities for the proposed action in the Owyhee River system.

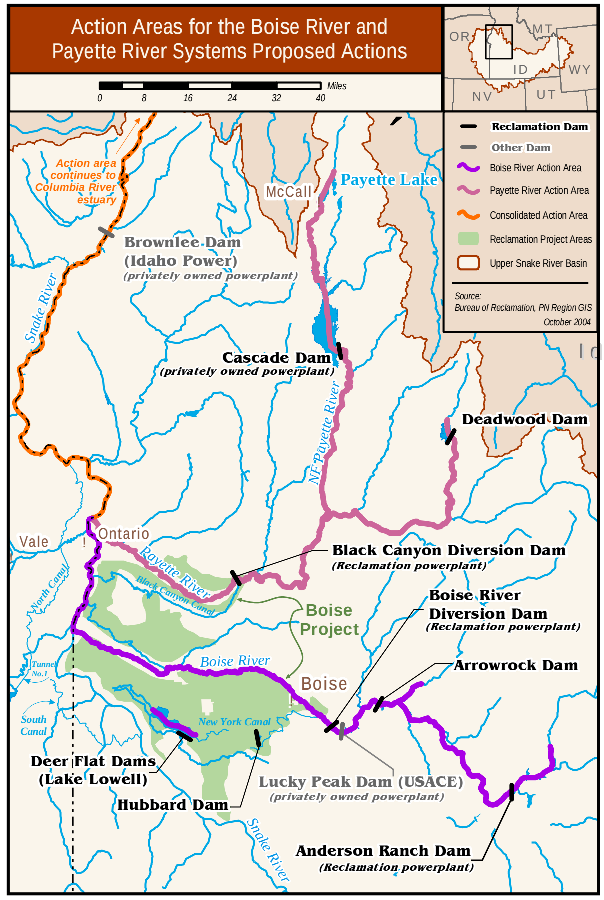

Figure 2-4. Action areas and features and facilities for the proposed actions in the Boise River system and Payette River system.

2.6 Future O&M in the Owyhee River System

2.6.1 Proposed Action

Future O&M in the Owyhee River system includes:

- Storage in and release of water from Owyhee Dam and Reservoir.
- Diversion of water into or at Tunnel No. 1, Dead Ox Pumping Plant, Ontario-Nyssa Pumping Plant, and Gem Pumping Plants #1 and #2.
- Routine maintenance (as described in Appendix B) at the above facilities.

The above features and facilities are a part of the Owyhee Project; they are authorized for the irrigation of about 124,000 acres of land in southeastern Oregon and southwestern Idaho.

2.6.2 Action Area

The action area associated with this proposed action includes these river and reservoir corridors (see Figure 2-3):

- Owyhee Reservoir and the Owyhee River from Owyhee Dam downstream to its confluence with the Snake River.
- The Snake River from the Gem Pumping Plants (near RM 426.6) downstream to its confluence with the Columbia River.
- The Columbia River from its confluence with the Snake River to the Columbia River estuary.

2.7 Future O&M in the Boise River System

2.7.1 Proposed Action

Future O&M in the Boise River system includes:

- Storage in and release of water from Anderson Ranch Dam and Reservoir, Arrowrock Dam and Reservoir, Hubbard Dam and Reservoir, and Deer Flat Dams and Lake Lowell.
- Storage in and release of irrigation water from Lucky Peak Dam and Reservoir.
- Diversion of water at Boise River Diversion Dam.
- Power generation at Anderson Ranch and Boise River Diversion Dam Powerplants.
- Routine maintenance (as described in Appendix B) at the above facilities except Lucky Peak Dam and Reservoir.
- Provision of salmon flow augmentation water to Brownlee Reservoir (as described in Appendix B) from uncontracted storage space in Lucky Peak Reservoir, rented storage from the Water District 63 rental pool, and use of powerhead space in Anderson Ranch Reservoir.

The above features and facilities are a part of the Arrowrock Division of the Boise Project and the Lucky Peak Project. The Arrowrock Division facilities have various authorizations, including irrigation, local flood control, hydropower generation, conservation of fish, and recreation. The Lucky Peak Project (built by and within the jurisdiction of the Army Corps of Engineers) is authorized for local flood control and irrigation. Reclamation markets the stored water (for irrigation) and coordinates the operations of the Arrowrock Division of the Boise Project with the Lucky Peak

Project to accomplish flood control objectives and to store water for irrigation. The Army corps of Engineers has jurisdiction over operation and maintenance of Lucky Peak Project facilities.

2.7.2 Action Area

The action area associated with this proposed action includes these river and reservoir corridors (see Figure 2-4 on page 18):

- Anderson Ranch Reservoir and the South Fork Boise River from Anderson Ranch Dam downstream to its confluence with the Boise River.
- Arrowrock Reservoir and the Boise River from Arrowrock Reservoir downstream to its confluence with the Snake River.
- Lake Lowell.
- The Snake River from its confluence with the Boise River downstream to its confluence with the Columbia River.
- The Columbia River from its confluence with the Snake River to the Columbia River estuary.

2.8 Future O&M in the Payette River System

2.8.1 Proposed Action

Future O&M in the Payette River system includes:

- Storage in and release of water from Deadwood Dam and Reservoir and Cascade Dam and Lake Cascade.
- Diversion of water at Black Canyon Diversion Dam.
- Power generation at Black Canyon Diversion Dam Powerplant.
- Routine maintenance (as described in Appendix B) at the above facilities.
- Provision of salmon flow augmentation water to Brownlee Reservoir (as described in Appendix B) from uncontracted space in Lake Cascade and Deadwood Reservoir and rented storage from the Water District 65 rental pool.

The above features and facilities are part of the Payette Division of the Boise Project. These facilities are authorized for irrigation and hydropower generation.

2.8.2 Action Area

The action area associated with this proposed action includes these river and reservoir corridors (see Figure 2-4 on page 18):

- Payette Lake and the North Fork Payette River from Payette Lake downstream to its confluence with the Payette River, including Lake Cascade (Payette Lake is not a part of the proposed action, but its operations are coordinated with Reclamation facilities).
- Deadwood Reservoir and the Deadwood River from Deadwood Dam downstream to its confluence with the South Fork Payette River.
- The South Fork Payette River from its confluence with the Deadwood River downstream to its confluence with the North Fork Payette River.
- The Payette River from its confluence with the North Fork Payette River and South Fork Payette River downstream to its confluence with the Snake River.
- The Snake River from its confluence with the Payette River downstream to its confluence with the Columbia River.
- The Columbia River from its confluence with the Snake River to the Columbia River estuary.

2.9 Future O&M in the Malheur River System

2.9.1 Proposed Action

Future O&M in the Malheur River system includes:

- Storage in and release of water from Agency Valley Dam and Beulah Reservoir and Bully Creek Dam and Reservoir.
- Storage in and release of water associated with 50 percent of storage in Warm Springs Dam and Reservoir.
- Diversion of water at Harper and Bully Creek Diversion Dams.
- Routine maintenance (as described in Appendix B) at the above facilities.
- Provision of salmon flow augmentation water to Brownlee Reservoir (as described in Appendix B) from acquired natural flow rights of 17,650 acre-feet from the Malheur River (with supplemental Snake River rights).

The above features and facilities are part of the Vale Project. These facilities are authorized for irrigation and local flood control. The Bully Creek facilities are also authorized for recreation and fish and wildlife preservation and propagation. Reclamation has an interest in 50 percent of the Warm Springs Reservoir.

2.9.2 Action Area

The action area associated with this proposed action includes these river and reservoir corridors (see Figure 2-5):

- Beulah Reservoir and the North Fork Malheur River downstream from Agency Valley Dam to its confluence with the Malheur River.
- Bully Creek Reservoir and Bully Creek downstream from Bully Creek Diversion Dam to its confluence with the Malheur River.
- Warm Springs Reservoir and the Malheur River downstream from Warm Springs Dam to its confluence with the Snake River.
- The Snake River from its confluence with the Malheur River downstream to its confluence with the Columbia River.
- The Columbia River from its confluence with the Snake River to the Columbia River estuary.

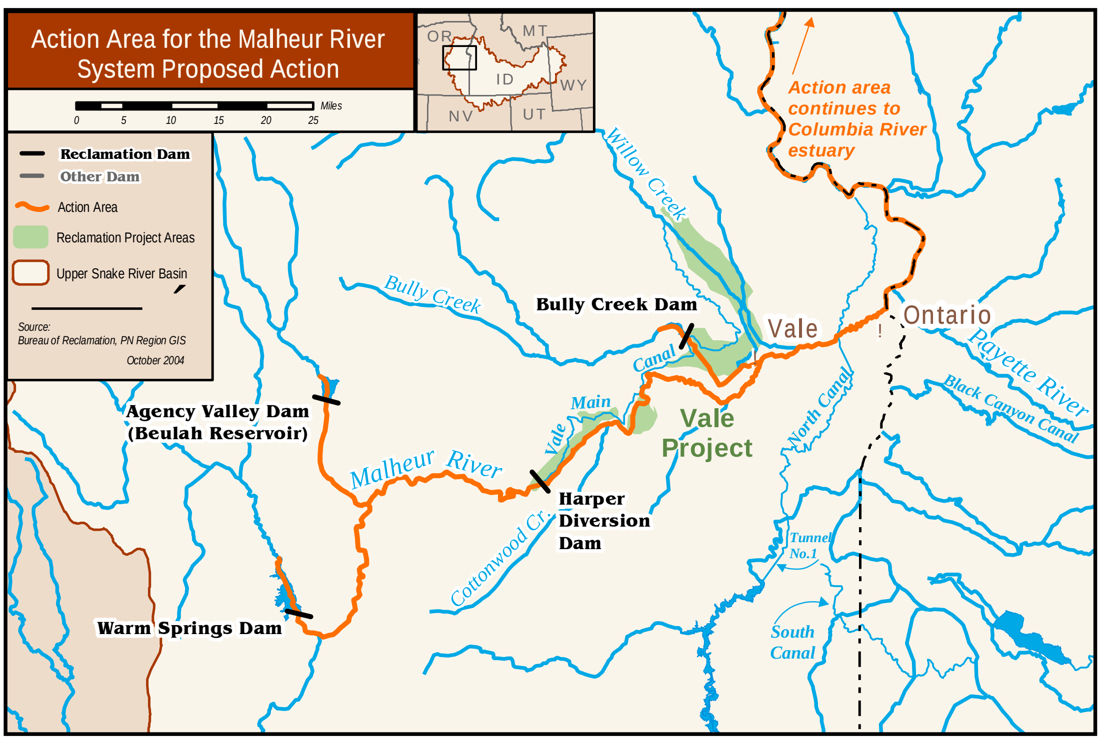

Figure 2-5. Action area and features and facilities for the proposed action in the Malheur River system.

2.10 Future O&M in Mann Creek System

2.10.1 Proposed Action

Future O&M in the Mann Creek system includes:

- Storage in and release of water from Mann Creek Dam and Reservoir.
- Diversion of water at Mann Creek Dam outlet.
- Routine maintenance (as described in Appendix B) at the above facilities.

The above features and facilities are part of the Mann Creek Project, which is authorized for the irrigation of about 5,100 acres of land near Weiser, Idaho. The authorization also includes minimum basic recreation facilities and fish and wildlife conservation and development.

2.10.2 Action Area

The action area associated with this proposed action includes these river and reservoir corridors (see Figure 2-6):

- Mann Creek Reservoir and Mann Creek downstream from Mann Creek Dam to its confluence with the Weiser River
- The Weiser River from its confluence with Mann Creek downstream to its confluence with the Snake River.
- The Snake River from its confluence with the Weiser River downstream to its confluence with the Columbia River.
- The Columbia River from its confluence with the Snake River to the Columbia River estuary.

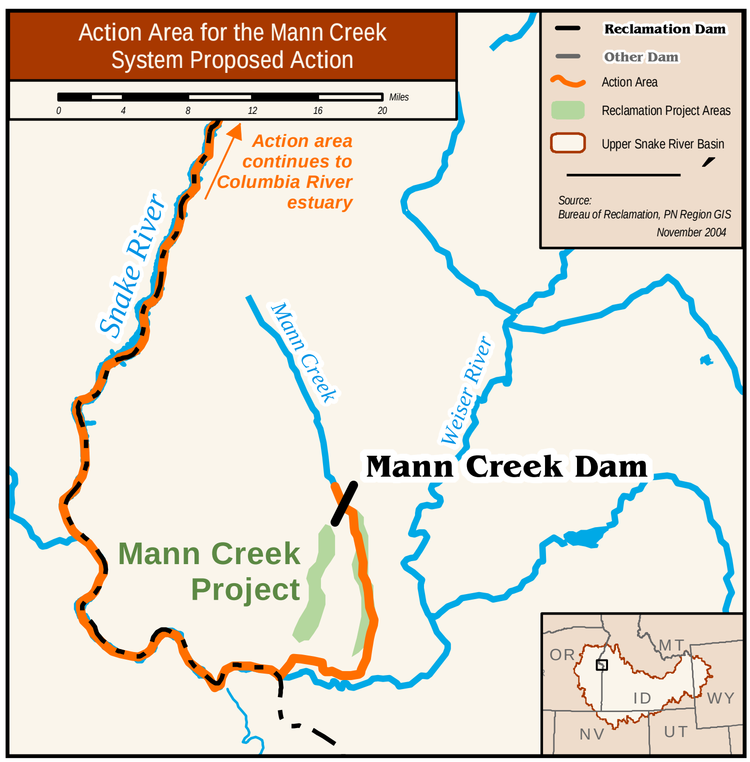

Figure 2-6. Action area and features and facilities for the proposed action in the Mann Creek system.

2.11 Future O&M in the Burnt River System

2.11.1 Proposed Action

Future O&M in the Burnt River system includes:

- Storage in and release of water from Unity Dam and Reservoir.
- Routine maintenance (as described in Appendix B) at the above facilities.

The above features and facilities are part of the Burnt River Project, which is authorized for irrigation of about 15,600 acres of land in eastern Oregon.

2.11.2 Action Area

The action area associated with this proposed action includes these river and reservoir corridors (see Figure 2-7):

- Unity Reservoir and the Burnt River from Unity Dam downstream to its confluence with the Snake River.
- The Snake River from its confluence with the Burnt River downstream to its confluence with the Columbia River.
- The Columbia River from its confluence with the Snake River to the Columbia River estuary.

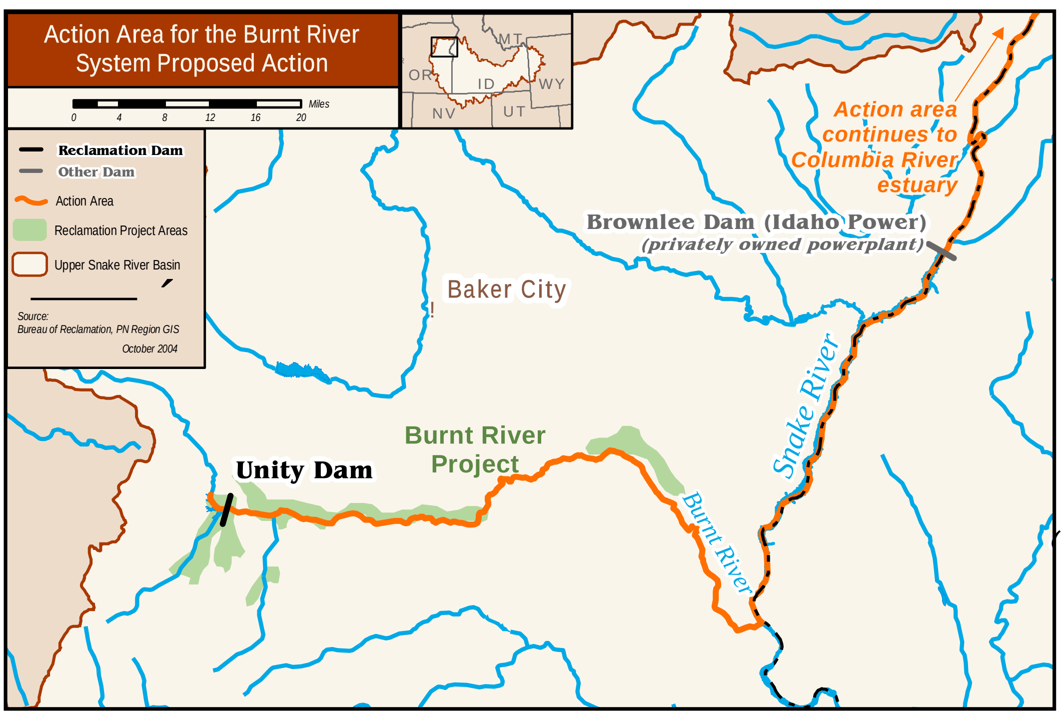

Figure 2-7. Action area and features and facilities for the proposed action in the Burnt River system.

2.12 Future O&M in the Upper Powder River System

2.12.1 Proposed Action

Future O&M in the upper Powder River system includes:

- Storage in and release of water from Mason Dam and Phillips Lake.
- Diversion of water at Savely Dam and Lilley Pumping Plant.
- Routine maintenance (as described in Appendix B) at the above facilities.

The above facilities are part of the Upper Division of the Baker Project, which is authorized for irrigation, local flood control, measures to conserve fish and wildlife, and recreation. The Upper Division provides irrigation water to about 19,000 acres of land in and around Baker City, Oregon.

2.12.2 Action Area

The action area associated with this proposed action includes these river and reservoir corridors (see Figure 2-8):

- Phillips Lake and the Powder River downstream from Mason Dam to its confluence with the Snake River.

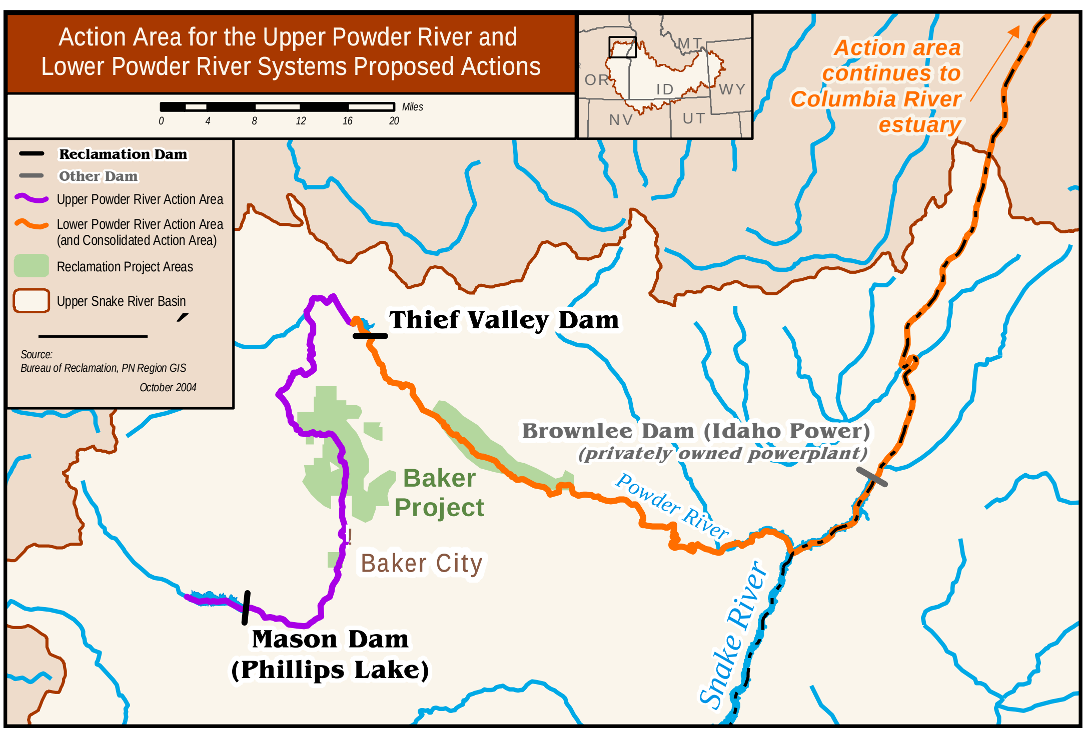

Figure 2-8. Action areas and features and facilities for the proposed actions in the upper Powder River system and the lower Powder River system.

- The Snake River from its confluence with the Powder River downstream to its confluence with the Columbia River.
- The Columbia River from its confluence with the Snake River to the Columbia River estuary.

2.13 Future O&M in the Lower Powder River System

2.13.1 Proposed Action

Future O&M in the lower Powder River system includes:

- Storage in and release of water from Thief Valley Dam and Reservoir.
- Routine maintenance (as described in Appendix B) at the above facilities.

The above features and facilities are part of the Lower Division of the Baker Project, which is authorized for the irrigation of about 7,300 acres of land downstream from Thief Valley Dam and Reservoir near Baker City, Oregon.

2.13.2 Action Area

The action area associated with this proposed action includes these river and reservoir corridors (see Figure 2-8 on page 25):

- Thief Valley Reservoir and the Powder River downstream from Thief Valley Dam to its confluence with the Snake River.
- The Snake River from its confluence with the Powder River downstream to its confluence with the Columbia River.
- The Columbia River from its confluence with the Snake River to the Columbia River estuary.

2.14 Future Provision of Salmon Flow Augmentation from Rental or Acquisition of Natural Flow Rights

2.14.1 Proposed Action

This action is Reclamation's future provision of salmon flow augmentation water to Brownlee Reservoir (as described in Appendix B) from acquired or long-term leased consumptive natural flow water rights from the Snake River between Milner Dam and Swan Falls Dam (high-lift pumpers) during the salmon flow augmentation period.

The Term Sheet contemplates Reclamation acquiring or entering into a long-term lease of 60,000 acre-feet from consumptive natural flow water rights diverted and consumed below Milner Dam, with a corresponding increase in flow augmentation, for a total of 487,000 acre-feet. The Term Sheet also contemplates that third parties may acquire natural flows or other water supplies to substitute for reservoir storage that would otherwise be used for flow augmentation. For this analysis, Reclamation assumes that as noted above, it may secure up to 100,000 acre-feet of natural flows in a given year for flow augmentation. Only the first 60,000 acre-feet of secured natural flows will be used to increase the flow augmentation volume beyond 427,000 acre-feet.

2.14.2 Action Area

The action area associated with this proposed action includes these river and reservoir corridors:

- The Snake River downstream from Milner Dam to its confluence with the Columbia River.
- The Columbia River from its confluence with the Snake River to the Columbia River estuary.

2.15 Literature Cited

Parenthetical Reference	Bibliographic Citation
Nez Perce Tribe et al. 2004	Nez Perce Tribe, the State of Idaho, and the U.S. Department of the Interior. 2004. Mediator's Term Sheet. May 15, 2004. Website: www.doi.gov/news/NPTermSheet.pdf.
NOAA Fisheries 2004	National Marine Fisheries Service. 2004. Letter from D. Robert Lohn, Northwest Regional Administrator, National Marine Fisheries Service, to J. William McDonald, Pacific Northwest Regional Director, Bureau of Reclamation. Letter dated May 12, 2004.
USBR 2004a	U.S. Bureau of Reclamation. 2004a. Letter from J. William McDonald, Pacific Northwest Regional Director, Bureau of Reclamation, to D. Robert Lohn, Northwest Regional Administrator, National Marine Fisheries Service. Letter dated May 14, 2004.

Parenthetical Reference	Bibliographic Citation
USBR 2004b	U.S. Bureau of Reclamation. 2004b. *Operations Description for Bureau of Reclamation Projects in the Snake River Basin above Brownlee Reservoir*. Snake River Area, Pacific Northwest Region, Boise, Idaho.

Chapter 3 HYDROLOGIC CONDITIONS

This chapter describes hydrologic conditions in the upper Snake River basin. This information is presented in three parts. The first part, Section 3.1, provides an overview of the upper Snake River basin and describes the range of hydrologic conditions that have occurred as a result of past operations. This includes a summary of the range of Federal reservoir contents and outflows. Section 3.2 describes the development of an upper Snake River model used to simulate current hydrologic conditions and future conditions expected to occur with the 11 proposed actions. The third part, Section 3.3.1, describes the modeled analysis and previous studies that attempt to describe the effects to lower Snake River flows from Reclamation's storage and diversion operations at upper Snake River projects.

3.1 Past Hydrologic Conditions

3.1.1 Overview of the Upper Snake River Basin

The Snake River begins at its headwaters near Yellowstone National Park in Wyoming, turns west to the Idaho border, and flows northwest to its confluence with the Henrys Fork near Rexburg, Idaho. From that point, the river follows a southerly crescent across Idaho to the Idaho-Oregon border where it then turns north. The Boise, Payette, and Weiser Rivers in Idaho and the Owyhee, Malheur, Burnt, and Powder Rivers in Oregon join the Snake River in this Idaho-Oregon border reach. The Snake River then passes through Idaho Power's Hells Canyon Complex. Brownlee Dam, near RM 285, is the uppermost facility, with Oxbow and Hells Canyon Dams downstream. Reclamation (2004) describes private irrigation development in the basin, the Federal promotion of agriculture, and Federal irrigation development.

The Snake River basin upstream from Brownlee Dam drains about 72,590 square miles. This area includes 31 dams and reservoirs with at least 20,000 acre-feet of storage each. Reclamation, Idaho Power, and a host of other organizations own and operate various facilities. These facilities have substantial influence on water resources, supplies, and the movement of surface and ground water through the region. The total storage capacity of these reservoirs is more than 9.7 million acre-feet. In addition, there are numerous smaller state, local, and privately owned and operated dams and reservoirs throughout the upper Snake River basin.

The annual flow of the Snake River averages about 14 million acre-feet per year into Brownlee Reservoir and about 37 million acre-feet below Lower Granite Dam, downstream from Lewiston. This compares to annual average flows of 135 million acre-feet for the Columbia River at The Dalles, Oregon (BPA 2004), and 198 million acre-feet at the mouth of the Columbia River (BPA et al. 2001).

As of 2002, about 3.3 million acres were being irrigated in the State of Idaho (USDA 2002). This includes some acreage outside the Snake River basin but does not include about 170,000 acres of land in the Snake River basin in eastern Oregon currently irrigated as part of Reclamation projects. Reclamation provides a full water supply to an estimated 605,000 acres and a supplemental water supply to an estimated 986,000 acres (USBR 2001b). These estimates are derived from 1992 information and may be slightly higher due to minor increases in authorized areas for service since 1992. Most of the lands receiving a supplemental water supply were originally privately developed and irrigated from natural flows but subsequently contracted for supplemental storage from a Reclamation project. About 1.7 million acres are irrigated from entirely private water sources (USBR 1998).

Although irrigated acreage served by Federal projects has changed little since 1959, total irrigation in Idaho has increased by more than 25 percent (USBR 1998). Much of the new, private irrigation during this period uses groundwater.

3.1.2 Overview of Past Reservoir Hydrologic Operations

Appendix C provides general historical hydrologic data for river reaches and reservoirs to help portray the range of systems' operations and hydrologic conditions that have occurred from past operations in the action areas. These conditions have contributed to the current status of ESA-listed species. The tables in Appendix C summarize the observed minimum, maximum, and median reservoir contents and outflows for the period from 1971 to 2003 for selected storage facilities. These tables reflect the entire range of operations that have occurred for the period of record. The tabulated data do not represent a single water year, but rather they are a composite of the records for each individual day within each month. These tables contain companion data to the summary hydrographs presented in Appendix B of Reclamation's *Operations Description for Bureau of Reclamation Projects in the Snake River Basin above Brownlee Reservoir* (2004), which provides the information summarized in the tables for all reservoirs included in this consultation.

Table 3-1 shows the average volume of water released from total storage from Reclamation reservoirs during the summer irrigation season from 1990 to 2003 was about 3.3 million acre-feet. In total, the average volume of water released in the upper Snake, Boise, and Payette River systems was approximately 3.0 million acre-feet; the average volume of water released in the Owyhee River system was

Table 3-1. Average volume of water released from total storage in upper Snake River systems from 1990 to 2003.

Project/Area	Average Volume of Water Released During the Irrigation Season [2] (acre-feet)
Upper Snake above Milner Projects Total	**2,154,000**
Boise System	523,000
Payette System	293,000
Boise Project Total	**816,000**
Owyhee	334,000
Owyhee Project Total	**334,000**
Beulah	37,000
Warm Springs	93,000
Bully Creek	19,000
Vale Project Total	**149,000**
Thief Valley	14,000
Phillips Lake	37,000
Baker Project Total	**51,000**
Unity	21,000
Burnt River Project Total	**21,000**
Grand Total	**3,525,000**

1 Does not include Mann Creek or Little Wood Projects.

2 Average volume was obtained by subtracting minimum storage from maximum storage during the April-to-October irrigation season.

approximately 334,000 acre-feet, and the average volume of water released in the remaining Oregon projects was approximately 221,000 acre-feet.

3.1.3 Hydrologic Changes

Hydrologic conditions (e.g., the timing and magnitude of streamflows) at many locations in the upper Snake River basin have changed over the past century as a result of numerous water development projects that involve hydropower generation, water withdrawals, reservoir storage, and return flows. The construction and subsequent operations of Reclamation facilities have contributed to these hydrologic changes and the present hydrologic conditions.

Figure 3-1, Figure 3-2, and Figure 3-3 illustrate mean monthly observed and estimated unregulated flow at three locations in the upper Snake River basin: the Snake River at Milner, Boise River at Lucky Peak, and Payette River at Horseshoe Bend. Unregulated flows were developed from observed flows with the effects of storage, measured/estimated diversions, and measured/estimated return flows removed. It is calculated by removing the effects of historical reservoir operations, diversions, and short-term surface returns from the observed flow record. Unregulated flows reflect the historical river gains and typically have not been modified to reflect the current level of groundwater pumping, irrigation withdrawals, return flows, etc. These figures provide a general comparison of current hydrologic conditions and how water development activities have altered the hydrology at these locations.

Unregulated flows should not be confused with "modified" flows, which are historical streamflows adjusted to the year 2000 level of irrigation depletion. Modified flows are described in Section 3.2 of this chapter.

Figure 3-1 shows that much of the water volume is diverted for irrigation before passing the Snake River at Milner gage. Unregulated flows depicted in Figure 3-1 reflect removal of the effects from Reclamation and non-Reclamation facilities. Figure 3-2 and Figure 3-3 reflect removal of the effects of all storage, diversion, and short-term return flows from Reclamation and non-Reclamation facilities. Figure 3-2 and Figure 3-3 show the effect reservoir regulation has on streamflows upstream from most irrigation activity.

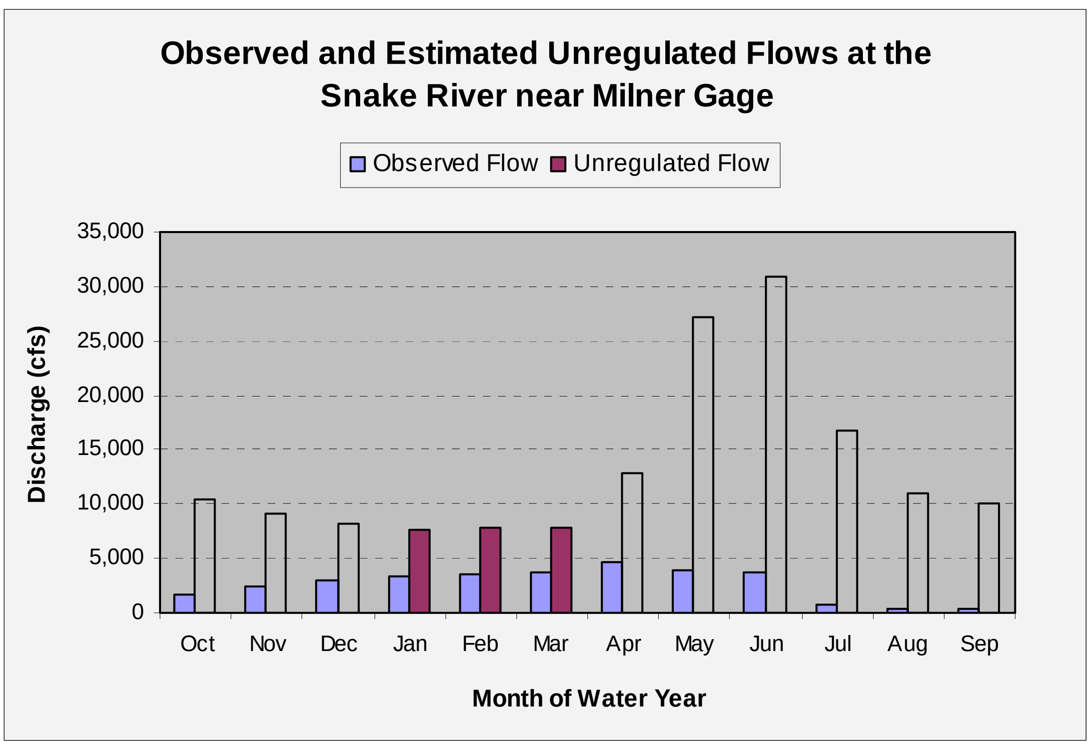

Figure 3-1. Average monthly observed and estimated unregulated flow at the Snake River near Milner gage from 1928 to 2000 (observed from USGS, unregulated from MODSIM).

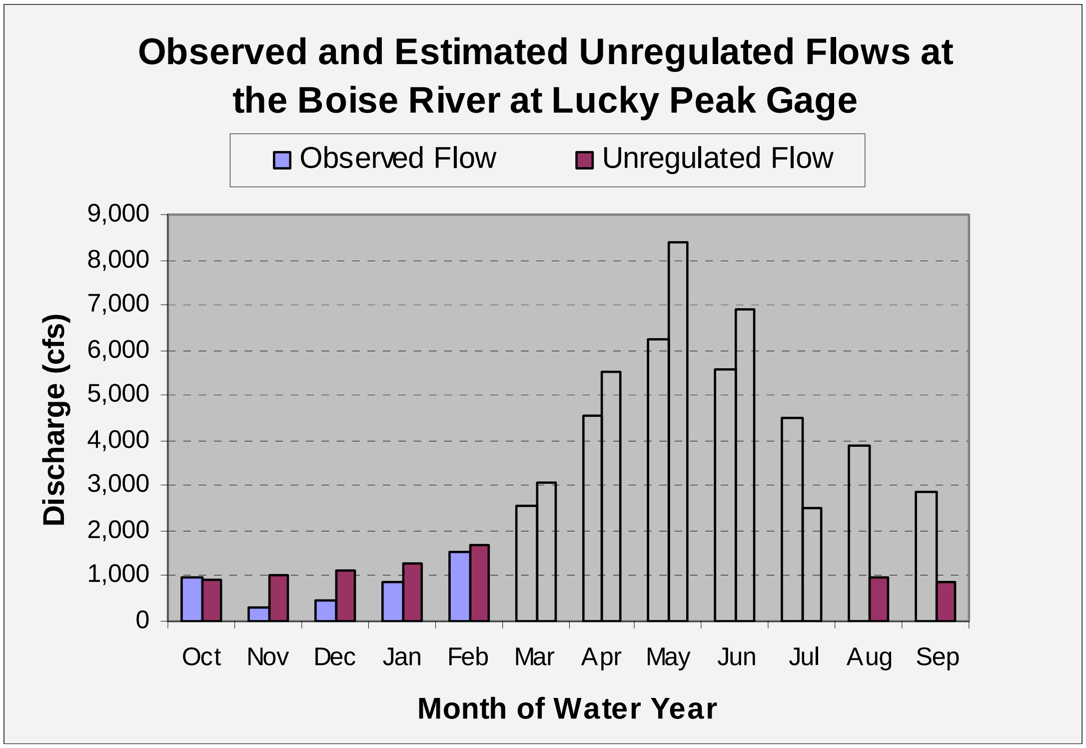

Figure 3-2. Average monthly observed and estimated unregulated flow at the Boise River at Lucky Peak gage from 1971 to 2000 (from USBR Hydromet data).

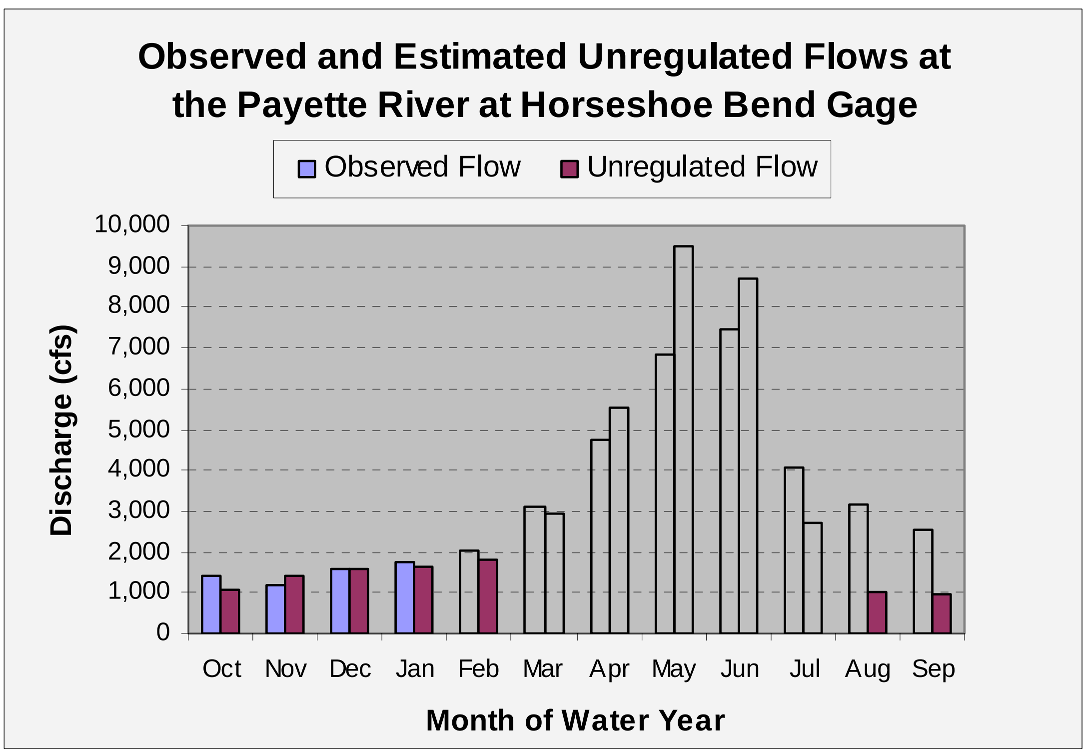

Figure 3-3. Average monthly observed and estimated unregulated flow at the Payette River at Horseshoe Bend gage from 1971 to 2000 (from USBR Hydromet data).

3.2 Modeled Hydrologic Conditions Analysis

Reclamation developed the Upper Snake River model using MODSIM to simulate current hydrologic conditions and future hydrologic conditions that would occur with implementation of the proposed actions. This section provides a general description of model development and results. Appendix E more fully describes the model, its development, and verification. *Pisces*, a user interface, can be used to access the data contained on CD-ROM. Tables in Appendix D summarize some of the modeled results.

MODSIM is a general-purpose river and reservoir operations computer simulation model. The model includes the river system features (storage reservoirs, irrigation demands, operational flow objectives, and reservoir contents) present in 2004. The Upper Snake River MODSIM model is an updated version of the model used in previous Reclamation consultations on upper Snake River basin project operations. Previous analyses used a 1928-to-1989 gains data set modified to the year 1989 level of irrigation. This analysis includes additional years in the gains data set (1928 to 2000) and a level of irrigation modified to the year 2000. The model results are monthly averages.

3.2.1 Modeling Current Operations and the Proposed Actions

Comparisons of observed and unregulated flows for the periods of record from either 1928 to 2000 or 1971 to 2000, as shown in Section 3.1.3, do not adequately illustrate the effects of current irrigation practices, reservoir operations, and return flows. This is because not all reservoirs were in place or operating the same way throughout the period. Irrigation practices have also evolved.

To establish a baseline for later analysis of the hydrologic effects attributed to the proposed actions, it was necessary to determine how the current reservoir operating priorities and current irrigation practices, including the influence of groundwater pumping, would have affected runoff if they were imposed on the historical record. To do this, Reclamation created a 1928-to-2000 data set of river gains adjusted to the 2000 level of irrigation depletion. This complex process ultimately added gains to the early years of the historical record and subtracted gains from the remainder of the period (see Appendix E and Larson 2003).

After preparing the adjusted gains data set, Reclamation used its Upper Snake River MODSIM model to simulate reservoir operations and water distribution for two scenarios: current project operations (labeled "Current_Operations") and future proposed actions (labeled "Proposed_Action"). The resulting flows from current operations are called "modified flows."

Both simulations include provisions of flow augmentation for listed anadromous fish in the Snake and Columbia Rivers. Water for salmon flow augmentation may come from a variety of sources, including uncontracted storage space, annual storage rentals from willing irrigation entities, natural flow rentals and acquisitions, and powerhead space. The calculations for how much salmon flow augmentation water Reclamation can provide in a given year include factors for:

- The availability of water in the rental pools based on past contributions.
- The availability of natural flow rentals.
- The volume of Reclamation space that has refilled from the previous year.
- The availability of water that can be released from reservoir space reserved for powerhead.

Current Operations

This simulation models the hydrologic conditions of Reclamation's current operations using operational criteria reflective of current river operation practices and applied to the water supply record from 1928 to 2000. Current river operations practices refer to meeting today's irrigation demand (all 1991-to-2000 recorded diversions based on water supply), flood control operation rules, target recreation reservoir levels, and target instream flow levels. This simulation includes provision of up to 427,000 acre-feet of salmon flow augmentation water through storage releases and acquired and leased natural flows. Flows past Milner Dam are limited to a maximum of 1,500 cfs. No water in powerhead space is available for flow augmentation from Palisades Reservoir or Lake Walcott.

Proposed Actions

The Proposed Action scenario simulates future hydrologic conditions with implementation of the proposed actions (the storing, releasing, and diverting of project water). This simulation uses the same assumptions as the Current Operations simulation with additions to reflect the proposed actions, including an additional annual acquisition of 60,000 acre-feet of natural flow rights below Milner Dam for flow augmentation. Natural flow is assumed to be leased or acquired from high-lift pumpers during the flow augmentation period. The maximum volume of flow augmentation to be provided in a given year is 487,000 acre-feet. In those years when rental water is scarce, Reclamation will make available up to 78,500 acre-feet (or accrual, if less) of Palisades Reservoir powerhead space as a last resort to achieve up to 427,000 acre-feet for flow augmentation (conditions for use of powerhead are described in Appendix B.1.2). In very dry years, Reclamation may allow up to 30,000 acre-feet of uncontracted space in the Payette River basin for irrigation rental on a temporary basis as described in the Term Sheet (Nez Perce Tribe et al. 2004) and in Appendix B.2.

This simulation also modifies the timing of flow augmentation at Milner Dam; in most years, flow augmentation is modeled as being released in July and August with flows up to 2,500 cfs. In dry years, flow augmentation is modeled as beginning in June. As described in Appendix B, augmentation in the proposed actions will begin after the maximum reservoir fill is achieved and after flood releases past Milner Dam are complete. This will normally occur after June 20, resulting in maximum releases for flow augmentation of less than 2,500 cfs. However, flow augmentation releases may be delayed until after July 4 due to late runoff. In such cases, releases of up to 3,000 cfs may be necessary before the end of the flow augmentation period in order to satisfy USFWS ramping criteria. The monthly computer simulation cannot capture the complexities of daily ramping criteria combined with variable start and end dates. Therefore, the modeled monthly average flows in Appendix D will not precisely reflect the daily flow rates, especially below Milner Dam.

Model Calibration

The Current Operations model was calibrated to closely simulate observed river flows and reservoir operations since 1992. Reclamation has operated the reservoirs consistently since 1992 while attempting to meet salmon flow augmentation objectives. Figure 3-4 shows a graphic comparison of the calibration at the Snake River at Weiser gage. Appendix E provides more examples.

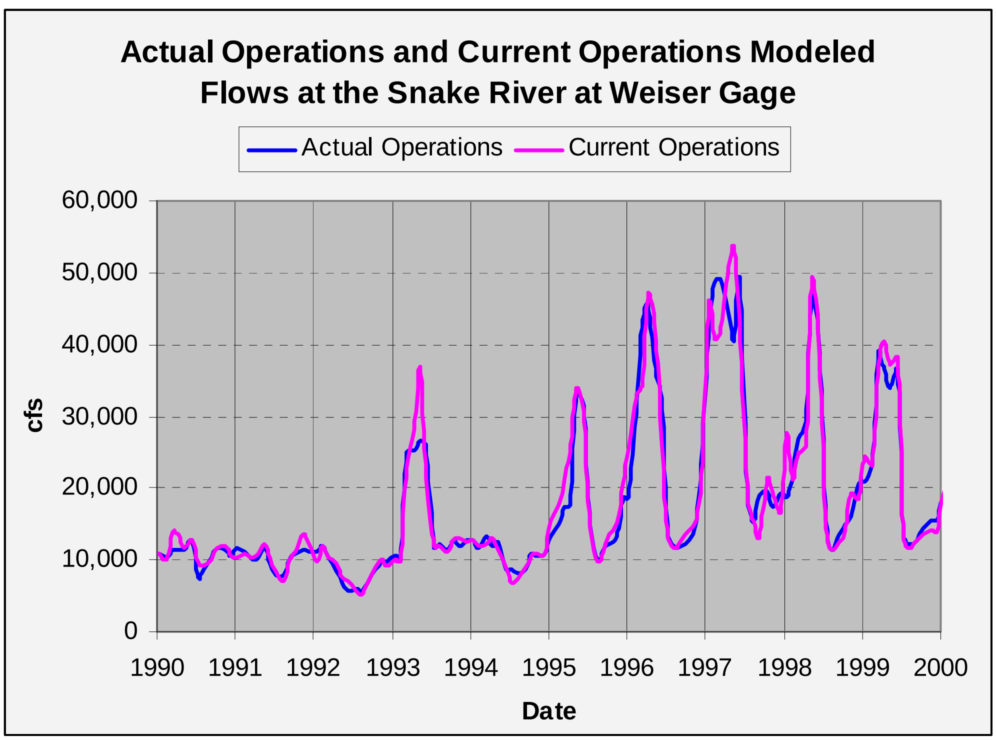

Figure 3-4. Modeled current conditions versus observed monthly average flows at the Snake River at Weiser gage (1990-2000).

3.2.2 General River and Reservoir Modeled Results for the Proposed Actions

Reclamation developed *Pisces*, a software interface, to view the modeled output for the computer simulations. Appendix E contains a CD-ROM with this interface. Through this interface, a user can view the following modeled output as either tables or graphs:

- Time series data for river flows and reservoir contents and elevations (a time series is a hydrograph for the period of record).
- Exceedance data for river flows and reservoir contents and elevations (an exceedance curve shows how often a river reach or reservoir equals or exceeds a specific flow or volume).

The data are output as monthly average flows or end-of-month reservoir contents or elevations and define a simulated range of operations at these facilities. This data is available for the Current Operations and Proposed Action scenarios. Tables in Appendix D show modeled minimum, maximum, and median end-of-month reservoir contents by month and average monthly reservoir outflows for some proposed actions.

The species' chapters also include modeled data relevant in describing specific hydrologic conditions and how these relate to the species population numbers, distribution, and related parameters with regard to analyzing the proposed actions' effects. The CD-ROM in Appendix E allows access to the complete modeled results for additional reservoirs and river nodes. *Pisces* also displays hydrologic data reflecting actual operations. This is historical operations presented as monthly averages, not modeled data.

The following four figures (Figure 3-5 through Figure 3-8) show how flows and reservoir contents differ between the modeled results from current operations and the proposed actions using the 1990-to-2000 period of record. It is readily apparent that the hydrologic differences between the two scenarios are small.

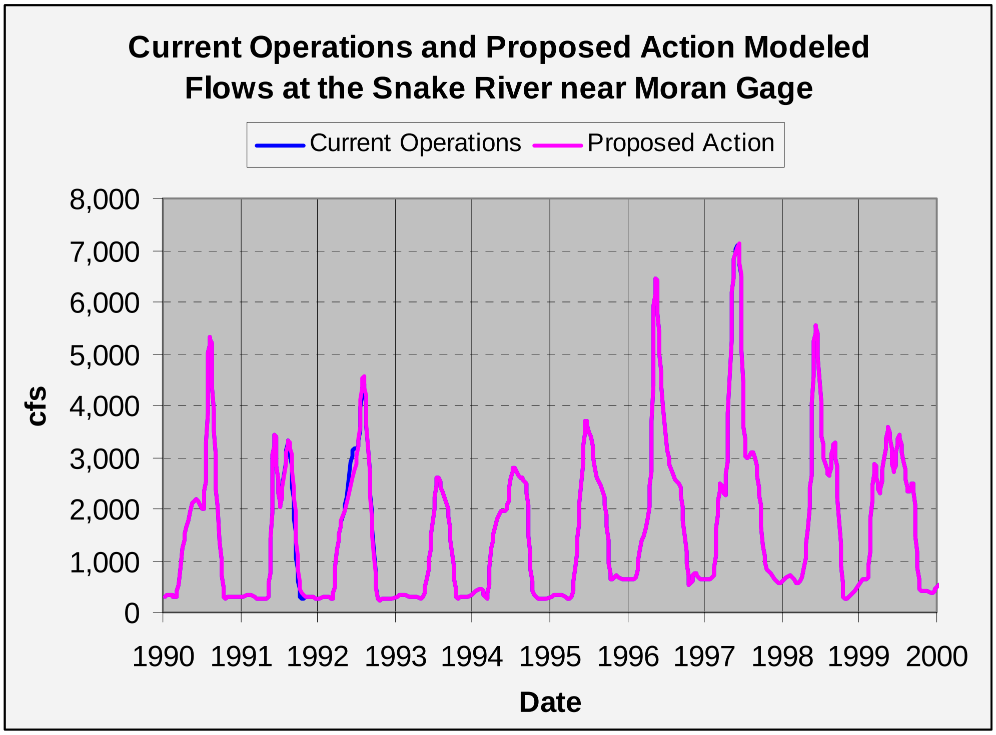

Figure 3-5. Modeled results from current operations and the proposed actions for flows at the Snake River near Moran gage (near Jackson Lake Dam) from 1990 to 2000.

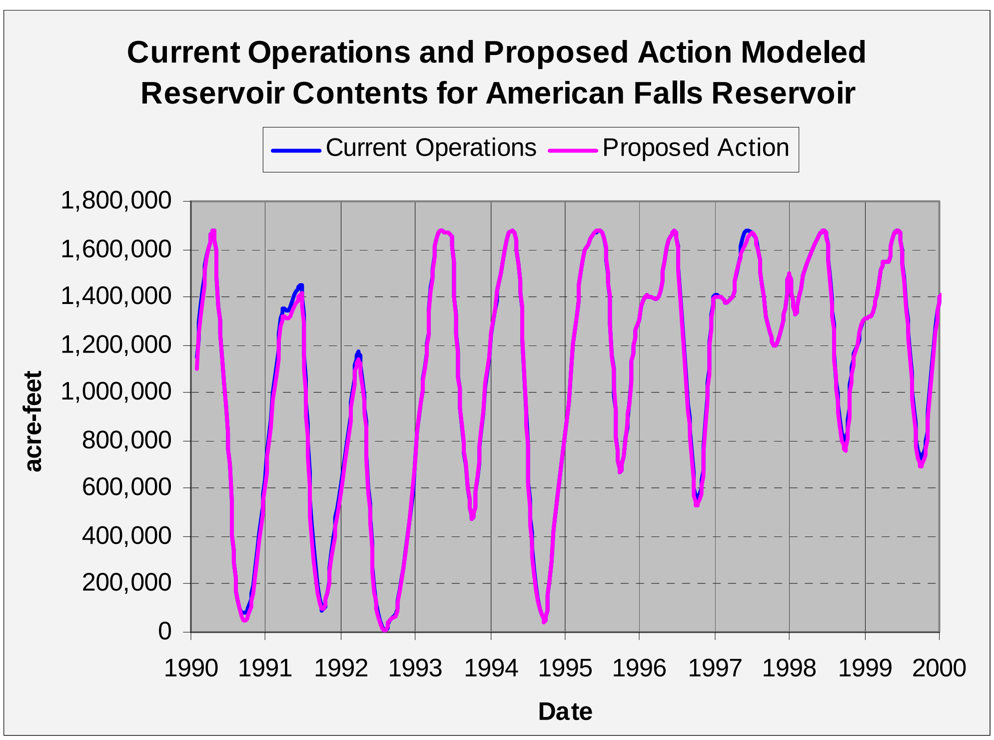

Figure 3-6. Modeled results from current operations and the proposed actions for reservoir contents at American Falls Reservoir from 1990 to 2000.

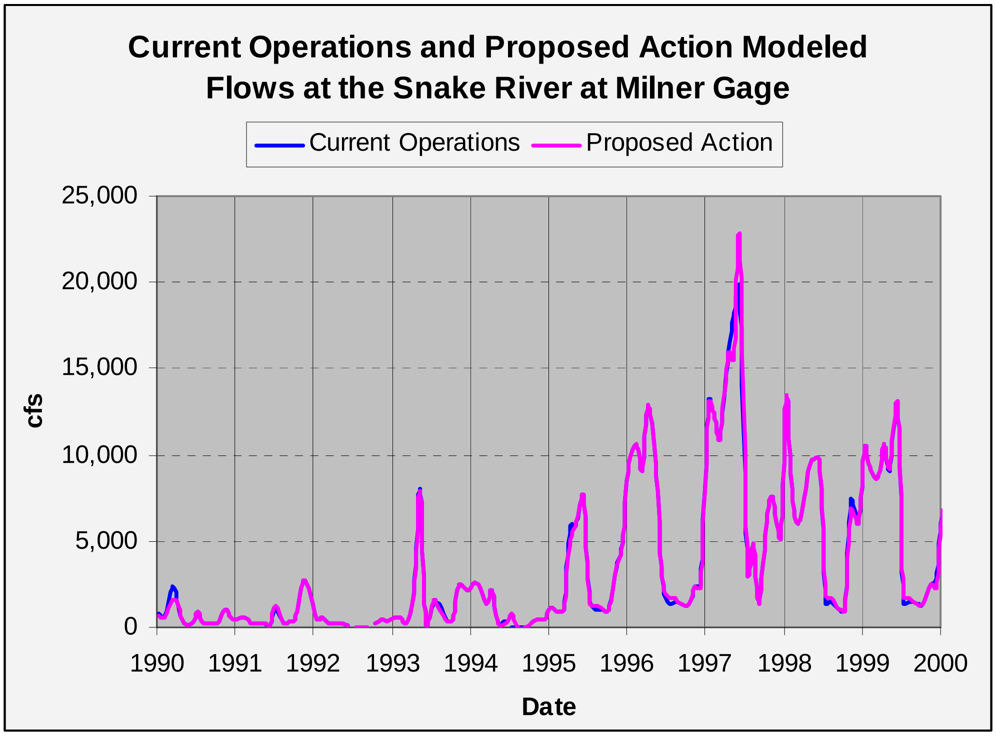

Figure 3-7. Modeled results from current operations and the proposed actions for flows at the Snake River at Milner from 1990 to 2000.

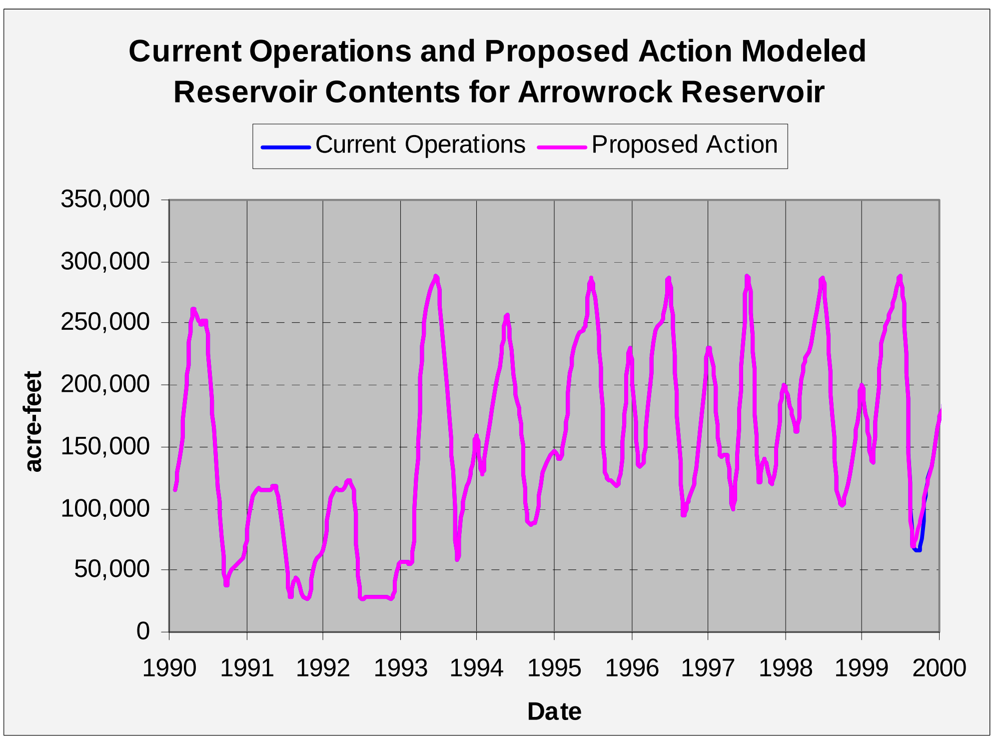

Figure 3-8. Modeled results from current operations and the proposed actions for reservoir contents at Arrowrock Reservoir from 1990 to 2000.

3.2.3 Salmon Flow Augmentation Model Results

Under current operations, the model predicts Reclamation could supply at least 427,000 acre-feet in 50 percent of years. This is far less than originally computed in Reclamation's amended biological assessment (2001a), which suggested 427,000 acre-feet would be available with 80 percent reliability if powerhead was not available. Previous analyses assumed the irrigation community would be far more willing to rent water for flow augmentation than has been reflected in recent years. The current Upper Snake River MODSIM model computes flow augmentation contributions based on the irrigators' recent past behavior (from 1992 to 2004) as related to reservoir carryover and anticipated runoff volume.

The modeled results show that the proposed actions are more likely to provide 427,000 acre-feet for salmon flow augmentation than the current operations (see Table 3-2 and Figure 3-9). The proposed actions are estimated to supply at least 427,000 acre-feet or more in roughly three-fourths of the water years and as much as 487,000 acre-feet in slightly less than half the water years.

Historically, Reclamation has provided 427,000 acre-feet or close to this volume in about 62 percent of the years since 1992, when it first committed to providing up to 427,000 acre-feet for salmon flow augmentation. Recently, Reclamation has not been able to provide a full 427,000 acre-feet beginning in 2001 due to drought conditions. The Snake River at Heise gage, 2001, 2002, 2003, and 2004 have been among the

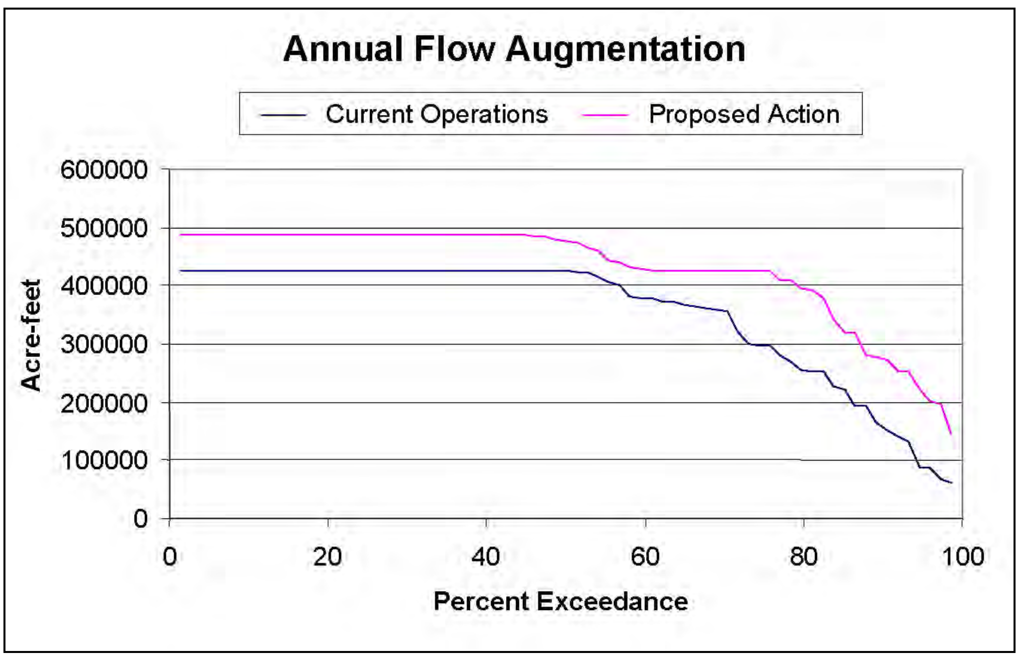

Figure 3-9. Exceedance curve comparing the likelihood of providing annual flow augmentation volumes for the modeled current operations and proposed action scenarios.

Table 3-2. Likelihood of providing various volumes of salmon flow augmentation for the modeled current operations and the proposed action scenarios.

Flow Augmentation Volume (acre-feet)	Probability of Equaling or Exceeding with:	
	Current Operations	Proposed Action
487,000	0 percent	45 percent
427,000	50 percent	76 percent
300,000	73 percent	87 percent

driest years of record. Taken consecutively, they represent the driest four-year period of record. Tables D-3 and D-4 in Appendix C show the volumes of salmon flow augmentation Reclamation has provided historically from the upper Snake River basin since 1991 and the storage sources for these volumes.

3.2.4 Modeled Flows at Lower Granite and McNary Dams

NOAA Fisheries (2000) identified spring and summer flow objectives for salmon and steelhead at Lower Granite and McNary Dams on the Snake River and Columbia River, respectively, in biological opinions covering FCRPS operations (see Table 3-3).

The Upper Snake River MODSIM database and output do not extend to control points below Brownlee Dam. In order to quantify potential flow effects at Lower Granite and McNary Dams from Reclamation's proposed actions (including the storage, release, and diversion of project water), it was necessary to integrate flows above Brownlee Dam with those of reservoirs in the FCRPS. This was accomplished by using BPA's Hydrosim model output. The Hydrosim run used was FRIII_03SN6704, which reflects the current biological opinion operation for the FCRPS.

To adequately address the hydrologic impacts downstream from Brownlee Dam attributable to Reclamation's proposed actions, the output from the FRIII_03SN6704 run needed to be adjusted to reflect the modeled inflows to Brownlee Reservoir. The original Brownlee Reservoir discharges in the Hydrosim run were adjusted by the outputs from the Upper Snake River MODSIM model for the Current Operations and

Table 3-3. Seasonal flow objectives and planning dates for the Snake and Columbia Rivers (from NOAA Fisheries 2000).

Location	Spring		Summer	
	Dates	Objective [1]	Dates	Objective [1]
Snake River at Lower Granite Dam	4/03 - 6/20	85,000 to 100,000 cfs	6/21 - 8/31	50,000 to 55,000 cfs
Columbia River at McNary Dam	4/10 - 6/30	220,000 to 260,000 cfs	7/01 - 8/31	200,000 cfs

1 Objective varies according to water volume forecasts.

Proposed Action scenarios. This was done by computing the difference between the Brownlee Reservoir inflows used in the Hydrosim model run with those computed by Reclamation's MODSIM output. That difference in flow was then added to (or subtracted from) the FRIII_03SN6704 flow values at Lower Granite and McNary Dams to produce new flow values at these locations.

Reclamation's Upper Snake River MODSIM model used a 1928-to-2000 period of record, while the Hydrosim run used a 1929-to-1978 period of record. Therefore, the MODSIM generated inflows to Brownlee Reservoir for the 1929-to-1978 period were used in adjusting the Hydrosim runs.

Table 3-4 and Table 3-5 show the modeled flows at Lower Granite and McNary Dams for current operations and the proposed actions at the 10, 50, and 90 percent exceedance levels. During the fall and winter (from October through December), there is no difference in flows at McNary and Lower Granite Dams between the modeled current operations and the proposed actions flows. Generally, at Lower Granite Dam flows are slightly less or the same from January through March and in September with slightly more flow from April through August for the proposed actions compared to current operations. In drier years (at the 90 percent exceedance), the proposed actions result in a greater percentage increase in flows. A similar effect to flows occurs at McNary Dam. For all the months, the differences in flows are small.

3.3 Flow Effects in the Lower Snake River at Brownlee Reservoir

Current hydrologic conditions in the lower Snake River at Brownlee Reservoir are the result of numerous upstream water development activities, including, but not limited to, hydropower development, private and Federal irrigation and flood control projects, and municipal and industrial diversions and discharges. Reclamation's construction and subsequent operations of its project facilities have contributed to these conditions. Influences from Reclamation's O&M activities have influenced the hydrologic conditions in the Snake River for almost a century beginning with the construction of the Minidoka Project. All facilities associated with the proposed actions have been operating for at least 40 years.

Previous ESA consultations for Reclamation's O&M activities in the upper Snake River basin have included consumptive use analyses to describe hydrologic effects. Most recently, Reclamation developed a modeled analysis for this consultation to identify and isolate the hydrologic effects in the lower Snake River at Brownlee Reservoir resulting from past and present storage, release, and diversion operations at these associated facilities. This modeled analysis is described first; the subsequent sections review previous hydrologic studies.

Table 3-4. Modeled Lower Granite Flows for the 10, 50, and 90 percent exceedance levels for the period of record from 1929 to 1978.

	10 percent		50 percent		90 percent	
Month	Current Operations (cfs)	Proposed Action (cfs)	Current Operations (cfs)	Proposed Action (cfs)	Current Operations (cfs)	Proposed Action (cfs)
October	28,833	28,833	23,753	23,748	18,822	18,820
November	27,281	27,281	20,083	19,715	15,843	15,842
December	51,658	51,658	29,633	29,388	16,896	16,896
January	64,144	63,661	32,854	32,765	21,533	21,533
February	61,107	61,016	35,427	35,427	15,794	15,783
March	76,082	75,658	43,976	43,930	25,551	25,551
April	110,386	110,216	69,078	69,144	32,976	33,077
May	160,548	160,744	106,284	106,480	68,944	69,139
June	164,398	164,600	97,682	97,827	53,541	54,896
July	69,497	70,271	53,263	53,545	40,890	42,172
August	34,735	34,921	30,581	30,801	19,182	19,683
September	24,973	24,973	21,371	21,371	17,381	17,346

Table 3-5. Modeled McNary Flows for the 10, 50, and 90 percent exceedance levels for the period of record from 1929 to 1978.

	10 percent		50 percent		90 percent	
Month	Current Operations (cfs)	Proposed Action (cfs)	Current Operations (cfs)	Proposed Action (cfs)	Current Operations (cfs)	Proposed Action (cfs)
October	127,567	127,567	106,992	106,992	101,714	101,712
November	140,426	140,426	117,897	117,896	111,621	111,621
December	196,842	196,842	127,131	127,131	113,746	113,746
January	250,847	250,847	176,272	176,222	100,338	100,338
February	234,941	234,941	142,163	142,140	90,167	90,197
March	203,077	202,979	139,296	139,250	95,814	95,814
April	278,383	278,484	189,170	189,271	104,306	104,407
May	390,721	390,916	272,238	272,433	144,682	144,877
June	403,069	403,271	265,243	265,445	166,371	166,573
July	281,040	281,455	203,635	204,111	148,696	149,929
August	194,679	194,865	162,493	162,812	121,774	121,894
September	114,071	113,834	91,354	91,351	81,049	81,049

3.3.1 Modeled Analysis

Reclamation completed a simulation study to analyze a "Without Projects Operations" scenario; this scenario isolates the flow effects at Brownlee Reservoir that are attributable to the combined effects of storing and releasing project water from project reservoirs, of diverting project water at downstream points of delivery, and of return flows. Larson (2004) more fully describes this simulation study. This scenario simulates the hydrologic conditions that would occur if Reclamation's facilities were not operating but with all non-Reclamation operations continuing. This simulation is an artificial scenario that makes no assumptions as to how water users would have reacted had Reclamation not built the dams, headworks, canals, or secured natural flow water rights. Removing the Reclamation dam operations means that rivers run through empty reservoirs. In addition, project water is not stored, released, or diverted.

Creating the "Without Projects Operations" Scenario

Reclamation modified the Current Operations data set from the Upper Snake River MODSIM model described in Section 3.2 to create a "Without Projects Operations" scenario. The Current Operations data set input was modified to remove Reclamation reservoirs, storage contracts, diversions, and natural flow rights associated with Reclamation development. Adjustments were made to local gains by various methods in each of the major sub-basins.

Table 3-6 shows the Reclamation reservoirs and associated storage contracts removed from the Current Operations model data sets to develop a "Without Projects Operations" scenario. Space assignments in Henrys Lake and Blackfoot Reservoir were assumed to remain as in the Current Operations data set. All operational target flow objectives (such

Table 3-6. Federal storage and diversion facilities and associated actions to develop a "Without Projects Operations" scenario. [1]

Storage Facility	Action
Jackson Lake Dam	Removed
Grassy lake Dam	Removed
Island Park Dam	Removed
American Falls Dam	Removed
Minidoka Dam	Removed
Palisades Dam	Removed
Ririe Dam	Removed
Little Wood River Dam	Removed
Owyhee Dam	Removed
Anderson Ranch Dam	Removed
Arrowrock Dam	Removed
Hubbard Dam	Not modeled
Deer Flats Dam	Removed

Diversion Facility	Action
Cascade Creek Diversion Dam	Not modeled
Minidoka Northside Headworks	Diverts 40% of natural flow right
Minidoka Southside Headworks	Diverts 40% of natural flow right
Unit A Pumping Plant	Removed
Milner-Gooding Canal Headworks	Removed
Falls Irrigation Pumping Plant	Removed
Tunnel No. 1	Removed
Dead Ox Pumping Plant	Removed
Ontario-Nyssa Pumping Plant	Removed
Gem Pumping Plants #1 and #2	Diverts private natural flow only
Boise River Diversion Dam	Diverts private natural flow only
Black Canyon Diversion Dam	Diverts private natural flow only

1 Project facilities and operations associated with the Vale, Mann Creek, Burnt River, and Baker Projects were not included in the Upper Snake River MODSIM model and therefore are not modeled in the "Without Projects Operations" simulation. Storage facilities associated with these projects include Warms Springs, Agency Valley, Bully Creek, Mann Creek, Unity, Mason, and Thief Valley Dams. Diversion facilities associated with these projects include Harper Diversion Dam, Bully Creek Diversion Dam, Mann Creek Dam Outlet, and Savely Dam and Lilley Pumping Plant.

as flood control or minimum flows) were removed. With the exception of privately held natural flow water rights, diversions to Reclamation facilities were shut off. Table 3-6 also summarizes Reclamation diversions that were removed from the Current Operations data set. These include all diversion of project water.

Gains to the Snake River above King Hill associated with Reclamation activities were adjusted using response functions from the Eastern Snake Plain Aquifer (ESPA) regional groundwater model (Johnson et al. 1998; Johnson and Cosgrove 1999). Adjustments to the gains in the Boise, Payette, the mainstem of the Snake River downstream of King Hill, and Owyhee River basins were made using estimated water budgets to derive "return flow factors." This approach is very different from those done in previous analyses. Appendix E and Larson (2003) more fully address the development of the gains data set.

Findings

Developing a "Without Projects Operations" scenario was an academic exercise to isolate the effects of Reclamation operations on Brownlee Reservoir inflow. Brownlee Reservoir inflows were compared in two scenarios: a Current Operations scenario, which reflects year 2000 levels of irrigation demands, diversions, and depletions; and a hypothetical "Without Projects Operations" scenario, which contains the same demands but less delivery and depletions because there would be less water available during the demand season. Table 3-7 summarizes this comparison for three individual years, representing dry (1992), average (1995), and wet (1997) water conditions.

Table 3-7. Modeled change of flow into Brownlee Reservoir for a dry (1992), average (1995), and wet (1997) year.

	1992 Dry			1995 Average			1997 Wet		
Month	**Current Operations (cfs)**	**Without Projects Operations (cfs)**	**Hydrologic Change [1] (cfs)**	**Current Operations (cfs)**	**Without Projects Operations (cfs)**	**Hydrologic Change [1] (cfs)**	**Current Operations (cfs)**	**Without Projects Operations (cfs)**	**Hydrologic Change [1] (cfs)**
October	11,180	8,857	2,323	10,700	13,727	-3,026	14,214	13,003	1,211
November	13,450	17,759	-4,309	10,805	15,682	-4,877	15,332	21,903	-6,571
December	12,174	16,086	-3,912	10,924	16,937	-6,014	19,236	26,383	-7,147
January	9,644	14,422	-4,778	15,430	20,285	-4,855	45,509	42,694	2,815
February	12,181	18,339	-6,158	17,585	26,218	-8,633	40,346	28,839	11,508
March	10,201	16,545	-6,344	21,236	31,038	-9,802	41,518	34,909	6,609
April	9,608	11,050	-1,442	24,882	29,731	-4,850	50,753	49,337	1,416
May	7,470	8,828	-1,358	34,058	50,002	-15,944	53,582	81,494	-27,912
June	6,954	4,328	2,626	30,597	51,284	-20,686	43,271	67,606	-24,335
July	5,646	3,863	1,783	14,660	13,225	1,435	17,976	16,761	1,215
August	5,030	3,437	1,593	9,900	4,597	5,303	15,351	6,974	8,376
September	6,923	5,395	1,528	11,259	6,916	4,344	13,292	9,314	3,978

1 Change in flow attributed to Reclamation operations (Current Operations minus Without Projects Operations).

Removing Reclamation reservoirs, diversion facilities, and all diversion of project water dramatically changes the timing of flows in the Snake River. Natural flow irrigation diversions usually begin in April. Project storage releases normally follow in June. Reclamation's operations generally decrease flows in the Snake River and its tributaries from November through June. Flood control evacuations are the exception to this pattern in years of high runoff like 1997 (see Table 3-7 on page 45). Reclamation's operations increase flows in the Snake River from late July until early October. Without Reclamation, river reaches would dry up completely in some years because private natural flow diversions would take the entire river flow. This would most often occur in summer and early fall. Affected reaches include the Snake River at Blackfoot, the Snake River at Milner, and the Payette River at Payette. This is illustrated in time series plots for the years 1990 through 2000 (see Figure 3-10 through Figure 3-12).

This analysis also suggests that the annual return flow to the Snake River would also be diminished without Reclamation operations. The "Without Projects Operations" scenario results in more water remaining in the Snake River because storage deliveries are shut off, natural flow deliveries associated with Reclamation activities are halted, and evaporation losses are reduced. The annual average difference in flows at Brownlee Reservoir, comparing flows without Reclamation operating to flows with Reclamation operating, was determined to be 2.01 million acre-feet.

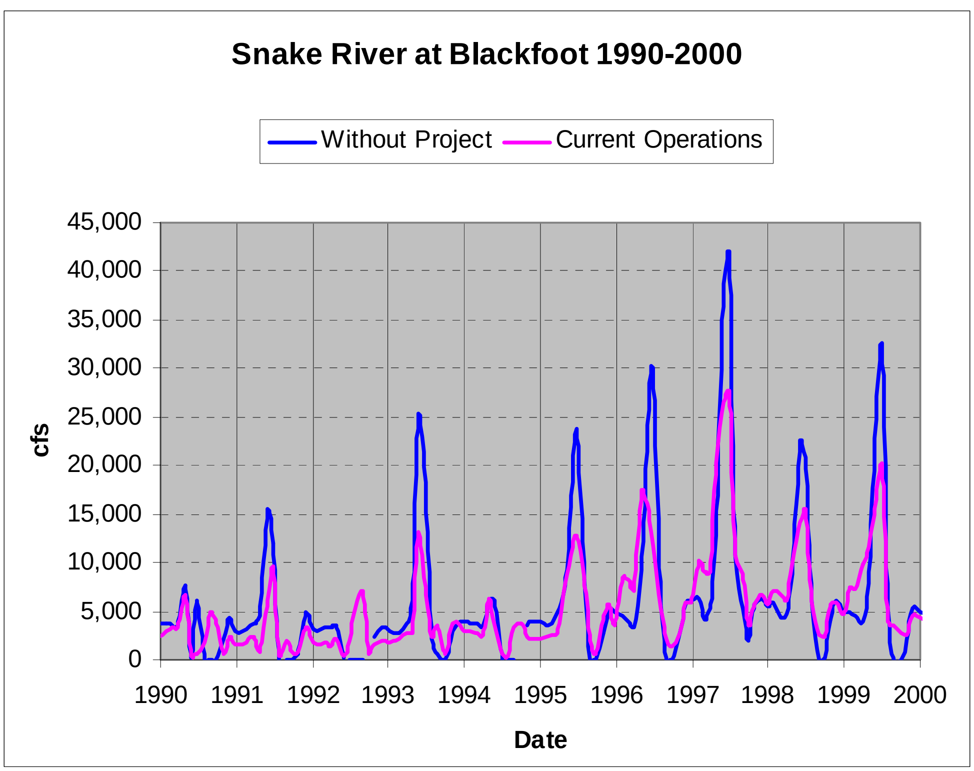

Figure 3-10. Modeled flows at the Snake River at Blackfoot gage showing Current Operations versus Without Projects Operations for the years from 1990 to 2000.

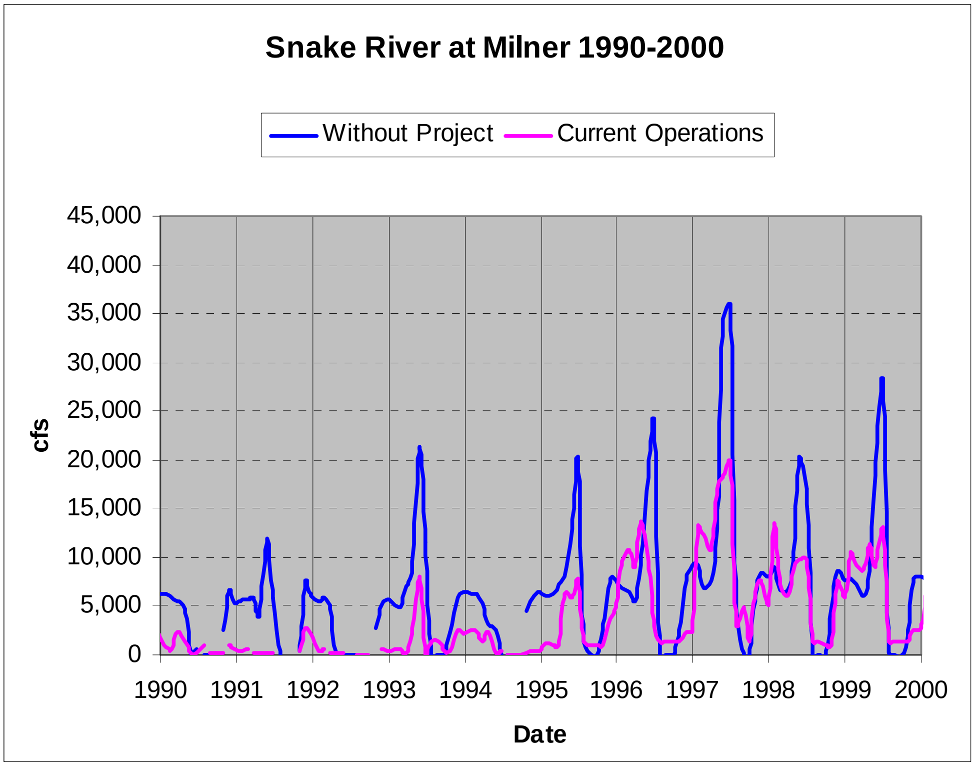

Figure 3-11. Modeled flows at the Snake River at Milner gage showing Current Operations versus Without Projects Operations for the years from 1990 to 2000.

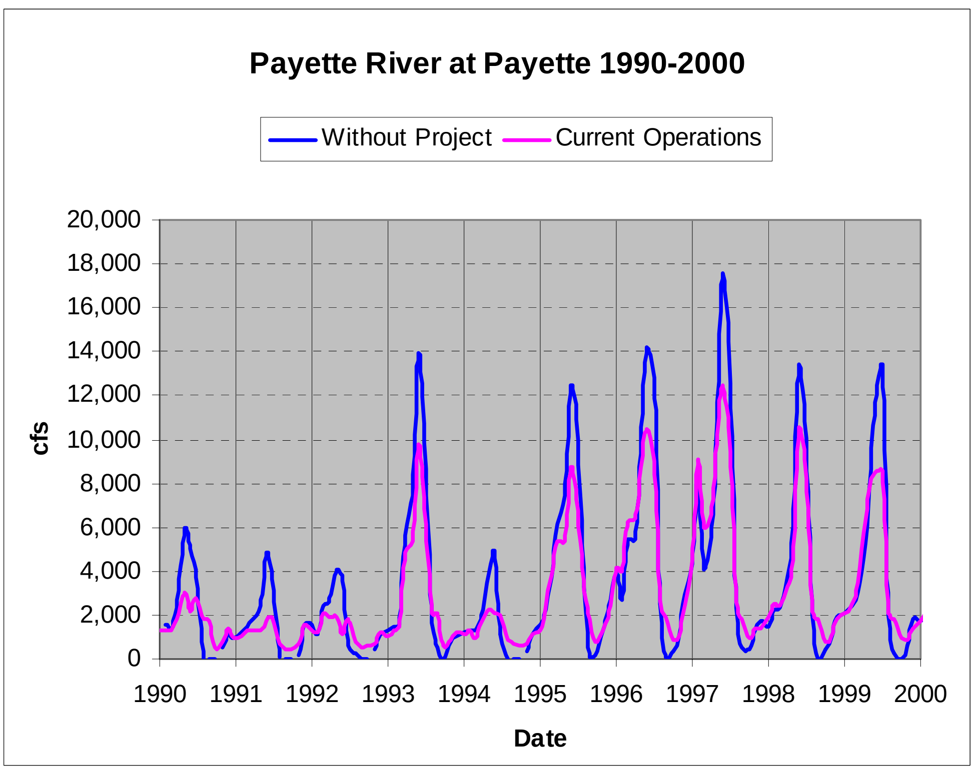

Figure 3-12. Modeled flows at the Payette River at Payette gage showing Current Operations versus Without Projects Operations for the years from 1990 to 2000.

3.3.2 Summary of Previous Studies

The effects to lower Snake River flows from O&M of upper Snake River projects have been evaluated in previous ESA consultations. These studies have involved simple consumptive use analyses, which was the best scientific information available at the time. The following summarizes these study findings.

Reclamation's June 2000 Consumptive Use Study

Reclamation (2000) provided NOAA Fisheries with a consumptive use analysis in June 2000. An annual consumptive use estimate of approximately 3.8 million acre-feet was determined based on approximately 1.6 million acres of combined full service and supplemental lands served by Reclamation storage facilities multiplied by an average estimated crop consumption of 2.33 acre-feet per acre. Return flows were calculated as the monthly water deliveries from Reclamation storage facilities minus consumptive use. Return flows were then routed back to the Snake River where they were not subject to later diversion.

The annual consumptive use estimate of 3.8 million acre-feet took into account all lands irrigated with Reclamation storage water as described in the *1992 Summary Statistics, Water, Land, and Related Data* (USBR 1992). The 3.8 million acre-feet estimate did not take into account natural flow deliveries through Reclamation canals. Return flows from Reclamation irrigation were not subject to diversion as "natural" flows and therefore were assumed to eventually flow to Brownlee Reservoir.

This analysis was done without any simulation modeling. Based on the computed monthly consumptive use values, effects to flows in the lower Snake and Columbia Rivers were assessed.

Reclamation's 2001 Upper Snake Supplemental Biological Assessment

In response to peer review comments, Reclamation updated the June 2000 consumptive use analysis (USBR 2000) when preparing its April 2001 supplemental biological assessment. The 1.6 million acres used in the analysis described above was adjusted to 930,000 "equivalent acres" served by Reclamation storage facilities. About 986,000 acres of the original 1.6 million acres were private lands that received supplemental water for about one-third of their water supply (Sutter 2000). Therefore, these private acres were adjusted to 325,410 acres receiving a full supply for computational purposes (approximately one-third of 986,000 acres).

The 2.33 acre-feet consumptive use average value used in the earlier analysis was adjusted to 1.72 acre-feet to reflect antecedent moisture conditions and effective summer precipitation. The 930,000 equivalent acres were then multiplied by an average estimated crop consumption of 1.72 acre-feet per acre. Return flows and routing were done similar to the June 2000 analysis. This analysis estimated the average annual consumptive use as 1.6 million acre-feet compared to 3.8 million acre-feet in the June 2000 study.

The 1.6 million acre-feet consumptive use estimate did not take into account natural flow deliveries through Reclamation canals. It also did not take into account that return flows from Reclamation are subject to diversion as “natural” flows and may never appear at Brownlee Reservoir. The analysis was done without any simulation modeling. Reclamation recognized these analysis limitations and stated so in its supplemental biological assessment (USBR 2001b):

> “[B]ecause return flows from one project may be intercepted or diverted by other downstream users, there is no certainty that water currently intercepted by Reclamation dams and later released would remain in the Snake River, that is to say, there is no guarantee that water would not be diverted by junior water rights holders.”

Comparison of Previous Studies to the Current Analysis of Flow Effects in the Snake River

The current modeled “Without Projects Operations” analysis described in this biological assessment is not directly comparative to Reclamation’s June 2000 consumptive use analysis (USBR 2000) or the April 2001 supplemental biological assessment (USBR 2001b). The consumptive use studies described above did not fully reflect Reclamation’s influence on water development in the region.

The modeled “Without Projects Operations” simulation developed for this biological assessment is Reclamation’s first attempt to assess impacts based on actual measured data: historical diversions, historical streamflows, historical river gains, and legal water rights. Historical gains were adjusted to the 2000 level of irrigation development. An attempt was made to address changes in return flows. In the Snake River above King Hill, return flows were routed with response functions generated by the ESPA groundwater model (Johnson et al. 1998; Johnson and Cosgrove 1999). A monthly surface water model (MODSIM) was used to derive delivery capability with the local gains’ adjustments. Reservoir evaporation was taken into account. Consumptive use and return flow efficiencies are products of model calibration with observed data. This recent study reflects the best scientific information quantifying the hydrologic effects of Reclamation’s upper Snake River operations.

3.4 Literature Cited

Parenthetical Reference	Bibliographic Citation
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Larson 2003	Larson, R.K. 2003. *Draft 2000 Level Local Gains Computation Snake River above King Hill*. Pacific Northwest Region, Bureau of Reclamation, Boise, Idaho.
Larson 2004	Larson, R.K. 2004. *Without Project Simulation of Reclamation's Upper Snake River Operations – Draft Report*. Pacific Northwest Region, Bureau of Reclamation, Boise, Idaho.
Nez Perce Tribe et al. 2004	Nez Perce Tribe, the State of Idaho, and the U.S. Department of the Interior. 2004. Mediator's Term Sheet. May 15, 2004. Website: www.doi.gov/news/NPTermSheet.pdf.
NOAA Fisheries 2000	National Marine Fisheries Service. 2000. *Biological Opinion, Reinitiation of Consultation on Operation of the Federal Columbia River Power System, Including the Juvenile Fish Transportation Program, and 19 Bureau of Reclamation Projects in the Columbia Basin*. December 20, 2000. National Marine Fisheries Service Northwest Region, Seattle, Washington.
Sutter 2000	Sutter, R. 2000. "Review of Method Used by NMFS to Calculate "BOR-CAUSED NON-ATTAINMENT" Percentages for Meeting Fish Flow Objectives at Lower Granite Dam in Table 6.2-2 of the July 27, 2000 Draft NMFS BiOp." Idaho Department of Water Resources, September 27, 2000.
USBR 1992	U.S. Bureau of Reclamation. 1992. *1992 Summary Statistics: Water, Land, and Related Data*.

Parenthetical Reference	Bibliographic Citation
USBR 1998	U.S. Bureau of Reclamation. 1998. *Biological Assessment on Bureau of Reclamation Operations and Maintenance on the Snake River Basin Above Lower Granite Reservoir*. Pacific Northwest Region, Boise, Idaho.
USBR 2000	U.S. Bureau of Reclamation. 2000. Consumptive Use Analysis data provided to the National Marine Fisheries Service in June 2000 by F. Jeff Peterson, Pacific Northwest Region, Boise, Idaho.
USBR 2001a	U.S. Bureau of Reclamation. 2001a. *Amended Biological Assessment for Bureau of Reclamation Operations and Maintenance in the Snake River Basin Above Brownlee Reservoir*. Pacific Northwest Region, Boise, Idaho.
USBR 2001b	U.S. Bureau of Reclamation. 2001b. *Supplemental Biological Assessment on Operations and Maintenance in the Snake River Basin above Lower Granite Reservoir*. Pacific Northwest Region, Boise, Idaho.
USBR 2004	U.S. Bureau of Reclamation. 2004. *Operations Description for Bureau of Reclamation Projects in the Snake River Basin above Brownlee Reservoir*. Snake River Area, Pacific Northwest Region, Boise, Idaho.
USBR unpublished	U.S. Bureau of Reclamation. Unpublished. "Analysis of Storage, Irrigation, Return Flows ad Net Depletions in the Snake River Basin, Draft Report." February 2001. Pacific Northwest Region, Boise, Idaho.
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PART II

CHAPTERS FOR THE USFWS

Chapter 4 AQUATIC SNAILS

4.1 Status

Five species of aquatic mollusks in the middle Snake River were listed as endangered or threatened in 1992 (57 FR 59244). The Banbury Springs lanx (*Lanx* sp.), the Idaho springsnail (*Pyrgulopsis idahoensis*), the Snake River physa (*Physa natricina*), and the Utah valvata (*Valvata utahensis*) were listed as endangered. The Bliss Rapids snail (*Taylorconcha serpenticola*) was listed as threatened. The *Federal Register* notice provided summary information for the species. All five species are endemic to the Snake River and/or some springs and tributaries, and all are thought to be generally intolerant of pollution. These species were listed due to declining distribution within the Snake River, adverse habitat modification and deteriorating water quality from hydroelectric development, peak-loading effects from water and power operations, water withdrawal and storage, water pollution, and inadequate government regulatory mechanisms. However, studies conducted since the listing show that the Bliss Rapids and Idaho springsnail are significantly more widespread than described in 1992 (Cazier 2001a, 2001b, 2001c, 2002), and actually may fully occupy the described historical distribution of the species.

The USFWS (1995) recovery plan for these species includes short- and long-term multi-agency objectives to restore viable, self-reproducing colonies of the listed snails. Downlisting or delisting will depend on the detection of increasing, self-reproducing colonies at monitoring sites within each species' recovery area for at least a 5-year period. The recovery area for these species extends from American Falls Dam (RM 709) downstream to C.J. Strike Reservoir (RM 518) (USFWS 1995). It should be noted that the State of Idaho, in conjunction with Idaho Power, formally petitioned the USFWS in the fall of 2004 to delist the Idaho springsnail.

As described in Appendix A, the proposed actions will have no effect on the Banbury Springs lanx or habitat important to its survival; this chapter does not discuss the Banbury Springs lanx further.

4.1.1 Previous Consultations

The 1999 USFWS biological opinion for Reclamation's O&M activities in the upper Snake River basin concluded that the normal operations and maintenance of the Reclamation facilities and the delivery of salmon flow augmentation may affect, but is not likely to adversely affect, the Bliss Rapids and Utah valvata snails; will have an unknown affect on the Snake River physa; and will have an undetermined effect on the Idaho springsnail. The opinion concluded that the proposed action will not jeopardize the continued existence of the listed snail species. The required terms and conditions and the current status of Reclamation activities related to these conditions are:

1. Meet with the USFWS to determine the delivery of salmon augmentation water. Reclamation has coordinated the delivery of salmon augmentation water with the USFWS, NOAA Fisheries, and other agencies.
2. Meet with the USFWS to develop an overall monitoring strategy. Reclamation and the USFWS agreed on a field and laboratory research and monitoring plan that is currently underway (Wood et al. 2000). Laboratory tolerance studies and field measurements executed as part of this plan are summarized in several reports (Lysne 2003a; Weigel 2002, 2003).
3. Meet with the USFWS to determine ramping rates for the salmon augmentation water releases. Reclamation applied the agreed 100 to 200 cfs per day downramping rate of salmon augmentation water releases during periods when salmon augmentation water was released upstream from Milner Dam.
4. Identify and track other agencies' water quality monitoring actions. Reclamation water quality staff is involved in coordinating water quality monitoring and the total maximum daily load (TMDL) process.
5. Consult with the USFWS on the design and implementation of snail shell surveys. Reclamation conducted shell surveys in American Falls Reservoir and downstream reaches to Jackson Bridge. These data have not revealed a relationship between shells and live individuals. Therefore, Reclamation and the USFWS have agreed to focus efforts on detecting live individuals.
6. Perform additional analysis in Lake Walcott to determine if water quality is adequate for the persistence of Utah valvata. The analysis of the 1997 Lake Walcott data indicates that most of the Utah valvata in Lake Walcott are dependent on flows from the Snake River for water quality (Irizarry 1999). Water quality monitoring indicates that Lake Walcott supports cold water biota in most years.

4.2 Distribution

4.2.1 Historical Distribution

Historical distributions of the four species of snails are based on fossil records collected as early as 1880 (USFWS 1995). The distribution of these species ranged from Utah Lake near Lehi, Utah, west to Homedale, Idaho. Based on the fossil record, the snail species are endemic to the Pliocene Lake Idaho region and its

Pleistocene successors (Frest 1991). The fossil record shows larger than current distribution, with historical populations considered to be continuous throughout their range. Snake River physa were collected live from the mainstem Snake River between Grandview and Hagerman, Idaho, from 1956 to 1985 (Taylor 1988) and from below Minidoka Dam in 1987 (Pentac 1991). Utah valvata was documented as one of the most abundant species of mollusks in the Snake River and Box Canyon Creek during surveys conducted in the 1960s and 1980s (Bowler and Frest 1992).

4.2.2 Current Distribution

The current distribution of the four species is restricted to the Snake River basin, Idaho, from the lower Henrys Fork (RM 9.3) downstream to the Snake River, and from the Snake River (RM 837.4) downstream to Brownlee Reservoir (near RM 345) near Weiser. Table 4-1 presents a summary of recent locations for the snail species, and Figure 4-1 (see page 58) displays these locations.

Table 4-1. Summary of locations and data sources for listed snails found during recent surveys.

Snake River Mile	Entity	Year	Location [1]	Species
365-370	Idaho Power	1997, 1998	M	Idaho Springsnail
392-460	Idaho Power	1997, 1998	M	Idaho Springsnail
468	Idaho Power	1997, 1998	M	Idaho Springsnail
473-495	Idaho Power	1997, 1998	M	Idaho Springsnail
495-496	Idaho Power	1997, 1998	R	Idaho Springsnail
Bruneau Arm 3.8	Idaho Power	1997, 1998	R	Idaho Springsnail
545-560	Idaho Power	1992	M	Bliss Rapids Snail
551-553	Idaho Power	2000	M	Idaho Springsnail
555	Idaho Power	1995	M	Snake River Physa (suspected)
565-573	Idaho Power	2000	M, S	Bliss Rapids Snail
571	Idaho Power	1996	M	Snake River Physa (suspected)
570-571	Idaho Power	2001	M	Idaho Springsnail (suspected)
584-590	Idaho Power	1992-2000	M, S	Utah Valvata
671	Pentac, Reclamation	1987, 1995	M	Snake River Physa
669-675	Reclamation	1996, 1997	M	Utah Valvata
677-700	Reclamation	1997	M	Utah Valvata
706	Reclamation	1996	M	Utah Valvata
708	Reclamation	1996	M	Utah Valvata
714	Reclamation	1998	R	Utah Valvata
777	USFWS	2003	M	Utah Valvata
Henrys Fork 9.3	Montana State University	2004	M	Utah Valvata

1 Location designations are for Mainstem, Reservoir, and Shoreline.

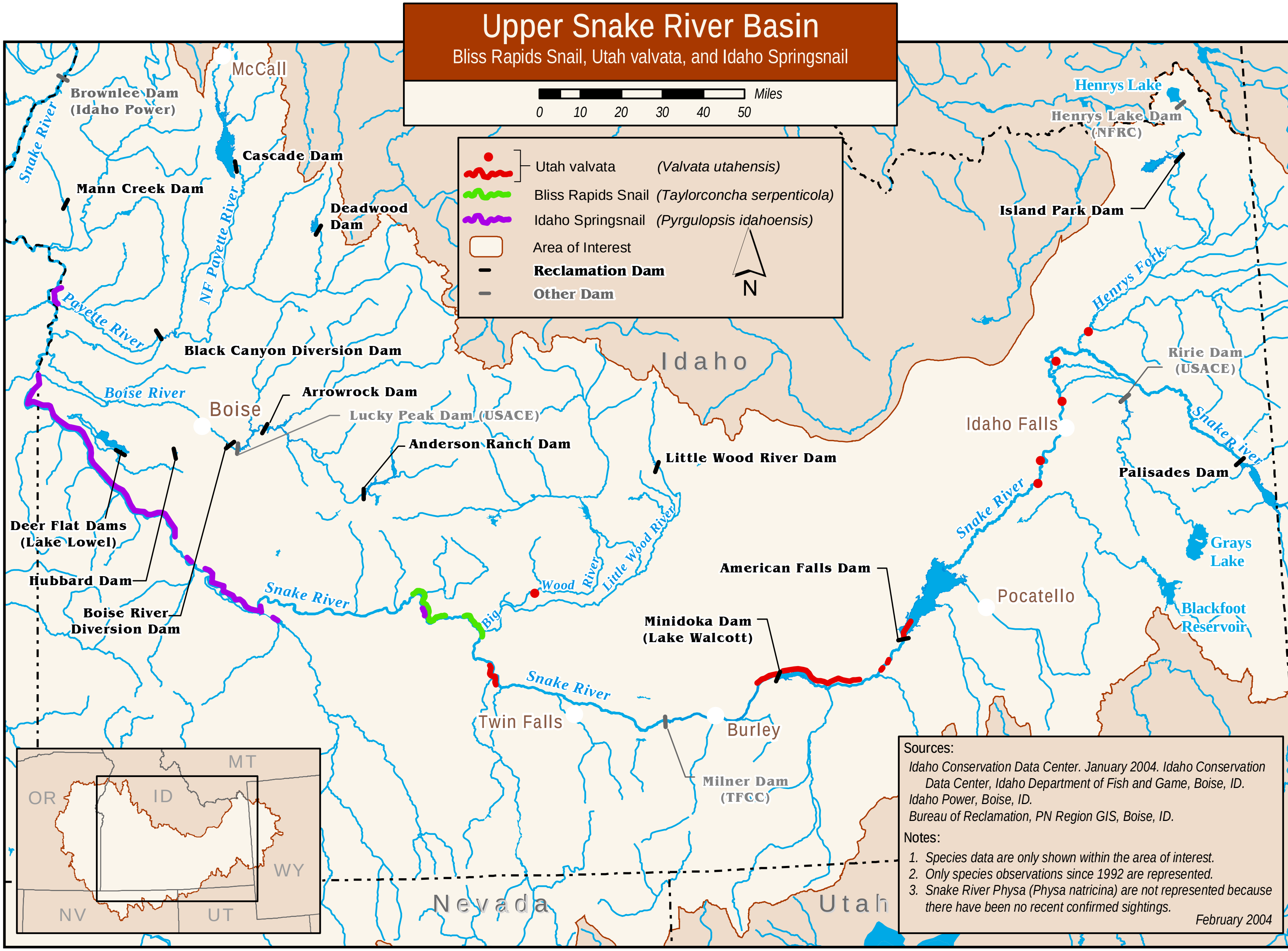

Figure 4-1. The distribution of the four ESA-listed snails in the Snake River and Henrys Fork.

Utah Valvata

The Utah valvata has a discontinuous distribution ranging from Hagerman (near RM 572) upstream to the lower Henrys Fork (RM 9.3, near the Snake River mile 837.4). Below Milner Dam (RM 639.1), this species is present in the Box Canyon (RM 588.2) and Thousand Springs (RM 585) areas, Niagara Springs (RM 599), and Upper Salmon Falls Reservoir (RM 580). Surveys during the early 1990s found average population densities of 0.25 snails per m^2 in two colonies (Frest and Johannes 1992). A colony also exists in the Big Wood River near Gooding, Idaho. The extent of the distribution of Utah valvata in the Big Wood River is unknown, but shells have been found in areas of Magic Reservoir (Lysne 2003b).

Snake River Physa

Live verified specimens of the Snake River physa have not been collected during invertebrate surveys conducted on the Snake River during the last 10 years; however, there were two unverified suspected sightings near Bliss, Idaho (Stephensen and Cazier 1999). In addition, Keebaugh (2004) at the Orma J. Smith Museum of Natural History recently discovered 4 Snake River physa (alive when sampled) and 12 empty Snake River physa shells. The Orma J. Smith Museum of Natural History, located at Albertsons College in Caldwell, Idaho, is the Federal depository for Federal Snake River snail collections. Reclamation consultants collected the potential Snake River physa specimens during samplings in 1996 below Minidoka Dam (see Table 4-2 on page 60). The identification of the specimens has not been verified; therefore, their taxonomic classification is contingent upon a final verification by the appropriate authorities.

Bliss Rapids Snail

The Bliss Rapids snail has a discontinuous distribution and is found in the tailwaters of Bliss and Lower Salmon Falls Dams, Thousand Springs, Banbury Springs, Box Canyon Springs, and Niagara Springs (USFWS 1995; Cazier 1997, 2001a, 2001b). It is most abundant in springs and tributaries from Clover Creek to Twin Falls but is found in scattered colonies along the Snake River, most associated with springs or tributaries. This species is not found in pools or reservoir habitats.

Idaho Springsnail

The Idaho springsnail ranges from upper Brownlee Reservoir (RM 345) upstream to Bancroft Springs (RM 553) near Bliss, Idaho, and is found in high densities in shoreline habitat along portions of C.J. Strike Reservoir (Cazier et al. 2000; Cazier 2001a, 2001b, 2001c) (see Figure 4-1 on page 57).

Table 4-2. Summary of Orma J. Smith Museum of Natural History potential Snake River physa holdings as of June 22, 2004.

Museum Accession #	Survey Date	Survey Site	River Mile	Latitude/Longitude	Status	Quantity
28830	27 Aug 1996	Site A9/V2	670.9	42°39'17.51"N, 113°33'21.68"W	Live	1
28926	28 Aug 1996	Site C9	672.7	42°39'49.80"N, 113°31'31.01"W	Live	1
45349	29 Aug 1996	Site D1	673.1	Lost	Live	1
28968	29 Aug 1996	Site E2	674.2	42°40'23.99"N, 113°29'54.61"W	Live	1
30200	26 Aug 1996	Site E3	674.6	42°40'28.08"N, 113°29'27.93"W	Empty	1
41524	23 Oct 1997	Zone 1, Site A-3	670.4	42°39'15.71"N, 113°33'50.24"W	Empty	1
41426	22 Oct 1997	Zone 1, Site A-3	669.6	42°38'43.77"N, 113°34'37.09"W	Empty	1
45282	27 Aug 1996	Site A10/V1	671.0	42°39'20.00"N, 113°33'16.06"W	Empty	1
41408	22 Oct 1997	Zone 1a, Site A-1	669.2	42°38'25.76"N, 113°34'53.39"W	Empty	1
30656	13 Nov 1995	Site 1A, Grid B,0	667.3	42°39'03.53"N, 113°33'55.15"W	Empty	1
41477	22 Oct 1997	Zone 1a, Site A-14	669.7	42°38'40.71"N, 113°34'23.23"W	Empty	1
31592	13 Nov 1995	Site 1A, Grid E,0	667.3	42°39'03.53"N, 113°33'55.15"W	Empty	2
30681	13 Nov 1995	Site 1A, Grid J,3	667.3	42°39'03.53"N, 113°33'55.15"W	Empty	1
41515	22 Oct 1997	Zone 1A, Site A-12	669.1	42°38'16.75"N, 113°34'43.86"W	Empty	1
28797	27 Aug 1996	Site A2	670.4	42°39'14.16"N, 113°33'56.97"W	Empty	4

4.3 Life History

Utah valvata have a turbanate shell that typically reaches a maximum diameter of 6 to 7 mm. The snail is thought to be univoltine (1 year life cycle) with a reproductive period in the spring and/or fall. The Utah valvata is hermaphroditic (individuals have both male and female sex organs), but it is unknown whether it will self-fertilize. Utah valvata are between 2.5 and 3.5 mm in size during their first reproduction, and they deposit egg masses on hard surfaces that have 3 to 12 eggs per sac. The egg masses are up to 1.5 mm in diameter. Egg masses have been observed between April and November (peak in June and July) in laboratory aquaria (Lysne 2003a). After hatching, the emergent Utah valvata are 0.7 mm in size (Lysne 2003a).

The Snake River physa reaches a height of 5 to 7 mm and has an elongate shell with compressed whorls at the top. The snail is hermaphroditic. Few Snake River physa have been collected live, so little is known about their life history.

Adult Bliss Rapids snails are up to 3.0 mm in size with conical shells. Most information on the life history of this snail has been collected in laboratory aquaria and in Banbury Springs. The Bliss Rapids snail is 2.3 to 3.0 mm in size during their first reproduction, and they deposit egg masses on cobbles. The egg sacs contain 5 to 15 eggs. The snails reproduce during summer and early autumn in the Snake River, and early summer in Banbury Springs (Richards 2004). Seasonal die off occurs from October to December (Cazier 1997). Bliss Rapids snails inhabit all of the conventional river habitats (main river, edgewater, springs, and swiftwater zones); however, association with springs or spring-influenced areas in the mainstem is common (Cazier 1997).

The Idaho springsnail is conical with a narrow and tall shell that is 5 to 7 mm high. The Idaho springsnail deposits a single egg in an egg sac on the shells of conspecifics (Lysne 2003a). After hatching, the emergent snails are 0.6 mm in size (Lysne 2003a). They are believed to inhabit cold, well-oxygenated water with low turbidity, and they associate with mud and sand to gravel or boulder-sized substrates (Lysne 2003a).

4.4 Habitat Requirements

All four species of snails require permanent, flowing, freshwater environments to survive and reproduce, with the exception of Utah valvata, which is able to reproduce in reservoir habitats. Some species may be found in river and reservoir habitats, whereas others are restricted to spring habitats. Most species are thought to be detritivore and/or algavore grazers (Pennak 1989).

Utah valvata are usually found in lower velocity habitats of free-flowing river, spring habitat, or reservoirs (USFWS 1995; Weigel 2002, 2003). They are typically associated with fine sediments (<0.25 mm diameter) or gravels mixed with fines. The species is absent from boulder and bedrock substrates (Weigel 2003). Laboratory sediment selection experiments found a preference for pebble size substrates (Lysne 2003a). Laboratory temperature tolerance experiments found that temperatures above 30 °C were lethal, and temperatures below 7 °C caused the snails to become inactive (Lysne 2003a). Significant mortality occurs when the snails are dried; however, they appear to tolerate dewatering if conditions are damp (Lysne 2003a).

The Snake River physa is thought to use the undersides of larger sediments, primarily boulders, in swift currents. This species is thought to only utilize deeper, large river habitat in or adjacent to swift currents (USFWS 1995).

The Bliss Rapids snail occurs on cobble and boulder size substrates in flowing waters of unimpounded reaches of the mainstem Snake River and in a few tributary spring habitats (USFWS 1995). The snail is generally not associated with fine sediments (Cazier 1997, 2002) and normally avoids surfaces with attached plants (Hershler et al. 1994).

The Idaho springsnail is found in riverine or reservoir habitats on the mainstem Snake River (USFWS 1995) and the Bruneau River arm of C.J. Strike Reservoir (Cazier 2002). Sediment selection experiments conducted in the laboratory did not identify a sediment size that was preferred by the species (Lysne 2003a). Temperature tolerance experiments found that temperatures above 30 °C were lethal, and below 9 °C caused the snails to become inactive (Lysne 2003a). Significant mortality occurs when the snails are dried; however, they appear to tolerate dewatering if conditions are damp (Lysne 2003a).

4.5 Factors Contributing to Species Decline

The USFWS (2004) describes how various factors have adversely affected the free-flowing, cold water environments where the listed Snake River snail species have existed for many years. The following human activities have adversely modified habitat and have contributed to deteriorated water quality:

- Hydroelectric development, operations, and maintenance.
- Water withdrawal and diversions.
- Point and non-point source water pollution.
- Inadequate regulatory mechanisms (which have failed to provide protection to habitats).
- Adverse effects associated with non-native species.

4.5.1 Dams and Water Operations

Development of water impoundments and hydroelectric dams has changed the fundamental character of the Snake River (USFWS 2004). Dams have reduced the number of river miles containing free-flowing large-river habitat on the Snake River, and this has fragmented the previously continuous river habitat. Dams have also affected fluvial dynamics and contributed to water quality degradation (USFWS 2004). The dams also have the potential to create physical barriers that may prevent colonies of snails from interacting with one another and recolonizing habitat after a disturbance. Fragmented habitat has isolated extant snails into smaller subpopulations, which are now more vulnerable to extirpation from stochastic events and the other factors listed above (USFWS 2004).

Water operations and storage associated with irrigation projects alter the natural flow regimes of the river. Some aspects of river impoundment appear to be favorable to Utah valvata (Weigel 2002, 2003).

4.5.2 Water Quality

The USFWS (1995) identified cold, clean water as a habitat requirement for the listed snails. State of Idaho water quality standards for cold water biota establish dissolved oxygen concentrations of 6 mg/L or greater and water temperatures of 22 °C or less with a maximum daily average of no greater than 19 °C. Their habitat requirements and evidence from field surveys indicate that several species of the listed snails prefer colder temperatures, more swiftly flowing water, and higher dissolved oxygen than allowed for in the cold water biota standards (EPA 2002).

Snails are generally intolerant of organic enrichment pollution (Lathrop and Markowitz 1995) and are more sensitive to metal exposure (Johnson et al. 1993) than other macroinvertebrate taxa commonly used as environmental indicators (Lysne 2003a). River impoundment, agriculture, aquaculture, and urbanization have affected water quality in the middle and upper Snake River (IDEQ 1998). The middle Snake River is currently listed as water quality limited under section 303(d) of the Clean Water Act for dissolved oxygen, nutrients, oil and grease, and sediment (IDEQ 1998).

Water quality problems are influenced by flow reductions and changes in thermal regime. Water quality degradation comes from inputs of nutrients, sediment, metals, pesticides, and other toxics. Waste from feedlots and dairies, hatchery and municipal sewage effluent, agricultural runoff, and other point and non-point discharges have the potential to affect the Snake River. During the irrigation season, 13 perennial streams and multiple agricultural surface drains contribute irrigation return flow to the Snake River between Shoshone Falls (RM 614.8) and Lower Salmon Falls (RM 573), as well effluent from more than 140 fish culture facilities, and municipal sewage discharge (IDHW 1991). Dairies and feedlots are now required to have zero discharge from their facilities. However, waste management results in manure being spread on agricultural lands and becoming inseparable from other nutrient sources. These factors, coupled with periodic drought-induced low flows, have contributed to reduced dissolved oxygen levels and increased plant growth. Further, the biological oxygen demand during decomposition from the annual decay of the increased plant growth may reduce dissolved oxygen.

Temperature, dissolved oxygen, and physical habitat changes may be detrimental to the snails' survival, reproduction, and diversity.

4.5.3 New Zealand Mudsnail

The non-native New Zealand mudsnail (*Potamopyrgus antipodarum*) has invaded the Snake River mainstem habitat occupied by the threatened and endangered native snails. The New Zealand mudsnail was first discovered in the middle Snake River in 1987 (Bowler 1991). The mudsnail has rapidly expanded its distribution throughout the United States in the last ten years with populations detected in California, Colorado, Montana, Washington, and Wyoming (USGS 2003). The mudsnail has greater thermal tolerances, growth rates, and fecundity than the native Snake River snails (Richards et al. 2001). Also, this species is parthenogenic (reproduces asexually) and is believed to be able to pass unharmed through the digestive tracts of some fish and wildlife.

Community level change has been detected in study areas where the mudsnail has invaded (Bowler 1991; Hall 2001; Hall et al. 2002). Some studies suggest that there are competitive interactions between the mudsnail and the native species of snails (Richards et al. 2001; Lysne 2003a). The decline of a native snail (*Pyrgulopsis* sp.) was documented during the rapid population growth of the non-native mudsnail (Gustafson 2001). The New Zealand mudsnail has become the most dominant species in the middle Snake River, representing as much as 80 percent of the macroinvertebrate community (EPA 2002). At these densities, the other macroinvertebrate taxa likely experience crowding and increased competition for resources such as mayflies, stoneflies, and caddisflies, which are favorable for supporting a functional aquatic community (Cada 2001).

4.6 Current Conditions in the Action Areas

4.6.1 Dams and Water Operations

Dam building and historical water operations and irrigation activities have contributed to the discontinuous distribution of aquatic snails in the Snake River. Because water is stored and delivered for irrigation, river flows and reservoirs have large seasonal fluctuations. Seasonally high river flows are not considered detrimental to native aquatic species, as these would have occurred naturally and are essential to create and maintain riverine habitats. However, low flows and year-round regulated flows could limit habitat suitability, water quality, and habitat connectivity.

In general, water operations have altered the natural hydrograph by reducing the spring peak flows, increasing summertime flows, reducing the river's connection to the floodplain, and reducing wintertime low flows. Flood control operations in some years cause increased late winter flows that are reduced before the spring runoff.

Aquifer recharge from surface irrigation applications and a wet climatic period caused water levels in the Snake River Plain aquifer to reach an all-time high in the early 1950s. Since then, groundwater levels have shown a net decline, primarily from increased groundwater pumping for irrigation and increased water conservation by upstream irrigators. These factors, combined with drought, have caused a dramatic decline in the groundwater level and subsequently, spring discharge rates, particularly in the Thousand Springs reach of the Snake River. The listed snails, particularly the Bliss Rapids Snail, rely heavily on spring-influenced reaches of the Snake River for their existence.

Historically, portions of the action areas were dewatered during water storage or delivery. Reaches of dewatered river occurred on the South Fork Snake River, Snake River downstream from Jackson Lake, in the Blackfoot area, and downstream from Milner Dam. Water operations above Miler Dam in the last decade have maintained some streamflow in the river during most conditions. Chapter 3 summarizes hydrologic conditions in the action areas.

The known distribution of listed aquatic snails ranges from the Henrys Fork at the Idaho Highway 33 bridge (Henrys Fork RM 9) near Rexburg downstream to Brownlee Reservoir. This is the area of analysis for the listed snails covered in this biological assessment. Several streamflow gages monitor river flows on both the Snake River and the Henrys Fork.

Lower Henrys Fork

The Henrys Fork near Rexburg gage is immediately downstream from the Idaho Highway 33 bridge. It has a 95-year period of record. The maximum recorded flow was 79,000 cfs in June 1976 (immediately following the Teton Dam failure). Excluding 1976, the maximum recorded daily flow was 16,400 on May 17, 1984. The lowest recorded daily flow was 183 cfs between March 24 and March 28, 1934. Flows at this site are influenced by the operations of a powerplant near Ashton, Henrys Lake, Island Park Reservoir, and Grassy Lake Dam. A considerable volume of water seeps into the Snake River Plain Aquifer upstream from this point.

Gustafson (2004) has conducted extensive invertebrate sampling (approximately 242 sites) in the Henrys Fork. Gustafson (2004) considers Utah valvata to be very rare in the drainage, having found them only at the Highway 33 bridge site. Further, Gustafson (2004) considers this to be an unnatural range expansion due to the warming and siltation of the Henrys Fork in this area.

Snake River from Henrys Fork Confluence to above American Falls Reservoir

The Snake River near Idaho Falls gage is the first gage downstream from the Henrys Fork confluence with the Snake River. This gage has a period of record from October

Table 4-3. Average mean monthly streamflows (cfs) at the Snake River near Idaho Falls and Snake River at Neeley gages for the period from 1987 to 2002.

Month	Henrys Fork near Idaho Falls	Snake River at Neeley
January	3,454	3,033
February	4,204	3,193
March	5,413	4,456
April	6,691	7,539
May	11,100	11,428
June	13,120	14,778
July	8,312	12,374
August	6,220	11,039
September	4,921	7,678
October	3,422	3,333
November	3,568	1,560
December	3,321	2,196

1987 through September 2002. The highest and lowest mean monthly streamflows recorded at this gage during this period are 35,400 cfs in June 1997 and 1,711 cfs in February 2002. Minimum flows typically occur between December and March at this site, and peak streamflows occur between May and August (see Table 4-3).

A November 2003 USFWS survey on the Snake River near RM 780 (near Firth, Idaho) found 7 live Utah valvata and 157 Utah valvata shells (USFWS 2003). All Utah valvata were found at depths greater than 2 feet and were generally associated with fine substrates (USFWS 2003). Relative to Reclamation monitoring sites (flowing sites) below American Falls Reservoir (Weigel 2002, 2003), very low densities of Utah valvata have been detected in the Snake River downstream from the confluence with the Henrys Fork (USFWS 2003). Little is known about the abundance, distribution, and habitat of this population.

American Falls Reservoir

Utah valvata are known to exist in American Falls Reservoir (Weigel 2003). Reclamation initiated random Utah valvata surveys in the reservoir in 2002, sampling a total of 178 sites at depths ranging from 0.9 to 16.1 meter between June 7 and June 14, 2002 (see Figure 4-2). A total of 461 live Utah valvata were collected from 37 0.25 m^2 plots (Weigel 2003). During the collection period, American Falls Reservoir elevation ranged from 4,343.5 feet on June 7 to 4,341.8 feet on June 14 (10.5 to 12.2 feet below the full pool elevation of 4,354 feet). Figure 4-3 (see page 68) shows the snail collection sites with depth data.

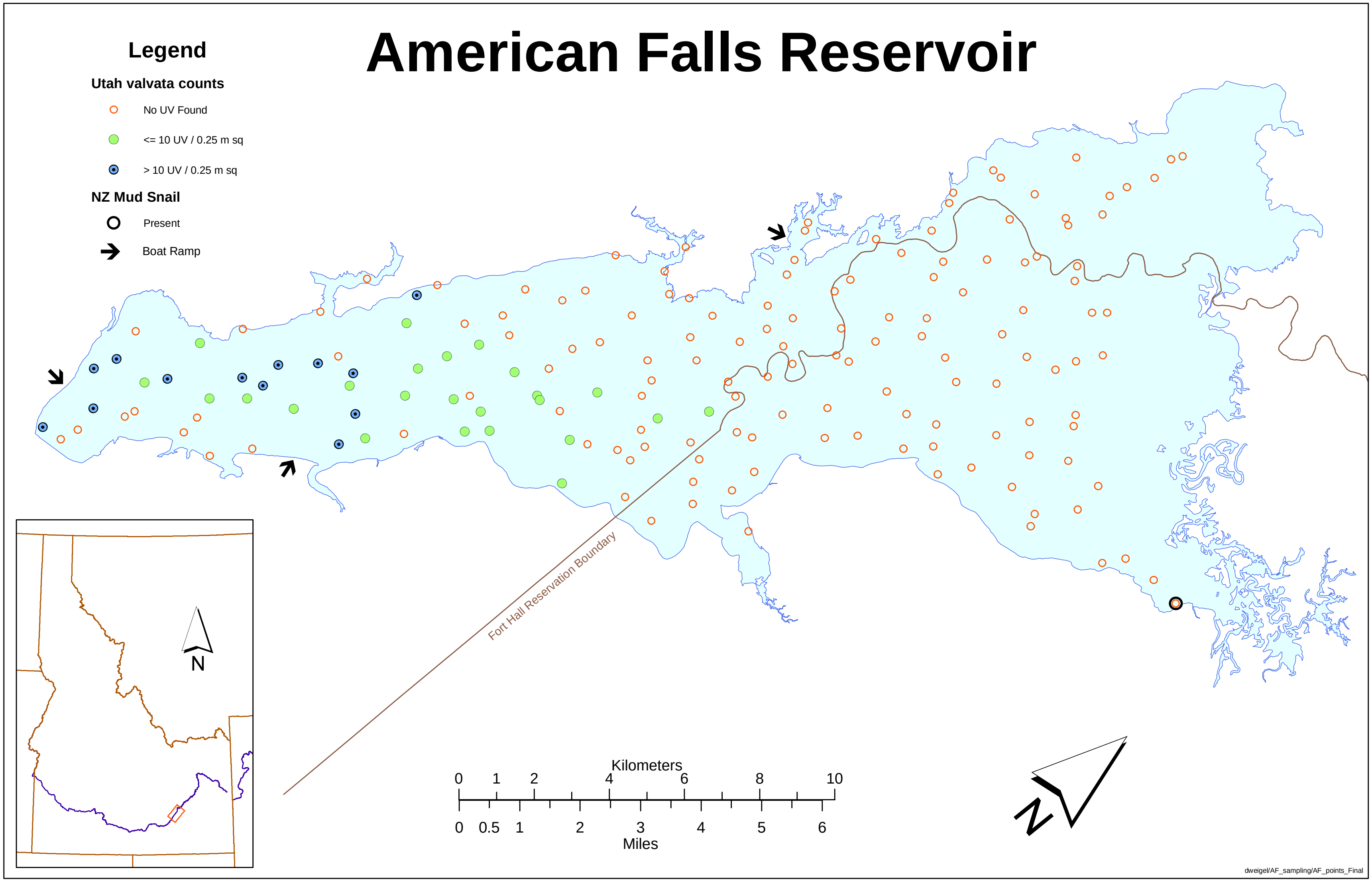

Figure 4-2. Reclamation's 2002 randomly located snail survey locations (Weigel 2003).

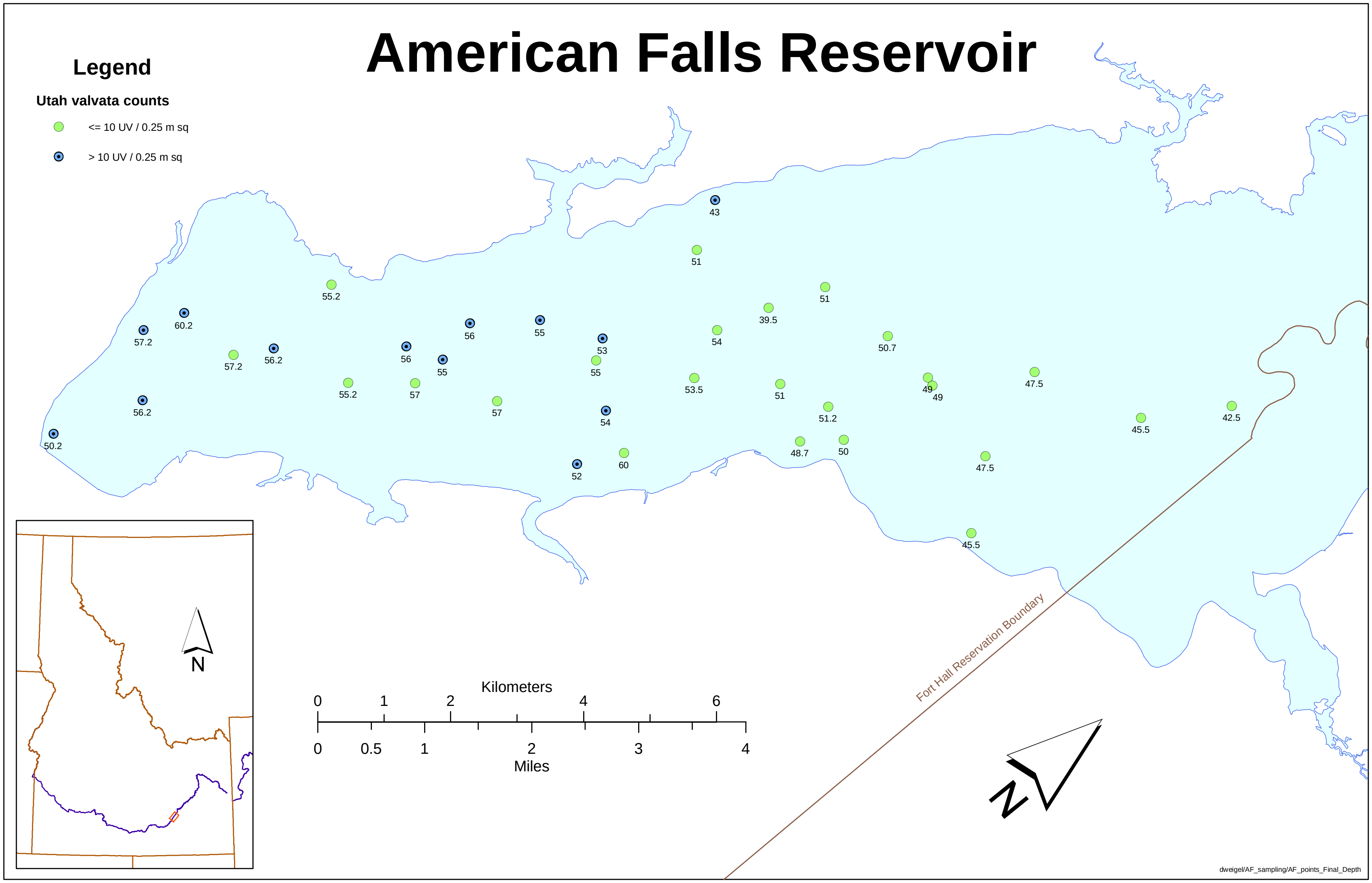

Figure 4-3. Utah valvata locations from Reclamation's 2002 American Falls Reservoir snail surveys. The numbers at each point indicate the depth (in feet) at that point from full pool elevation (Weigel 2003).

In 2003, Reclamation established transects in lower American Falls Reservoir for the 2003 snail survey and future monitoring. Transects were located based on 2002 snail locations and depths. Four randomly selected transects were surveyed, two on May 9 and two on August 4, yielding 20 and 105 live Utah valvata, respectively. No live Utah valvata or Utah valvata shells were found at points at or above the water line. American Falls Reservoir water surface elevations at time of sample were 4,347.5 feet on May 9 and 4,318.4 feet on August 4.

The size, location, and high probability of refill of American Falls Reservoir make it an important reservoir to supply irrigation water in the upper Snake River system, resulting in annual drawdowns. The reservoir usually reaches the lowest pool elevation in late September or early October. The total drawdown from full pool elevation between 1985 and 2003 ranged from 16 feet in 1998 to 57 feet in 1990. The average minimum elevation is 4,314 feet (40 feet below the full pool elevation of 4,354 feet), which was exceeded 68 percent of the time during these years. Only 6 of the 37 Utah valvata colonies identified in the 2002 survey would have been watered in September 1990 (see Figure 4-3).

The reservoir becomes full between March and July, and the surface elevation gradually declines through the spring and summer months. If American Falls Reservoir fills, it usually only remains at full pool for a short time (less than one month) before water withdrawals reduce the surface elevation. This operation prevents much of the reservoir from providing suitable, permanently watered habitat for aquatic snails and other mollusks.

Live Utah valvata have been detected in the lower half of American Falls Reservoir, but they were usually only detected at depths that remained watered more than 95 percent of the time (below elevation 4,311 feet). Mean density at these depths in 2002 was 49.6 snails per m^2 (Weigel 2003). Samples were collected at and above the waterline in 2002 and 2003, with no live Utah valvata or Utah valvata shells being encountered. It is assumed that Reclamation's past and current water operations prevent Utah valvata from occupying much of the reservoir.

The impacts of past and current water operations to Utah valvata in American Falls Reservoir depend on previous years' water elevations. The reservoir is operated for irrigation storage only, and annual drawdown is inevitable. The magnitude and duration of spring runoff, spring precipitation, irrigation season precipitation, and irrigation demands determine the drawdown's degree and duration. During wet periods, when the reservoir is not drawn down to lower levels, Utah valvata likely expand into the available habitat below a given year's minimum pool elevation. Dry periods following wet periods result in the dewatering of the habitat occupied by Utah valvata during the wet period expansion. Varying levels of Utah valvata mortality likely occur during periods of declining annual minimum pool elevations. The magnitude of this mortality is unknown. Bathymetry data and corresponding Utah valvata habitat data are not available for the reservoir, and Utah valvata expansion rates into available habitat are unknown. Therefore, correlations between the annual minimum water surface elevation, recolonization, and mortality are unknown.

Snake River from American Falls Dam to Upper Lake Walcott

The Snake River at Neeley gage (RM 713.5) is approximately 0.5 mile downstream from American Falls Dam (RM 714) and 1 mile upstream from known Utah valvata colonies. From 1987 to 2002, the maximum and minimum mean monthly river flows at this gage were 35,580 cfs in June 1997 and 306 cfs in March 1993. Minimum streamflows in this reach typically occur between November and February, and peak flows typically occur between May and August (see Table 4-3 on page 66).

During Reclamation surveys for Utah valvata colonies in this reach (RM 708 to 711), Weigel (2002) found moderate to high (up to 134 live snails per 0.25 m^2) densities of Utah valvata. Some level of seasonal mortality likely occurred as a result of past fluctuations in river flows, although it is not exactly understood how Utah valvata respond to fluctuating water levels in this reach. However, it appears that Utah valvata do not move with receding waters. As water levels fluctuate, portions of the reach dry rapidly (due to climate and exposure) while subsurface recharge and bank seepage help others remain moist. Lysne (2003a) reported 50 percent mortality for Utah valvata exposed to a dry treatment for 50 hours in a controlled setting, and no mortality in either the wet or moist treatments; therefore, 100 percent Utah valvata mortality is assumed when Utah valvata are left stranded for four days in segments where no bank seepage occurs.

To assess Utah valvata mortality at a known population, Reclamation surveyed dewatered shoreline along the Snake River downstream from Neeley (RM 711) (Weigel 2002). Figure 4-5 on page 76 shows these transects. Discharge was measured at the USGS Neeley river gage station (RM 713.5). As part of normal water operations, discharge was reduced in two steps from 7,991 to 4,957 cfs from September 6 to 13, 2001, and from 4,702 to 370 cfs from October 6 to 16, 2001. During these reductions in flow, gage height changed an average of 0.03 meter per day and 0.08 meter per day, respectively. Between September 13 and October 6, average daily discharge fluctuated between 4,400 and 5,500 cfs.

Fourteen 0.25 m^2 plots were surveyed on October 26, 27, and 30, 2001, 12 days after the last downramping. At each location, one plot was sampled less than 3.0 meters from the water edge, and one plot was sampled more than 3.0 meters from the water edge. Four locations (8 plots) were sampled on the south shore, and three locations (6 plots) were sampled on the north shore (Weigel 2002). Plots were visually selected to be representative of the shoreline and sediment sizes available (Weigel 2002).

Live Utah valvata were more abundant at the plots sampled on the south shore (average 51 and 64 live snails per 0.25 m^2 less than 3.0 meters and more than 3.0 meters from water line, respectively) than on the north shore (average 11 and 16 live snails per 0.25 m^2 less than 3.0 meters and more than 3.0 meters from water line, respectively) (Weigel 2002). The north bank is slightly steeper, and results in less dewatered shoreline. Snails were about equally abundant at sites greater than and less than 3.0 meters from the water's edge 12 days following reductions in flow. The high numbers of snails (up to 134 live snails per 0.25 m^2 on the south shore and 32 per 0.25 m^2 on the north shore) at plots farther from the current water's edge indicates that the snails may not be moving with the receding water level at the ramping rates implemented during 2001 (Weigel 2002). During the time of the shoreline survey, flow was approximately 360 cfs; however, most of this shoreline was still wet due to substrate and bank seepage. These conditions extend the survival of Utah valvata on the dewatered shorelines; however, shoreline survival during freezing winter temperatures is unlikely.

In November 2002, Reclamation estimated linear meters of dewatered Utah valvata habitat at four transects in the Neeley Reach when flows were 350 cfs. Transects began in the middle of the river and extended to the high water line. Transect lengths ranged from 22.2 to 67.7 meters, and the percent of occupied Utah valvata habitat that was exposed at a flow of 350 cfs ranged from 23 to 50 percent (see Table 4-4). Reclamation estimated that 2 percent of the sampled snails occupied the dewatered habitat in 2002 (Weigel 2003).

Table 4-4. Summary data for 2002 Utah valvata snail habitat at the Neeley Reach (RM 711).

Transect	Meters of Transect Occupied (m)	Occupied Habitat Dewatered (m)	Occupied Habitat Dewatered (percent)
4 North	22.2	11.2	50
4 South	67.7	16.2	24
5 South	55.8	12.9	23
6 South	30.5	7.7	25

Snails were collected in September when flows were near 7,000 cfs. Dewatered habitat was measured November 2, 2002, when flows were 350 cfs.

Winter flows in the river downstream from American Falls Dam vary with precipitation and water storage remaining in the reservoirs at the end of the irrigation season. Precipitation during the several water years preceding the fall of 2001 were average or above average. Therefore, winter flows were higher in this reach during these years. In 2001, the winter flow was reduced to 350 cfs for the first time since 1995. It is likely that the snails had dispersed into the later dewatered habitat near the shoreline when flows were higher and the habitat was available. Therefore, the flow reduction in 2001 likely resulted in higher numbers of stranded snails. However, the population utilizing this habitat likely was reduced during 2001 and did not have an opportunity to redisperse into this habitat by 2002, resulting in lower levels of mortality (2 percent mortality) in the subsequent low water year.

Due to the shape of the canyon and river channel, the habitat typically occupied by Utah valvata in this reach (fines to small gravel with fines) starts to become exposed during flows less than 5,500 cfs, which occur approximately 6 months out of every year. During some average and all non-flood operation years, discharge between November and March is below 5,500 cfs. However, during many wet years, especially during those when Reclamation exercises flood control operations at American Falls Dam, minimum annual discharge has usually been greater than 5,500 cfs. Using an operations simulation, Weigel (2002) predicted that December flows would be less than 5,500 cfs 58 percent of the time, and less than 2,000 cfs 35 percent of the time.

Reclamation conducted Snake River physa surveys in 2001 between upper Lake Walcott and American Falls Dam (Weigel 2002). Several Physa sp. were preserved and sent to Amy Worthington at the University of Alabama, Tuscaloosa, for verification. All snails preserved during this survey period were identified as *Physa gyrina*, a physid snail broadly distributed in North America. Live *P. natricina* were not collected during this survey.

Lake Walcott

Reservoir operations at Lake Walcott are consistent and driven by structural limitations at the Minidoka Dam spillway (USBR 2004). The reservoir is drawn down 5 feet annually during the winter and refilled to full pool (elevation 4,245 feet) in April. Reclamation maintains a full pool during the spring and summer to provide irrigation water into the canals on each side of the dam and to maximize the efficiency of the generators. The annual, consistent drawdown of Lake Walcott results in relatively stable year-to-year habitat availability. In the 0- to 2-meter water depth sampling stratum, live Utah valvata densities ranged from 0 to 7 snails per 0.25 m^2, with most snails being found at depths greater than 5 feet (Weigel 2002). For example, in October 2001 at the Lower Lake Walcott survey site, Utah valvata densities were 0 snails per 0.25 m^2 in the 0- to 2-meter sampling stratum and 107 snails per 0.25 m^2 in the 2- to 8-meter sampling stratum (Weigel 2002). Weigel (2002, 2003) more completely describes Utah valvata zonal distribution in Lake Walcott.

Stranding of live Utah valvata in Lake Walcott is approximately 1 percent of the individuals detected during Reclamation monitoring collections (Weigel 2003). This low rate of stranding indicates that Utah valvata may be able to avoid stranding during slower rates of water level changes, or low densities of Utah valvata in this depth stratum could be due to preference for deeper habitats or avoidance of this habitat due to physical and biological alterations related to the annual dewatering.

Snake River below Minidoka Dam

During the summer, Minidoka Dam passes about 10,000 cfs for downstream users. Any water that does not go through the powerplant is released over the dam's spillway structure. Currently, an average of 1,300 to 1,900 cfs is released over the spillway structure during the irrigation season, which extends from April through September. Water is released along the spillway structure in several ways. About 250 cfs leaks through the base of the stoplogs along the entire length. In addition, stoplogs are pulled out of certain bays to release water into established channels. In the middle of the spillway structure, three radial gates provide the greatest control of water releases. Summer water releases over the spillway occur as mitigation for the construction of the Inman Powerplant at Minidoka Dam in 1991 and 1992. Reclamation (2004) describes these releases.

In the winter, the radial gates are the only path for water releases from the spillway structure because the reservoir is drawn down 5 feet to an elevation below the base of the stoplogs. Water passed through the powerplants does not reach the downstream spillway area. In dry winters, no water is spilled through the radial gates, and the spillway dries up with the exception of a few small pools. In wet winters the powerplants alone sometimes cannot accommodate all of the flow, and the radial gates release some water; however, the rest of the spillway still remains dry.

Few snail samples have been collected in the spillway below Minidoka Dam. In June 2000, Reclamation conducted random sampling in the spillway (Weigel unpublished, Minidoka Spillway). Fifty samples were collected with live Utah valvata being found at 2 locations and empty shells being found at 20 locations (see Figure 4-4 on page 75). Random surveys were again conducted in the spillway in July 2004. Twenty-one samples were collected with Utah valvata shells being found at 4 locations. No live Utah valvata were found in 2004 (Newman unpublished). It is likely that Utah valvata disperse into the spillway area below Minidoka Dam during the irrigation season. However, with the annual de-watering of the spillway, it is unlikely that any resident listed snail colonies persist year-round in the spillway area.

Flows in the approximately 7.5-mile stretch of river from Minidoka Dam downstream to Milner Pool fluctuate annually; however, they are relatively constant compared to other reaches of the river. Few listed snails have been documented in this reach. Utah valvata were documented between Minidoka Dam (RM 674.5) and the Jackson Bridge (RM 669.7) in 1996 and 1997 (Ralston 1997, 1998). Reclamation conducted monthly snail surveys in 2000 from August through October between Minidoka Dam and Jackson Bridge (Weigel 2002). Two 2-mile river sections were selected and eight transects were placed within the reach (seven random transects and one overlapping previously identified Utah valvata locations; see Figure 4-5 on page 76). No listed snails were identified. Reclamation repeated the survey in 2001 and again, no listed snails were identified (Weigel 2002).

Keebaugh (2004) reviewed curated samples collected below Minidoka Dam in 1996 by a Reclamation consultant (see Table 4-2 on page 60). Research personnel at Albertsons College, Caldwell, Idaho, have identified the snails as potentially being Snake River physa. The specimens will be verified in the fall of 2004 by nationally recognized experts. It is not known how Reclamation's past operations have affected the Snake River physa.

Milner Dam Downstream to above Brownlee Reservoir

Downstream from Minidoka Dam, private dams alter the water operations, water quality, and river habitat. These dams include Milner Dam and the Idaho Power dams (Idaho Power's Mid-Snake Projects, C.J. Strike, and Swan Falls Dams) that are subject to ESA consultation through the Federal Energy Regulatory Commission (FERC) relicensing process. The Idaho Power dams are operated to optimize power generation and meet customer demand. Irrigation activities store or remove much of the surface water in the river upstream from Milner Dam. Streamflow is restored by tributaries, return flows, and springs (including those in the Thousand Springs area). The only Reclamation facilities located below Milner Dam on the Snake River are four pumps located near Marsing, Idaho.

Little snail information exists for the reach beginning immediately below Milner Dam downstream to the first Idaho Power facility. Milner Dam is generally considered to be the lowest control point in Reclamation's O&M in the Snake River system above Milner Dam, and downstream activities are conducted independent of those activities upstream from Milner Dam (USBR 2004). The upstream storage reservoirs do not supply irrigation water to entities that divert water from the Snake River downstream from Milner Dam, and there are no Reclamation reservoirs on the mainstem downstream from Milner Dam (USBR 2004).

The exercise of water rights, including private water rights, above Milner Dam has reduced flow at the dam to zero, though large flows do pass the dam in years of high runoff and when salmon flow augmentation water is delivered.

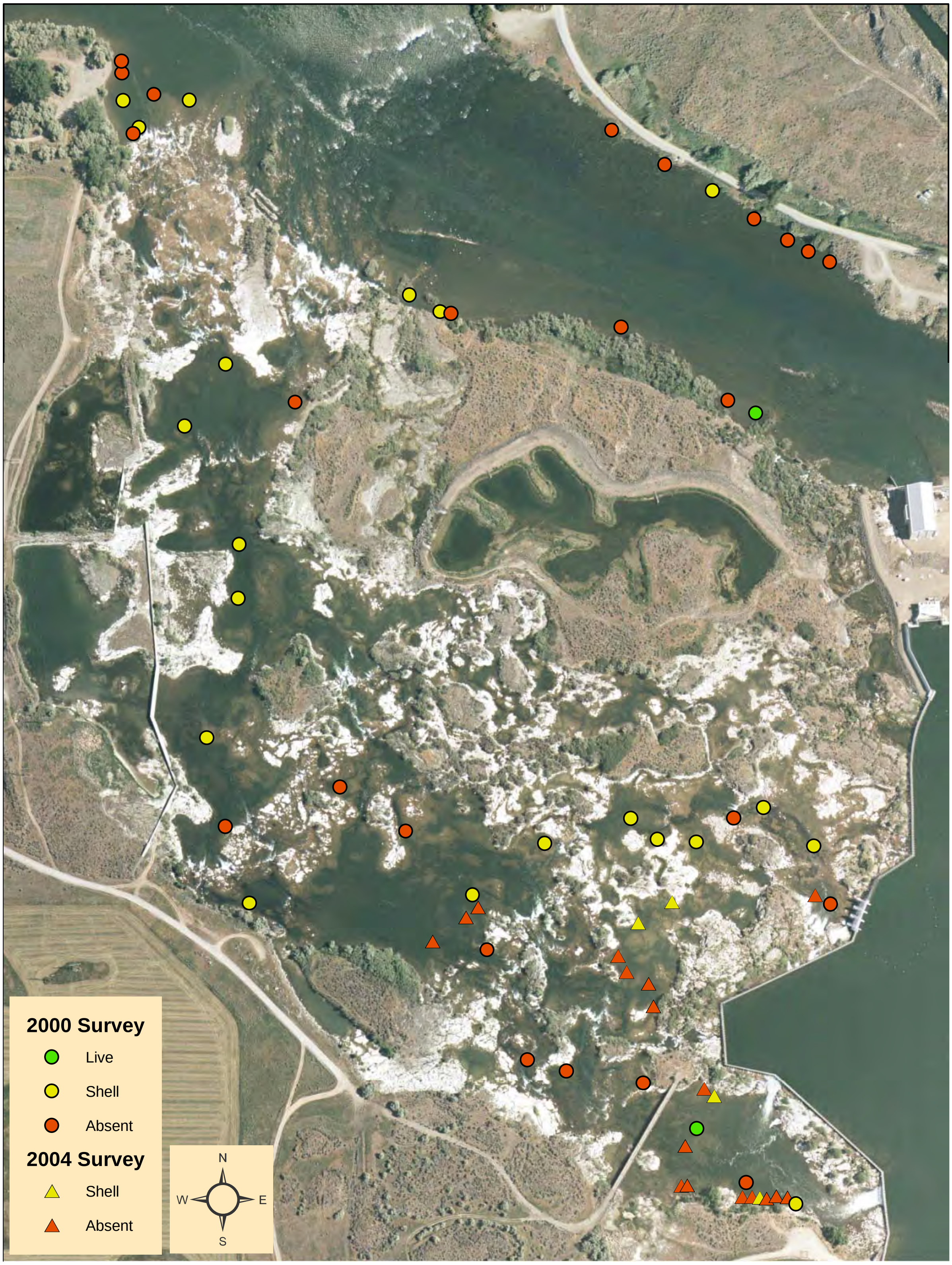

Figure 4-4. Live and empty-shell Utah valvata collections in 2000 and 2004 from the spillway area below Minidoka Dam (Weigel unpublished, Minidoka Spillway; Newman unpublished).

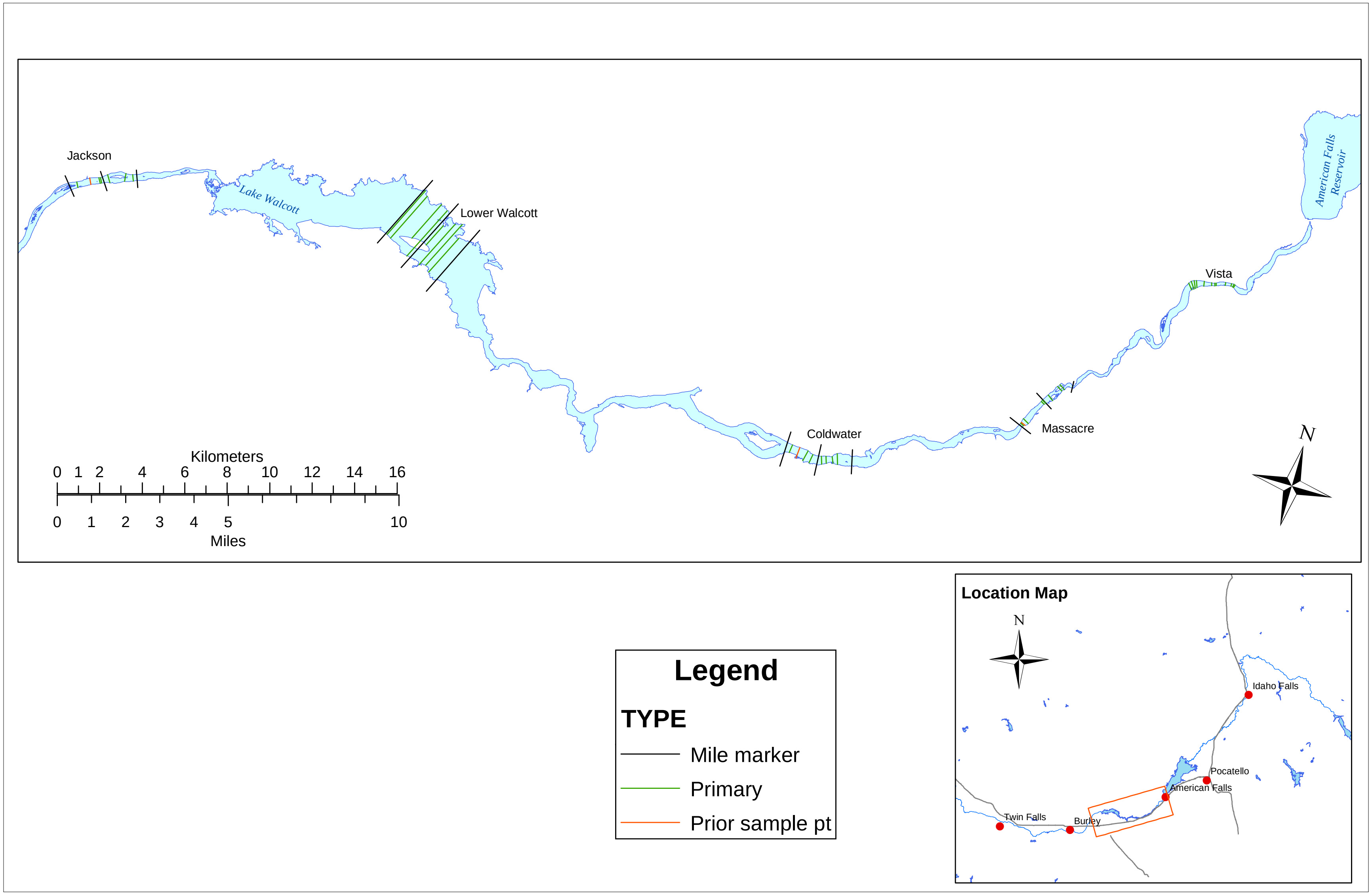

Figure 4-5. Locations of Reclamation's 2000, 2001, and 2002 survey transects from Jackson Bridge upstream to below American Falls Dam (Weigel 2002).

Idaho Power's FERC license requires Idaho Power to maintain, within its capability, a minimum release of 200 cfs immediately downstream from Milner Dam. However, there is no water right for this minimum release, so water must come from natural flow (spill water) between irrigation seasons or from storage or rental pools. This water may not always be available. During the past 95 years, flows have been reduced to between 50 and 0 cfs below Milner Dam 131 times for a period greater than 4 days (when flows below Milner Dam are reduced to, or very near, 0 cfs, the Snake River at Milner gage sometimes gives falsely inflated readings; many times recorded flows up to 50 cfs are false readings). Discharge of the Snake River Plain Aquifer from Bancroft Springs (RM 553) upstream to Briggs Springs (RM 590.5) provides most of the inflow to the Snake River in the reach from Milner Dam to King Hill.

All four species of listed snails covered under this consultation occur in the reach from Milner Dam to Brownlee Reservoir. Reclamation does not conduct annual snail surveys in this reach. However, Reclamation did conduct a small snail survey adjacent to the pumps near Marsing, Idaho, on September 28, 2004, prior to a proposed construction project. No listed snails were found (Weigel unpublished, Marsing Survey).

Utah valvata are known to exist in this reach in Upper Salmon Falls Reservoir approximately one mile upstream from the dam (USFWS 2004), in Thousand Springs (Frest and Johannes 1992), and in Box Canyon Springs (Taylor 1985). The population in Upper Salmon Falls Reservoir is the only population identified below Milner Dam on the Snake River. The other two populations are located in adjacent springs and are therefore excluded from this analysis. The target recovery area for this species extends downstream to RM 572. Idaho Power aquatic biologists routinely survey and monitor the Utah valvata in this area (Cazier 1997).

Below Milner Dam, the Idaho springsnail occurs from the upper end of Brownlee Reservoir at Cobb Rapids (RM 339.3) upstream to the Bancroft Springs area (Cazier 2002) (see Figure 4-1 on page 58). Idaho Power aquatic biologists routinely monitor the Idaho springsnail in this reach and have found densities ranging from 0 to 1,460 snails per m^2 (Cazier 2001a, 2001b, 2001c, 2002).

The Bliss Rapids snail is discontinuously distributed below Milner Dam and is associated with spring tributaries between Clover Creek (RM 547) and Twin Falls (RM 610.5) (USFWS 2004). Relative to the adjacent spring colonies, lower densities of Bliss Rapids snails are found in the mainstem Snake River (USFWS 2004). The presence of these snails in the mainstem is likely due to spring influence (Hershler et al. 1994). Idaho Power aquatic biologists routinely monitor the Bliss Rapids snail in the Snake River from Clover Creek to Twin Falls.

The Snake River physa is thought to occur from Grandview (RM 487) to the Hagerman reach (RM 573); however, recent suspected but unverified findings below Minidoka Dam, as discussed earlier, indicate it may be located farther upstream. The designated target recovery area for this species is from RM 553 to RM 675. Very little is known about this species and its status, but it appears to be very limited in its range and has always been rare (USFWS 2004). The only known, verified collections of the species occurred between 1959 and 1985, with live specimens coming from the Hagerman Reach, downstream from Lower Salmon Falls Dam (Taylor 1988).

4.6.2 Pumps and Diversions

In addition to the larger structures described above, numerous pumps and diversions affect flows and habitat in the action areas. The past effects of these diversions on the four species of listed snails are unknown. Collectively, the reduction of flow does reduce the amount of snail habitat available; however, this change has not been quantified. In addition, reductions in flow can be generally related to reductions in water quality. This, too, has not been quantified. However, it should be noted that Reclamation’s actions result in higher flow conditions in the Snake River during the summer months than would have likely existed historically.

Very little is known regarding snail entrainment. Currently, it is not known specifically how the four listed species disperse, outside of physical movement across the substrate. Some species of snail disperse by clinging to water surface tension and drifting or by simply altering their specific gravity and drifting (Pennak 1989). In addition, snail eggs or juveniles that become dislodged from the substrate may disperse by drifting in the water column. It is possible for listed snail adults, juveniles, and eggs to become entrained in water diversion structures on the Snake River. However, without knowing the dispersal mechanism, dispersal rates, and dispersing snail concentrations per unit volume of water, it is not possible to make any inferences regarding snail entrainment under current conditions.

4.6.3 Water Quality

The effects of construction and past and current operation of dams and diversions on the upper Snake River include a series of changes in the physical conditions upstream and downstream from the structures, particularly modifications to the temperature regime, water quality, and clarity. For example, irrigation return water is the largest contributor of sediments to the Snake River (USFWS 2004). It is estimated that over 300,000 pounds of soil are washed into the Snake River daily, during the irrigation season (EPA 2002). Water quality changes may be slight or considerable, depending upon water residence time in the reservoirs and whether surface or deep water is released. These depend on whether Reclamation is implementing flood operations, delivering irrigation water, or both. The modified physical and chemical conditions have resulted in changes to plant and animal life of the river.

Changes to water quality resulting from reduced flows generally affect concentrations of pollutants in the downstream reach. A reduction in flow will not add pollutants but may result in higher concentrations of pollutants in the flow-reduced reach. Flow reduction tends to increase the effect of pollutant inputs. Flow reduction may also have an effect on the temperature of water in the reach. Generally, the effect would be an increase in temperature when flow is reduced, but depending on the channel shape and velocity, temperature could also decrease or remain the same with flow reduction.

Although studies have not been conducted to determine the tolerance of the listed Snake River snails to reduced water quality, inferences can be made from the current known distribution and abundance of these snails (USFWS 2004). Both the Idaho springsnail and the Utah valvata appear to be at least somewhat tolerant of elevated water temperatures and sediment-laden habitats (USFWS 2004). By contrast, the Bliss Rapids snail is largely restricted to cold, well-oxygenated waters with rock or cobble substrates; it is absent or found in reduced numbers in the warmer waters of the Snake River. Very little is known about the Snake River physa, but it is assumed to be reliant on good water quality and found in deeper portions of the mainstem Snake River on stable, rock substrates. Water temperature and dissolved oxygen are believed to be far more restrictive and limiting for the Bliss Rapids snail and the Snake River physa (USFWS 2004).

The current distribution of snails is likely a result of the interaction between water operations, water quality, and river hydrology creating suitable environments. However, much of the available water quality data cannot be directly correlated with listed snail distribution and abundance in a quantifiable manner. Water quality information provided here is intended to describe the current water quality conditions.

Various agencies monitor water quality in the Snake River's upper and middle reaches. These data are usually collected at designated monitoring sites at weekly or biweekly time intervals. Although these water quality data cannot be directly correlated with the presence and abundance of listed snails, they are useful to describe the general trends and conditions in various reaches within the area of analysis.

State of Idaho water quality criteria for waters designated as supporting cold water aquatic life are dissolved oxygen concentrations exceeding 6 mg/L at all times and water temperatures of 22 °C or less with a maximum daily average of no greater than 19 °C. In lakes and reservoirs, the dissolved oxygen minimum concentration does not apply to the bottom 20 percent of water depth when depths are less than 35 meters or the bottom 7 meters of water where depths are greater than 35 meters (IAC 2004).

Snake River from the Confluence with the Henrys Fork to American Falls Reservoir

In 2000 and 2001, the USGS conducted temperature monitoring at two existing gage sites, the Snake River near Shelley and the Snake River near Blackfoot, from May to September. At the Shelley site, temperatures ranged from 7.2 to 21.8 °C in 2000 and from 7.7 to 24.3 °C in 2001. At the Blackfoot site, temperatures ranged from 7.9 to 23.1 °C in 2000 and from 9.3 to 23.5 °C in 2001. Maximum temperatures exceeded 20.0 °C at both sites in 2000 beginning in July and at both sites again in 2001 from June until the end of data collection.

The USGS, in cooperation with the IDEQ, tested water quality at four sites on the Snake River downstream from Idaho Falls for a four-year period. The sites were near Shelley, Firth, Blackfoot, and Ferry Butte (Tilden Bridge). All sites were sampled biweekly April to September in the years 2000 through 2003. The IDEQ found that nutrients did not appear to exceed current recommended EPA nutrient criteria in this section of the Snake River. Average total phosphorus did not exceed 0.035 mg/L, which is well below the EPA guidance of 0.050 mg/L for rivers and streams entering a lake or reservoir. Total suspended solids concentrations in the Snake River immediately upstream from American Falls Reservoir ranged from 0.5 to 79 mg/L at Tilden Bridge and from 0.50 to 30 mg/L at Firth (IDEQ 2003).

The USGS monitored the Snake River as part of their National Water Quality Assessment (NAWQA) program. Much of the NAWQA effort involved testing for pesticides and organic compound contamination in the water, sediment, and fish tissue samples from the upper Snake River. Fish collected from the Snake River near Blackfoot had detectable concentrations of dichlorodiphenyltrichloroethane (DDT) metabolites, polychlorinated biphenyls (PCB), and chlordane. Water tested from sites near Shelley and near Blackfoot was found to contain atrazine and Eptam (or EPTC). However, comparison of fish-tissue data collected during the NAWQA study with data collected during the early 1970s indicates that the bans on use have been effective in reducing the environmental concentrations of organochlorine compounds in the Snake River basin (USGS 1998).

There are limited metals data within the action areas. Reclamation does test for metals in water column samples collected triennially from the reservoirs. These data are of limited use and do not include sediment testing for metals.

American Falls Reservoir

Water column sampling occasionally reveals a specific monitoring location with dissolved oxygen levels below 6.0 mg/L at all tested depths. The IDEQ conducted 38 sampling trips at either a site near Little Hole Draw or near the dam. Three of these 38 trips revealed a water column that had dissolved oxygen levels of less than

6.0 mg/L at all depths, two times at the dam site and one time near Little Hole Draw. Although there are areas with periods of very low dissolved oxygen, they do not occur consistently across the reservoir. Total phosphorus concentrations in the reservoir are often above the 1986 EPA suggested levels for lakes and reservoirs (IDEQ 2003). Reclamation and the IDEQ water quality analysis between 1995 to 2003 show that total phosphorus levels were consistently above the 1986 EPA recommended level of 0.025 mg/L for reservoirs.

Shoreline erosion has been a concern since the reservoir was constructed. Reclamation performs shoreline maintenance each summer, including leveling and grading cliffs and covering exposed soil with riprap or vegetation to reduce erosion and sediment inputs into the reservoir. The extent that shoreline erosion affects concentrations of suspended solids and turbidity in the reservoir is not known.

While American Falls Reservoir maintains relatively large storage content, the Total Suspended Solids (TSS) and Turbidity measurements of the outflow measured at the Snake River at Neeley gage parallels the measurements of the Snake River inflow measured at Tilden Bridge. However, an increase in TSS and Turbidity concentrations occurs as the water moves through the reservoir. This occurs because tributary inflows often have higher sediment loads than the river, bank erosion contributes sediment to the reservoir, and there may be small exportation of stored sediment from the reservoir. Further, Aeolian (wind) deposits may be the largest input of sediment into the reservoir. The American Falls region topsoil consists of mostly windblown Loess material. When the wind blows heavily in the area, which occurs often, dust and sand are moved in enormous quantities with the wind. An unquantifiable volume of this sediment is deposited in the reservoir and could account for increases in turbidity as water moves downstream through the reservoir. This total increase is usually less than 20 Nephelometer Turbidity Units (NTUs), which is within the IDEQ limits for waters supporting cold water aquatic life.

As the reservoir is drawn down, the relationship between upstream and downstream sediment concentrations dissipates as sediment begins to be exported from the reservoir at higher rates. Higher rates of sediment exportation appears to begin at water storage levels in the range of 2 to 4 percent (approximately 33,000 to 67,000 acre-feet), depending on the year. Although four years of data have been collected, a good relationship between storage content and sediment exportation has not yet been found. Some of the other factors involved in sediment exportation rates include:

- reservoir inflow and outflow
- rate of inflow or outflow change
- rate of drawdown

- wind action (causing Aeolian deposition of sediment within the river and reservoir)
- earlier (including previous years) water operations
- water carryover within the reservoir

Data will continue to be collected during years that storage content is expected to drop below 5 percent, or 83,500 acre-feet. This water quality issue is in the river reach downstream from the reservoir, not in the reservoir itself. Since 1960, American Falls Reservoir has been drawn down below 2 percent of capacity (33,000 acre-feet) 7 times.

American Falls Dam to Milner Dam

Table 4-5 summarizes the water quality monitoring data for this reach.

The TMDL for the Lake Walcott Subbasin lists instream water quality targets for the Snake River from immediately below American Falls Dam downstream to Milner Dam. The target total suspended solid concentration is a monthly average of 25 mg/L with a daily maximum of 40 mg/L from American Falls Dam to Milner Dam. Dissolved oxygen concentrations are required to exceed 6 mg/L from American Falls Dam to the Burley/Heyburn Bridge and to exceed 5 mg/L from the bridge

Table 4-5. Water quality monitoring data collected from American Falls Dam to Milner Dam.

Collection Site [1]	Average	Standard Deviation	Minimum	Maximum
Neeley Pipeline downstream from American Falls Dam (RM 711)				
Summer Temperature (°C)	18.8 [2]		11.2	23.2
Dissolved Oxygen (mg/L)			1.7	15.1
Total Suspended Sediment (mg/L)	10	14	1	107
Total Phosphorus (mg/L)	0.079	0.041	0.023	0.217
Jackson Bridge downstream from Minidoka Dam (RM 673)				
Summer Temperature (°C)	20.0 [2]		14.2	24.3
Dissolved Oxygen (mg/L)			1.7	15.8
Total Suspended Sediment (mg/L)	9	7	1	60
Total Phosphorus (mg/L)	0.061	0.027	0.022	0.212
Milner Dam (RM 638)				
Summer Temperature (°C)	20.8 [2]		14.0	28.9
Dissolved Oxygen (mg/L)			5.4	14.6
Total Suspended Sediment (mg/L)	13	7	1	39
Total Phosphorus (mg/L)	0.111	0.067	0.038	0.450

1 Samples were collected bi-weekly from October 1995 to September 2003. All data, except average temperature, represent yearly data. See USBR (unpublished) for the source data.

2 Average summer temperature is calculated using data collected between June and August.

downstream to Milner Dam. The total phosphorus concentration target is a yearly average of 0.080 mg/L with a maximum of 0.128 mg/L from Minidoka Dam to Milner Dam. There is no total phosphorus target upstream from Minidoka Dam (IDEQ 1999).

The Walcott TMDL suspended solid concentration target is typically exceeded only when American Falls Reservoir is drawn down to below 5 percent of capacity (elevation 4,306 feet). When summertime dissolved oxygen concentrations are low in American Falls Reservoir, Idaho Power's FERC license for their project at American Falls Dam requires them to inject air into the water at the hydropower generators. Therefore, summertime dissolved oxygen concentrations have been greater than 6 mg/L at the Utah valvata colonies in the river downstream from American Falls Dam (Weigel 2003). Lake Walcott typically stays within the water quality standards for cold water biota (Weigel 2003).

There is insufficient data to quantitatively correlate low water levels in American Falls Reservoir with dissolved oxygen concentrations. However, the relationship between American Falls Reservoir water levels and mean residence time should be noted. For example, when American Falls Reservoir is drawn down to 50,000 acre-feet (3 percent of total capacity) and irrigation releases are 8,000 cfs (a common irrigation release), mean residence time is approximately 3 days. This reduces the water quality effects associated with impoundment.

During the summer, periods of reduced dissolved oxygen occur in Lake Walcott. In most instances, the variation of dissolved oxygen in the water column is minimal (difference of 2.0 mg/L between the surface and reservoir bottom). On occasion, reservoir bottom dissolved oxygen concentrations near the powerplant are below 2.0 mg/L.

The average total phosphorus concentration of Minidoka Dam discharge (as measured at Jackson Bridge) between 1995 and 2003 was 0.061 mg/L, which is a 23 percent decrease from the average total phosphorus concentration upstream at the Neeley site (downstream from American Falls Dam). Nutrient uptake by plant growth in Lake Walcott likely reduces the total phosphorus.

Average total suspended solids also decrease between the Neeley and Jackson Bridge sites (upstream and downstream from Lake Walcott). Average suspended solids concentrations drop by 10 percent (from 10 to 9 mg/L) in this reach. Solids settling out of the water column in Lake Walcott likely reduce suspended solids. Both suspended sediment and total phosphorus concentrations increase again before Milner Dam. Irrigation return flows, stormwater drains, and permitted loads from municipalities and industries may contribute to this increase.

The Milner Pool is listed as warm water biota for its designated use. Different numeric criteria for water temperature apply compared to the rest of the Snake River upstream from Milner Dam. Standards for warm water biota require temperatures of 33 ºC or less with a maximum daily average not greater than 29 ºC. All other reaches above Milner Dam have a designated use of cold water biota. Cold water biota standards require water temperatures of 22 ºC with a maximum daily average of no greater than 19 ºC.

Milner Dam to above Brownlee Reservoir

The reach of the Snake River downstream from Milner Dam is characterized by high nutrient concentrations and extensive growth of aquatic vegetation. A recent ecological risk assessment identified that high water temperatures, low flows, and sedimentation are the major stressors thought to be responsible for the decline in the native species of snails in this reach (EPA 2002). The assessment study recommended that adverse conditions can be improved if a spring freshet is reestablished with flows suitable to provide temperatures for fish reproduction and development. Table 4-6 summarizes water quality monitoring for sites in this river reach.

Between the sample dates of October 18, 1999, to December 27, 1999, the middle Snake River did not meet the state dissolved oxygen standards of 6.0 mg/L for cold

Table 4-6. Water quality monitoring data collected downstream from Milner Dam.

Collection Site [1]	Average	Standard Deviation	Minimum	Maximum
Blue Lakes Bridge (RM 612)				
Summer Temperature (°C)	20.4 [2]		15.4	24.3
Dissolved Oxygen (mg/L)			5.9	14.8
Total Suspended Sediment (mg/L)	17.5	11.5	1	91
Total Phosphorus (mg/L)	0.091	0.036	0.042	0.260
Clear Lakes Bridge (RM 594)				
Summer Temperature (°C)	17.6 [2]		8.6	22.3
Dissolved Oxygen (mg/L)			5.8	14.1
Total Suspended Sediment (mg/L)	25	20	4	120
Total Phosphorus (mg/L)	0.118	0.031	0.055	0.214
Bliss Bridge (RM 566)				
Summer Temperature (°C)	18.7 [2]		16.0	21.5
Dissolved Oxygen (mg/L)			6.2	13.3
Total Suspended Sediment (mg/L)	22.0	17.94	4	153
Total Phosphorus (mg/L)	0.097	0.024	0.060	0.232

1 Samples were collected bi-weekly from May 1995 to March 2001. All data, except average temperature, represent yearly data. See USBR (unpublished) for the source data.

2 Average summer temperature is calculated using data collected between June and August.

water biota. During this time, samples collected from the river between American Falls Reservoir and the Bliss reach showed dissolved oxygen concentrations below 6.0 mg/L for several consecutive sampling events at most sites. The cause is possibly due to die-off and subsequent decomposition of aquatic plants. However, over the 5-year monitoring period, this was the only time dissolved oxygen concentrations were recorded below 6.0 mg/L.

Total phosphorus in flowing water can be used as an index of the degree of eutrophication and nuisance plant growth. The Upper Snake Rock Creek TMDL established an instream total phosphorus target of 0.075 mg/L for the middle Snake River. From 1995 to 2000, all of the monitoring sites in this area showed elevated phosphorus concentrations characteristic of a eutrophic system. In the upper reaches of the middle Snake River (Milner Dam downstream to Blue Lakes Bridge) approximately 60 percent of the total samples collected exceeded the concentration of 0.075 mg/L. At Clear Lakes Bridge, the samples in exceedance of 0.075 mg/L were 93.6 percent with a range of 0.055 to 0.214 mg/L.

4.6.4 New Zealand Mudsnail

Changes in the invertebrate community are due to the above-described alterations in the physical and chemical environment below Reclamation's reservoirs. An overall reduction in habitat heterogeneity likely accounts for a reduction in species diversity and an increased abundance for those species favored by the altered conditions. The non-native New Zealand mudsnail (*Potamopyrgus antipodarum*) has invaded the Snake River mainstem habitat occupied by the threatened and endangered native snails. It has a high reproductive potential and can attain extremely high densities when introduced into a system. In addition, the mudsnail has a seemingly inverse relationship to water velocity and has greater thermal tolerances, growth rates, and fecundity than the native Snake River snails (Richards et al. 2001). The mudsnail is likely to continue to compete with resident snail fauna.

Mudsnail densities are increasing and expanding throughout the Snake River basin above Brownlee Reservoir. Mudsnails are documented in extremely high densities in free-flowing environments (Richards et al. 2001; Gustofson 2001) but appear to be less numerous in reservoir environments (Weigel 2002, 2003). It is not clear whether these lower densities are a result of the habitat or the ability of the species to disperse into this area.

Mudsnails were collected at only one site in the upstream end of American Falls Reservoir during a survey in 2002 (Weigel 2003). However, mudsnail densities in the river downstream from American Falls Reservoir are moderately high, exceeding 600 mudsnails per m^2 (Weigel 2002). Since 1997, mudsnails have steadily increased in Lake Walcott from 12.7 mudsnails per m^2 in 1997 (Irizarry 1999) to 80 mudsnails per m^2 in 2002 (Weigel 2003). Densities of New Zealand mudsnails in the middle Snake River near Banbury Springs are greater than 4,000 individuals per m^2 (Shinn 2001).

4.6.5 Urbanization

Multiple communities exist along the Snake River in the action areas. The communities affect the Snake River in a variety of ways. As adjacent lands give way to urban development, impacts to the Snake River increase. Waterfront property owners typically construct erosion barriers (i.e., rip rap, concrete water walls, etc.) and maintain manicured lawns, eliminating the riparian area and the habitat associated with the riparian/litoral region interface. Manicured lawns also increase the potential for nutrification through the application of lawn fertilizers.

Urbanization also requires sewage treatment. Septic systems, urban runoff, and sewage treatment plant discharge all contribute to declining water quality in the Snake River. There are several urban centers (Idaho Falls, Rexburg, Pocatello, Blackfoot, American Falls, Burley/Heyburn, and the Twin Falls area) located on the Snake River that collectively contribute large volumes of wastewater to the river. The Twin Falls sewage treatment plant alone can treat 7.8 million gallons per day of wastewater, which contributes nutrients, ammonia, suspended and settleable solids, and organic matter (EPA 2002).

4.7 Effects Analysis

The areas of analysis vary by species. The following subsections identify river reaches and reservoirs where the associated proposed actions may have a hydrologic influence. The effects discussion for each reach includes a discussion of a particular species only if that reach is within the species' area of analysis. Section 4.8 summarizes Reclamation's determination for each proposed action. The specific areas of analyses by species are:

- For the Utah valvata, the Henrys Fork from RM 9.3 to its mouth, and the Snake River from its confluence with the Henrys Fork (RM 832.4) downstream to Hagerman (near RM 572) (this is within the action area for future O&M in the Snake River system above Milner Dam and future provision of salmon flow augmentation from the rental or acquisition of natural flow rights).
- For the Snake River physa, the Snake River from American Falls Dam (RM 714) downstream to Grandview (RM 487) (this is within the action areas for future O&M in the Snake River system above Milner Dam, future

operations in the Little Wood River system, and future provision of salmon flow augmentation from the rental or acquisition of natural flow rights).

- For the Bliss Rapids snail, the Snake River from Twin Falls (RM 610.5) downstream to Clover Creek (RM 547) (this is within the action areas for future O&M in the Snake River system above Milner Dam, future operations in the Little Wood River system, and future provision of salmon flow augmentation from the rental or acquisition of natural flow rights).
- For the Idaho springsnail, the Snake River from Bancroft Springs (RM 553) downstream to Cobb Rapids at the upper end of Brownlee Reservoir (RM 339) (this is within the action areas for future O&M in the Snake River system above Milner Dam; future operations in the Little Wood River system; future O&M in the Owyhee, Boise, Payette, and Malheur River systems; and future provision of salmon flow augmentation from the rental or acquisition of natural flow rights).

The future O&M in the Snake River system above Milner Dam will continue to include Reclamation's operation of the reservoirs in the upper Snake River above Milner Dam as a unified storage system; water will be stored and released to maximize the capability of the storage reservoirs. This means that water will be physically stored in those reservoirs that are most difficult to fill (most often as far upstream as possible, regardless of storage right priorities) and will be released from the reservoirs that are most likely to refill the following year.

At any given time, reservoir storage and flows in various reaches of the upper Snake River above Milner Dam will vary depending upon several factors. These factors include the amount of precipitation in the previous year as well as in the past few weeks or days, reservoir carryover at the end of the storage season, air temperature, and irrigation demand. Reservoir content and streamflows at any instant provide limited information on the system operation as these could markedly differ in a few weeks or even a few days. River flows may even change greatly in a few hours. However, graphs of river flows and reservoir contents can provide a general overview of the range of possible operations. The tables in Appendix D summarize the estimated range of hydrologic conditions under the proposed actions. Appendix E provides more complete hydrologic conditions data. All modeled flows incorporate salmon augmentation water.

For the snails analyses, Reclamation chose to separate the upper Snake River into distinct segments based on operations, available data, potential impacts from the proposed actions, and the occurrence of snail populations. The distinct Snake River segments are: above American Falls Reservoir, American Falls Reservoir to above Lake Walcott, Lake Walcott to Milner Dam, Milner Dam to Shoshone Falls, and Shoshone Falls to above Brownlee Reservoir.

Although operational effects below Milner Dam may not be as direct as they are above Milner Dam, Reclamation's operations do affect the Snake River below Milner Dam. The analysis below Milner Dam was separated into two reaches based on localized impacts. Immediately below Milner Dam, future O&M in the Snake River system above Milner Dam is partially responsible for occasionally dewatering the Snake River through the storage and diversion of project water. Between Milner Dam and Shoshone Falls, limited spring input adds water to the channel.

From Shoshone Falls to above Brownlee Reservoir, combined effects associated with the proposed actions become increasingly difficult to distinguish from other localized factors. In this reach, river flows are increased via spring recharge, localized runoff, irrigation return flows, and municipal and industrial effluent. Water quality is also altered by urbanization, effluent from dairies, fish culture facilities, and irrigation returns. Any potential effects resulting from Reclamation's proposed actions become further attenuated by Idaho Power's localized operations.

Snail entrainment as a result of the proposed actions is difficult to assess. As described in Section 4.6.2, little is known regarding snail entrainment, and an accurate effects analysis is not possible. It is likely that entrainment does occur at diversions located below snail colonies; however, the timing and magnitude of entrainment, if it even occurs, is not known. Very little information exists regarding gastropod entrainment in the literature.

Reclamation does not know the effects, if any, of water quality on the listed snails in the action areas. No data has been collected or encountered that describes or quantifies the relationship between the listed snails and any single or suite of water quality constituents.

4.7.1 Snake River and the Henrys Fork above American Falls Reservoir

Aquatic snails in this river reach are in the action area for future O&M in the Snake River system above Milner Dam.

Reclamation (2004) describes the operation of numerous upper Snake River facilities. Grassy Lake Dam, Island Park Dam, and discharge from the Teton River and other tributaries to the Henrys Fork below Island Park Dam control flows in the lower Henrys Fork. Jackson Lake, Palisades Reservoir, and Ririe Reservoir also influence hydrologic conditions in this reach.

Utah valvata

The lower Henrys Fork and the Snake River from its confluence with the Henrys Fork downstream to American Falls Reservoir have populations of Utah valvata. A USFWS survey near Firth, Idaho, found 7 Utah valvata in the river channel at depths below 2 feet (USFWS 2003). Other information at these sites is limited; however, it is likely that the Utah valvata is unable to persist in river fluctuation zones near the shoreline. The few locations where Utah valvata persist are likely permanently watered habitats. As occurs in other locations monitored by Reclamation, Utah valvata likely annually disperse into available habitat during high flow periods. When flows are reduced following irrigations season, the dispersed snails may become stranded as the water recedes to the minimum winter flow. Because too little information is available for this site, it is only possible to draw general conclusions regarding Utah valvata mortality.

Reclamation is currently conducting a joint investigation with the Idaho Department of Fish and Game (IDFG), the Bureau of Land Management (BLM), and the Idaho Department of Transportation. Approximately 15 to 20 sites will be surveyed for snails on the Snake River above American Falls Reservoir to below Palisades Dam and on the Henrys Fork up to Henrys Lake. This information will be made available as soon as all sample identification work is complete; this will likely occur by February 2005.

Although Utah valvata have been documented in the Snake River above American Falls Reservoir and the lower Henrys Fork, little is known about their distribution, abundance, or population trends. In addition, nothing is known about the relationship between river discharge and Utah valvata population and habitat sustainability in this reach. Operations at Island Park and Grassy Lake Dams have little impact to the overall annual flow regime of the lower Henrys Fork where Utah valvata are found (specifically, near the Idaho Highway 33 bridge near Rexburg, Idaho).

Annual flow fluctuations from Jackson Lake and Palisades Reservoir, combined with the minor influence from Henrys Fork storage facilities, will affect Utah valvata in the Snake River above American Falls Reservoir; however, impacts to the species are currently unquantified. It is likely that snail mortality does occur in this reach as a result of Reclamation's annual water level fluctuation.

Future O&M in the Snake River system above Milner Dam will result in Utah valvata mortality above American Falls Reservoir. Data collected by the USFWS in 2003 indicate that Reclamation's proposed action precludes the snail from occupying littoral reaches of the Snake River. This would continue to occur under the proposed action.

4.7.2 Snake River from American Falls Reservoir to above Lake Walcott

Aquatic snails in this river reach are in the action area for future O&M in the Snake River system above Milner Dam.

Reclamation (2004) describes the operation of American Falls Dam. Reclamation tries to maintain 50,000 to 60,000 acre-feet in the reservoir but may drain it during low water years (when American Falls Reservoir is drawn down to less than 50,000 acre-feet, the detention time of water moving through the reservoir can be less than 3 days; at these times, the reach behaves more similarly to a river than a reservoir as the majority of the surface area of the reservoir has receded into the original Snake River channel). American Falls Reservoir has no designated "inactive" or "dead" storage. However, it should be noted that a 100 percent drawdown of American Falls Reservoir is not possible through Reclamation actions alone.

The reservoir fluctuates greatly from year to year with hydrologic conditions. Reclamation will maintain an overwinter flow of approximately 350 cfs to maintain water quality downstream from the dam even in years when the reservoir pool is very low at the end of the irrigation season. If inflows are higher than expected or if carryover storage is substantial, winter releases may range from 1,000 to 5,000 cfs. During flood operations, flows as high as 42,000 cfs are possible.

Utah Valvata

Water operations directly affect aquatic snails through shoreline stranding and by altering or reducing the quality and availability of the habitat (Christman et al. 1996). Low flows prevent snails from colonizing shoreline habitats; however, when flows are restored, snails can re-disperse over time into these shoreline habitats (Christman et al. 1996). Snail populations likely expand and contract as precipitation levels expand or contract the reservoir contents and river flows. It is likely that successive years of above-average precipitation and runoff will result in expansion of the snail populations, while a dry year following one or two wet years will result in higher levels of mortality (relative to the level of mortality in a low water year following successive low water years). Similarly, successive dry years (below-average precipitation and runoff) will result in lower levels of mortality.

Minimum annual water surface elevations for American Falls Reservoir may fluctuate from 4,296 to 4,345 feet. The shoreline areas that are annually dewatered will have minimal numbers of snails (less than 1 percent). Most of the Utah valvata population is found at and below elevation 4,311.4 feet. When American Falls Reservoir drafts to an elevation of 4,311.4 feet, it is at 7 percent total capacity. Nearly all Utah valvata locations identified by Weigel (2002) were at or below this elevation. It should be noted, however, that American Falls Reservoir was drafted to an elevation of 4,311 feet in September 2000. The data collected by Reclamation from 2001 to 2003 were collected during extreme drought conditions (potentially worse than the 1930s), therefore representing extreme conditions and fluctuations for the system.

Mortality is most likely to occur when the water surface elevation drops below 4,311.4 feet. The model predicts these deeper water areas will be watered approximately 74 percent of the time (see Figure 4-9 on page 94). Figure 4-6 displays the modeled summary hydrograph for the range of reservoir water surface elevations in the proposed action. However, because the model uses a monthly time step, there may be occasions when the monthly average elevation will be above 4,311.4 feet in months the reservoir water surface elevation drops below this elevation for short periods of time. Using historical daily data for the 79-year period of record, American Falls Reservoir was drafted below 4,311.4 feet for at least 4 days in 29 out of the 79 years (about 37 percent of years). Lysne (2003a) reported 50-percent mortality for Utah valvata exposed to a dry treatment for 50 hours in a controlled study. Although actual dessication rates may vary, dependent upon factors such as weather conditions, ambient temperature, and substrate compositions, snail mortality at 96 hours (4 days) would be near 100 percent. The proposed action will have less severe impacts to Utah valvata than past operations. For example, in 1993,

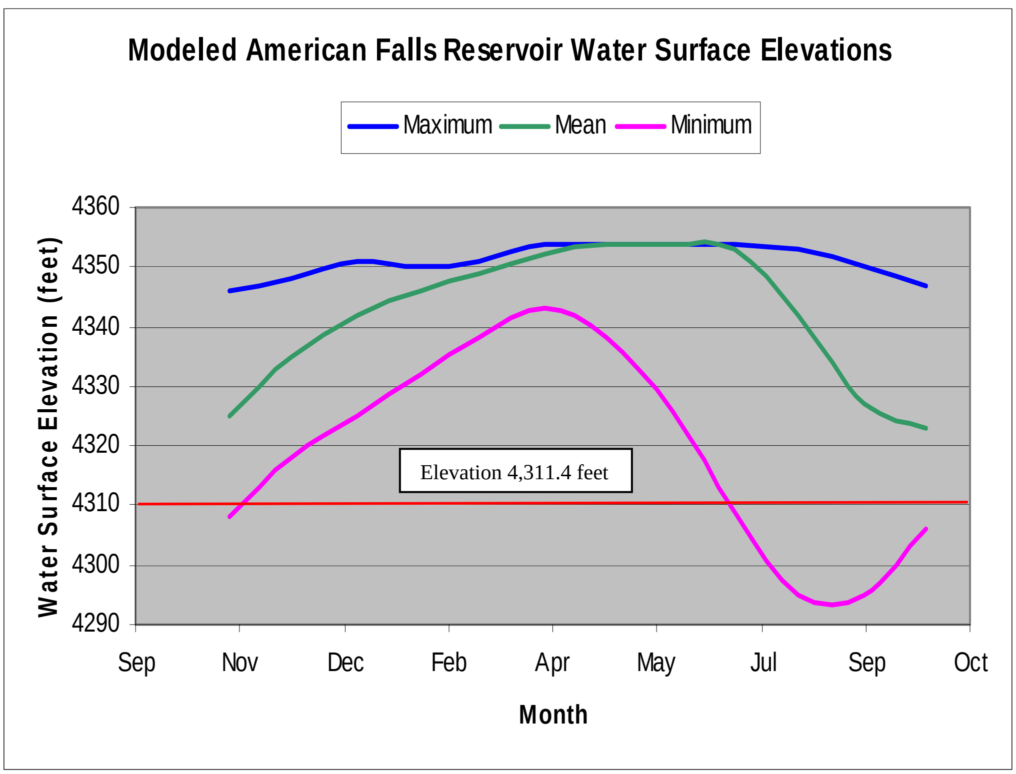

Figure 4-6. Modeled summary hydrograph of American Falls Reservoir water surface elevations under the proposed action (see USBR 2004, Appendix B, for explanation of summary hydrographs).

a relatively wet year, American Falls Reservoir was drafted to an elevation of 4,331 feet in September. Under the proposed action for similar water supply conditions, it is predicted to be drafted to 4,337 feet, an increase in elevation of 6 feet. Likewise, as previously discussed for a dry year, American Falls Reservoir is predicted to be 4 feet higher than actual operations.

The relationship between reservoir fluctuation and Utah valvata population response is unknown. The area of potential snail habitat in the reservoir is not known, nor is the snail recolonization/distribution rate into that habitat when the potential habitat becomes watered. In addition, bank seepage from local irrigation and bank storage produce wetted areas adjacent to the reservoir. Lysne (2003a) reported no mortality for Utah valvata exposed to a moist treatment in a controlled laboratory study; therefore, mortality resulting from desiccation is not anticipated in these wetted areas unless the snails fail to reach watered habitat prior to freezing conditions.

Previous stranding surveys have identified high levels of stranding during the fall flow reductions in the river reach downstream from American Falls Dam; in these areas, few snails appear to move with the receding water (Weigel 2002). However, in the fall of 2002, only 2 percent of the Utah valvata sampled during monitoring activities in this reach occupied the dewatered habitat. Due to the shape of the river channel, it is likely that most snail habitat begins to become exposed when flows drop below 5,500 cfs.

Figure 4-7 displays the modeled summary hydrograph for the range of flow conditions in the proposed action. During most wet years, minimum annual discharge

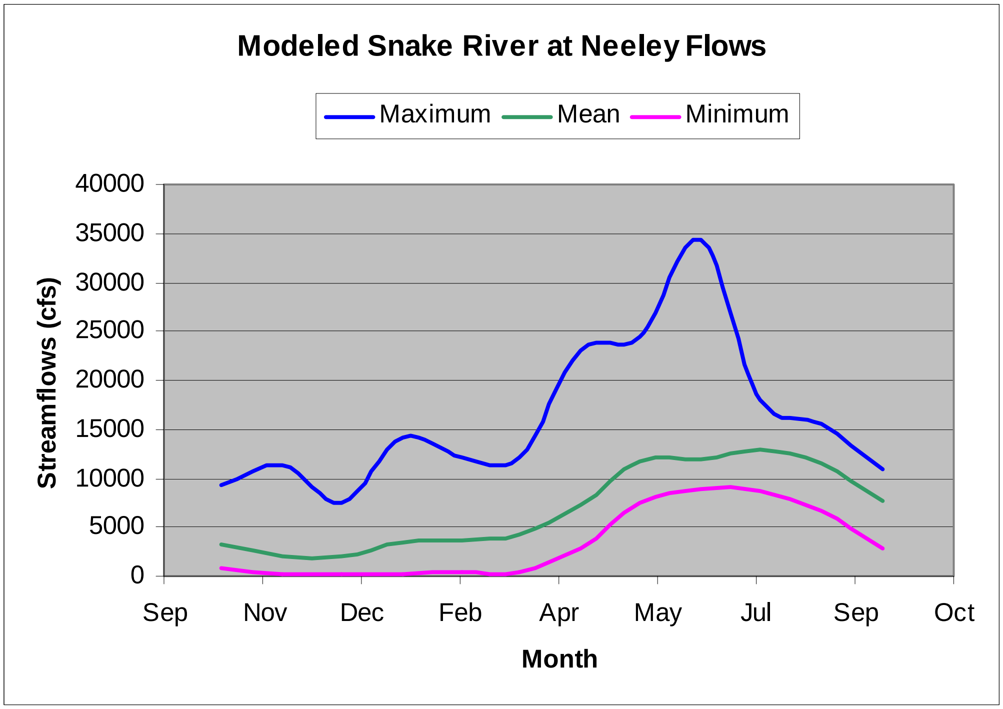

Figure 4-7. Modeled summary hydrograph of streamflows at the Snake River at Neeley gage under the proposed action.

will continue to be greater than 5,500 cfs. The model predicts flows will be above 5,500 cfs approximately 58 percent of the time.

Although not a legal minimum flow, 350 cfs is the target operational minimum for this reach. At flows below 350 cfs, cavitation occurs below the outlet gates in American Falls Dam. This was discovered in 1978, a dry year, when flows were reduced to approximately 200 cfs for two months. Therefore, future flows less than 350 cfs are highly unlikely. Under the proposed action, the monthly mean flow at the Neeley reach below American Falls Reservoir is predicted to be 350 cfs or less in 5 percent of years. Despite this, high levels of mortality are possible during the fall and winter months of a low water year following successive high water years. The proposed action will have similar impacts to Utah valvata as past operations.

Leading into and following irrigation season, Reclamation ramps its flows to meet irrigation demands. Ramping rates are not pre-determined or standard; rather, they are general rates established to ensure the safety of downstream river users. Ramping rates at American Falls Dam are set to not exceed a 0.5-foot-change in river stage per two-hour period. Snail mortality still occurs as few snails appear to move with the receding water.

Again, flow-based habitat availability data are lacking to accurately describe the relationship between discharge from American Falls Reservoir and the area of available Utah valvata habitat. It should be noted that the reach from below American Falls Reservoir to the upper end of Lake Walcott contains the highest densities of New Zealand mudsnails collected during Reclamation snail monitoring activities over the past four years (up to 607 per m^2). No information is available indicating whether or not the New Zealand mudsnail benefits from Reclamation operations.

Future O&M in the Snake River system above Milner Dam will result in Utah valvata mortality in American Falls Reservoir. Research conducted by Reclamation personnel from 2002 to 2003 indicate that the fluctuation of American Falls Reservoir prevents Utah valvata from occupying much of the reservoir. Figure 4-8, on page 94, shows the predicted percentage of Utah valvata habitat exposed, assuming all substrate is Utah valvata habitat, for American Falls Reservoir elevations at or below 4,311 feet. Figure 4-8 is not an empirical predictive model but rather is a general regression between water surface elevation and percent of Utah valvata habitat exposed. It is based on several assumptions. First, it assumes a direct relationship between water surface elevation and Utah valvata habitat. Second, it assumes all of the substrate is Utah valvata habitat. Third, it assumes 100 percent Utah valvata mortality once habitat becomes exposed. One-hundred percent mortality is not possible with water level fluctuation alone since Reclamation cannot completely dewater the reservoir. Figure 4-9, also on page 94, shows the number of years the model predicts American Falls Reservoir would have fallen to a minimum annual water surface elevation over the period of record from 1928 to 2000.

Future O&M in the Snake River system above Milner Dam will cause mortality in the Snake River below American Falls Dam in the Neeley reach. Reclamation's proposed actions will dewater approximately 23 to 50 percent of the Utah valvata habitat available in this reach in any given year. However, mortality will vary with preceding water years. Mortality can be expected to range from 2 to 50 percent in any given year.

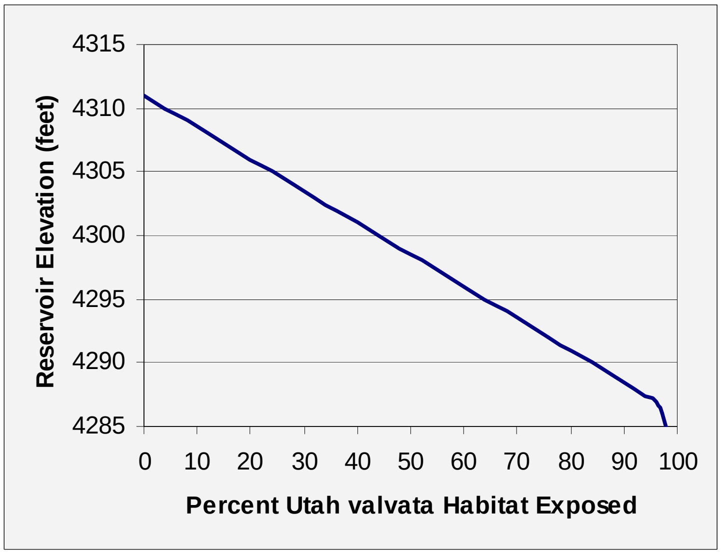

Figure 4-8. Percent of Utah valvata habitat exposed at given American Falls Reservoir elevations, assuming a direct relationship between mortality and water surface elevation.

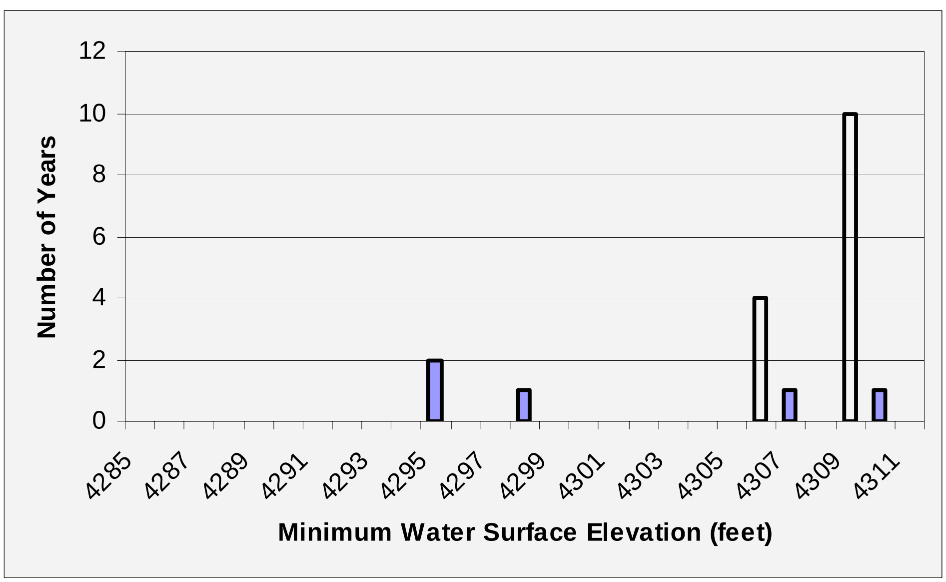

Figure 4-9. Number of years in 72 years that American Falls Reservoir will be drafted to minimum elevation under the proposed actions for water conditions simulating the period of record from 1928 to 2000.

4.7.3 Snake River from Lake Walcott to Milner Dam

Aquatic snails in this river reach are in the action area for future O&M in the Snake River system above Milner Dam.

Reclamation (2004) describes the operation of Minidoka Dam. Lake Walcott is held at full pool (elevation 4,245 feet) during the irrigation season to allow irrigation flows into the Minidoka Northside and Minidoka Southside Canals. Following irrigation season, Lake Walcott is drawn down five feet to elevation 4,240 feet to prevent ice damage to the spillway structures. Under the proposed action, ramping will not take place at Minidoka Dam. Past ramping operations did not benefit Utah valvata, as the snails did not appear to move with the receding water. During dry years, Lake Walcott can be drawn down near the end of irrigation season to provide storage water for irrigation purposes.

During the winter, Minidoka Dam passes inflow that comes from American Falls Reservoir releases and from reach gains (a total of 150 to 250 cfs). Outflow as low as 60 cfs is possible during the spring immediately prior to the irrigation season when Minidoka Dam is being raised to full pool (see Figure 4-10). The channel's shape from Minidoka Dam downstream to Milner Pool keeps much of the channel watered, even during flows below 400 cfs. The model predicts flows this low approximately 9 percent of the time.

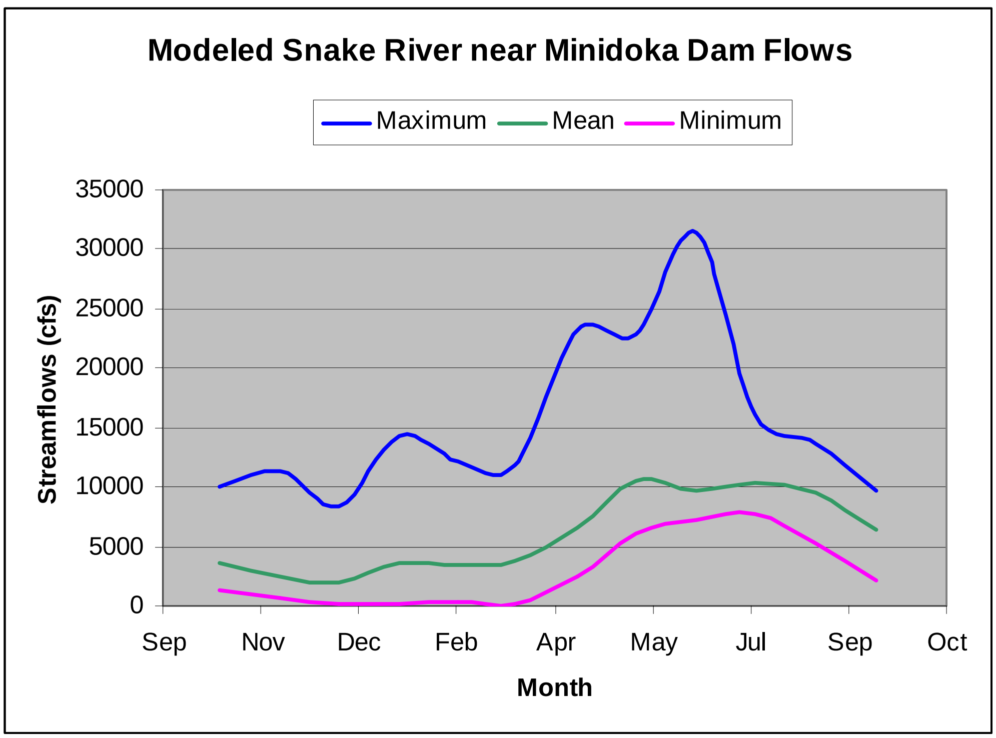

Figure 4-10. Modeled summary hydrograph of streamflows at the Snake River near Minidoka Dam gage under the proposed action. Lowest flows displayed on the hydrograph are 60 cfs in mid-March.

Utah Valvata

The annual drawdown of Lake Walcott prevents Utah valvata from recolonizing the shallower shoreline habitat in the reservoir; this results in little impact to the existing population (Petersen et al. 2000; Weigel 2002, 2003). In Lake Walcott, less than 1 percent of Utah valvata snails sampled during monitoring occupied the reservoir fluctuation zone. Thus, expected stranding will be less than 1 percent of the reservoir's Utah valvata population. The density of stranded Utah valvata in Lake Walcott ranges from 2.0 to 3.5 snails per m^2 in Utah valvata habitat (fines to small gravel with fines) (Weigel 2002, 2003).

Under the proposed action, Utah valvata will likely continue to disperse into the spillway area below Minidoka Dam; this will result in stranding and mortality during the annual dewatering period.

Flows in the 7.5-mile reach from Minidoka Dam downstream to Milner Pool fluctuate annually; however, they are relatively constant compared to other reaches of the river. Few listed snails have been documented in this reach. Utah valvata were documented between Minidoka Dam and the Jackson Bridge in 1996 and 1997 (Ralston 1997, 1998). Reclamation surveyed for snails between Minidoka Dam and Jackson Bridge monthly from August through October in both 2000 and 2001, but no listed snails were identified (Weigel 2002). Little fine sediment habitat existed in the reach between Minidoka Dam and Milner Pool for Utah valvata colonization. This is likely a result of high flows in May and June 1997. However, depositional bars are beginning to occur within this reach; therefore, it is likely that Utah valvata have since recolonized portions of this reach, but no further surveys have been conducted. Fines become more prevalent in upper Milner Pool, but no Utah valvata surveys have been conducted there.

As flows drop below 400 cfs, Utah valvata mortality via stranding will begin to occur. No studies have been conducted in this reach to quantify the relationship between listed snail habitat and flow. However, based on observation at various flows, listed snail habitat starts to become exposed at flows less than 400 cfs below Minidoka Dam downstream to Jackson Bridge. The proposed action does not increase or decrease the frequency or threshold of this occurrence.

Reclamation's actions will result in very low levels of mortality in Lake Walcott. Each year, under the proposed action, less than 1 percent of the Utah valvata population will be lost to stranding.

Future O&M in the Snake River system above Milner Dam will result in Utah valvata mortality in the spillway area below Minidoka Dam following irrigation season each year. This mortality will be very low considering densities of 1 live Utah valvata per 0.25 m^2 were found in 3.3 percent of the samples collected by Reclamation in 2002 and 2004. In the reach from Minidoka Dam downstream to above Milner Pool, Utah valvata mortality will occur when flows are reduced to below 400 cfs. The model predicts this will occur approximately 5 percent of the time.

Snake River Physa

The Snake River from Lake Walcott to Milner Dam does not possess the attributes consistent with Snake River physa habitat requirements. This reach has been generally considered outside of this species range, although it does exist within its designated recovery area (RM 553 to RM 675). Further, no known, verified specimens have ever been identified from this reach. As discussed earlier, Keebaugh (2004) recently discovered 4 suspected alive-when-sampled Snake River physa and 12 empty shells collected by Reclamation consultants in 1996 below Minidoka Dam. If the specimens are verified as Snake River physa after completion of this biological assessment, Reclamation will submit supplemental information.

4.7.4 Snake River from Milner Dam to Shoshone Falls

Aquatic snails in this river reach are in the action area for future O&M in the Snake River system above Milner Dam and provision of salmon flow augmentation from the rental or acquisition of natural flow rights.

Milner Dam is a large irrigation diversion structure with very limited storage capacity. It is privately owned and operated. After flood control operations are complete, typical operation of upstream facilities is to supply only enough water to meet the diversion demands of the canals diverting from the Milner Pool, Idaho Power contract storage, and salmon flow augmentation. Diversions from the Milner Pool have a combined capacity of approximately 11,000 cfs. These diversions consist of Reclamation project water and private natural flow rights.

Idaho Power has a contract for storage water in American Falls Reservoir, and Idaho Power usually orders its storage water at a rate of 230 cfs to meet conditions of its FERC license. Once Idaho Power's contract storage is exhausted and flow augmentation deliveries are complete, flow may be reduced to zero during the irrigation season in some years. The first 230 cfs (approximately) of flow below Milner Dam is directed through Idaho Power's small turbine at the right abutment of the dam's spillway structure and discharges immediately below the dam. The next 5,450 cfs flows through the first 1.6 miles of the Twin Falls South Side Canal to Idaho Power's Milner Hydroelectric Project. Additional flow, above approximately 5,680 cfs, is released through the dam's spillway. Winter flows below Milner Dam consist of water released from Minidoka Dam and local reach gains.

All Idaho Power facilities below Milner Dam are privately owned, and their operations are private actions and not associated with any proposed action, with the exception of its use of its American Falls Reservoir storage water.

Under the proposed action, augmentation flow releases may slightly increase flows past Milner Dam. It is unknown what, if any, effects this increase in flow will have on listed snails in the Snake River between Milner Dam and Shoshone Falls. Listed snail presence would have to be determined before any potential impacts resulting from augmentation flows could be assessed. The proposed action involves modifying the Milner Flow agreement to pass up to 3,000 cfs past Milner Dam when providing flow augmentation (see Chapter 3 for a discussion of this maximum flow and the modeled output). This is an increase from the 1,500-cfs operation in the past, which will result in a shorter release period. Figure 4-11 displays a modeled summary hydrograph of the streamflows under the proposed action for this gage.

Reclamation has not conducted any listed snail surveys downstream from Milner Dam and is not aware of other surveys that have been conducted in this reach; none of the four aquatic snail species are thought to occur there.

Utah Valvata

Although this reach is within the Utah valvata's designated recovery range, the species is not known to occur in the reach from Milner Dam to Shoshone Falls.

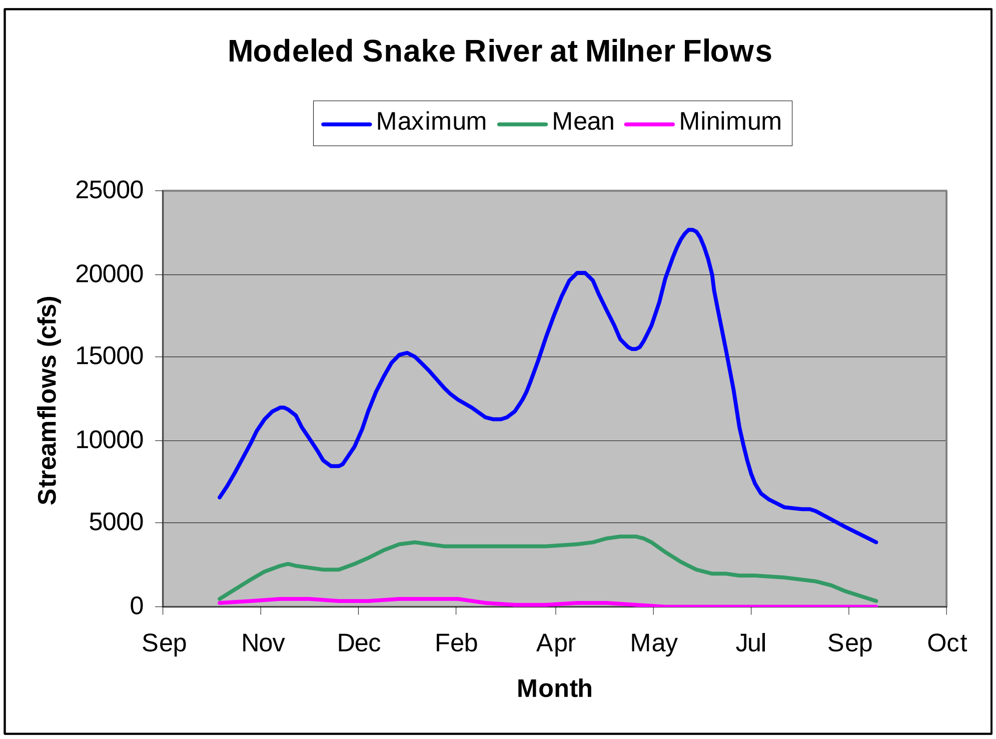

Figure 4-11. Modeled summary hydrograph of streamflows at the Snake River at Milner gage under the proposed action (this gage is below the Idaho Power powerhouse at Milner Dam).

Snake River Physa

Although this reach is within the Snake River physa designated recovery range, the species is not known to occur in the reach from Milner Dam to Shoshone Falls. This reach does, however, possess the attributes consistent with the suspected Snake River physa habitat requirements identified in the literature.

4.7.5 Snake River from Shoshone Falls to above Brownlee Reservoir

Aquatic snails in this reach occur in some or all of the action areas for future O&M in the Snake River system above Milner Dam; future operations in the Little Wood River system; future O&M in the Owyhee, Boise, Payette, and Malheur River systems; and future provision of salmon flow augmentation from the rental or acquisition of natural flow rights. This effects discussion considers the combined effects of those relevant proposed actions.

Reclamation does not own or operate any dam, diversion, or water withdrawal structure in the Snake River from Milner Dam downstream to Brownlee Reservoir with the exception of four pumping stations near Marsing, Idaho. All Idaho Power facilities below Milner Dam are privately owned, and their operations are private actions not associated with the proposed actions. However, Reclamation's storage, release, and diversion of water have hydrologically influenced this area during most average and low water years and will continue to do so.

Idaho Power owns and operates five hydroelectric projects on the middle Snake River: Shoshone Falls, Upper Salmon Falls, Lower Salmon Falls, Bliss, and C.J. Strike. All four of the listed snails covered under this consultation occur in this reach. Idaho Power is subject to consultation through the FERC relicensing process. Idaho Power's operations in this reach directly affect the river operations and habitat.

Under the proposed actions, augmentation flow releases during average to dry water years may slightly increase flows in this reach from current operations. The model predicts an increase from current operations of 147 cfs in minimum annual discharge at the Snake River near Murphy, Idaho. The effects of Reclamation's proposed actions will be attenuated and negligible in this reach of the river. The effects of Reclamation water releases in the past seem to have had a negligible impact on river stage at the Idaho Power facilities below Twin Falls (USBR 1996). An increase in flow augmentation releases from 1,500 cfs to 3,000 cfs will have a negligible impact on listed snails in this reach.

Reclamation is unable to distinguish any likely effects to listed snails attributable to the proposed actions.

Utah Valvata

Utah valvata are known to exist in this reach in Upper Salmon Falls Reservoir approximately one mile upstream from an Idaho Power dam (USFWS 2004). The population in Upper Salmon Falls Reservoir is the only population identified in this reach that occurs in the mainstem Snake River. Flow augmentation releases at Milner Dam will result in less than a 0.5-foot fluctuation at Upper Salmon Falls Reservoir where the snail occurs (see Figure 4-12), it is anticipated that no Utah valvata mortality will be attributable to this change.

Effects from future O&M in the Snake River system above Milner Dam and provision of salmon flow augmentation from the rental or acquisition of natural flow rights to this population of Utah valvata are insignificant relative to Idaho Power's actions and other impacts to the Snake River above this point to Milner Dam. Utah valvata mortality downstream from Milner Pool will not result from the proposed actions.

Snake River Physa

Although very little is known about the distribution, habitat requirements, or status of the Snake River physa, much of its designated recovery range is within this reach, extending downstream to RM 553. Flow augmentation releases at Milner Dam will

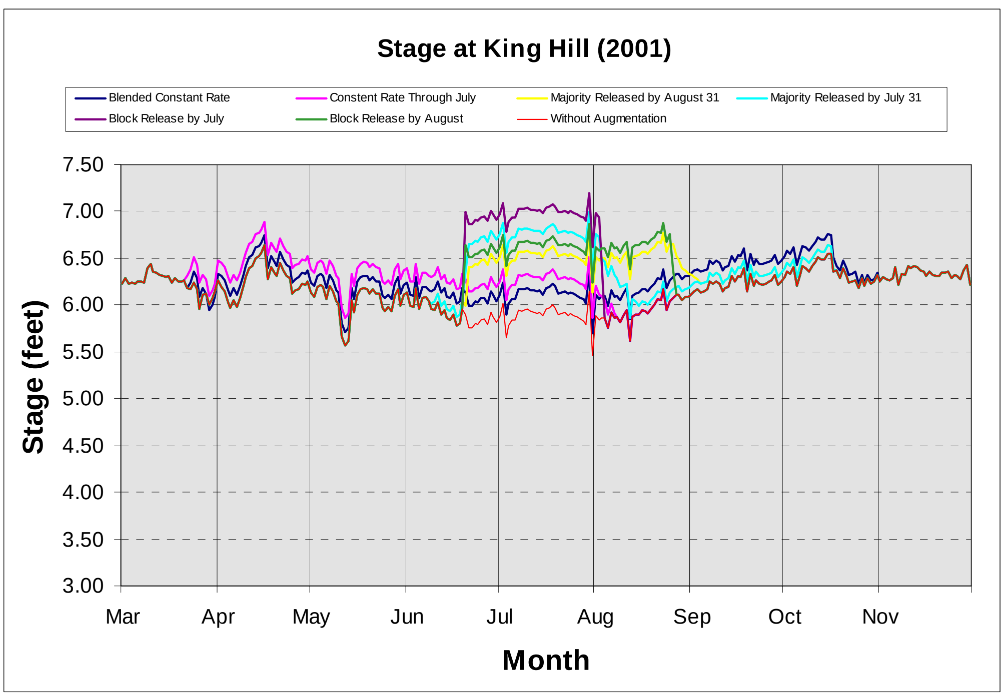

Figure 4-12. Snake River stage at King Hill under various salmon augmentation flow release strategies from Milner Dam. The yellow line most accurately portrays the proposed release strategy for the augmentation water. The red line represents river stage without augmentation.

result in less than a 0.5-foot fluctuation (increase) in river stage at King Hill (RM 546.6) where the snail may occur (RM 487 to RM 573). It is anticipated that no Snake River physa mortality will be attributable to this change.

The effects from future O&M in the Snake River system above Milner Dam, provision of salmon flow augmentation from the rental or acquisition of natural flow rights, and future operations in the Little Wood system become attenuated and insignificant in the reach relative to other local factors. Snake River physa mortality downstream from Milner Pool will not result from the proposed actions.

Bliss Rapids Snail

Although the Bliss Rapids snail is primarily associated with spring tributaries, the snail is found in the mainstem Snake River from RM 547 to RM 585. Flow augmentation releases at Milner Dam will result in less than a 0.5-foot fluctuation (increase) in river stage at King Hill (RM 546.6), which occurs immediately below the Bliss Rapids snails known distribution (RM 547 to RM 610.5). It is anticipated that no Bliss Rapids snail mortality will be attributable to this change.

The effects from future O&M in the Snake River system above Milner Dam, provision of salmon flow augmentation from the rental or acquisition of natural flow rights, and future operations in the Little Wood system become attenuated and insignificant in this reach relative to the direct effects from agricultural inputs, fish farm effluent, dairy effluent, urbanization, spring input, irrigation return flows, tributary input, localized runoff, and Idaho Power operations. Bliss Rapids snail mortality will not result from the proposed actions.

Idaho Springsnail

The Idaho springsnail occurs in this reach from the upper end of Brownlee Reservoir at Cobb Rapids (RM 339.3) upstream to the Bancroft Springs area (RM 553) (Cazier 2002). Idaho Power's operations and other previously described local impacts that occur in this reach collectively alter the availability and quality of Idaho springsnail habitat in this reach. Flow augmentation releases at Milner Dam will result in less than a 0.5-foot fluctuation (increase) in river stage at King Hill (RM 546.6); this is an increasingly negligible net change in river stage within this reach. Any effects become attenuated with these local factors and become increasingly insignificant relative to local factors in farther downstream reaches. The seven proposed actions will not result in Idaho springsnail mortality.

4.7.6 Cumulative Effects

Cumulative effects include the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the action areas. Future Federal actions that are unrelated to the proposed actions are not considered in this section because they require separate consultation.

A large number of activities occur in the action areas, such as agriculture, aquaculture, sewage treatment, construction, rural and urban development, degradation of waterways and springs, and contaminant spills. Municipal and industrial wastewater returns, agricultural returns, fish farm effluent, and spring input, including the Thousand Springs area and Box Canyon where large volumes of high quality water are input into the Snake River, may affect the listed snails to some degree. These activities will continue to occur into the future, and their effects constitute cumulative effects.

Section 303 of the Clean Water Act requires states and tribes to periodically publish a priority list of impaired waters, currently every two years. For waters identified on this list, states and tribes must develop TMDLs, which are water quality improvement plans that establish allowable pollutant loads set at levels to achieve water quality standards. The State of Idaho has been completing Subbasin Assessments and TMDLs in southern Idaho for some time now. The following TMDLs address the Snake River and many tributaries from the Bingham/Bonneville County Line downstream to King Hill, Idaho:

- Middle Snake River Watershed Management Plan (Total Phosphorus Only) – approved by the EPA in April 1997 (covers 94 miles between Milner Dam and King Hill, Idaho). Pollutant of concern is total phosphorus.
- Upper Snake Rock Watershed Management Plan – approved by the EPA in August 2000 (covers 14 stream segments of the Snake River within the same 94 miles between Milner Dam and King Hill, Idaho). Pollutants of concern are sediment, nutrients (phosphorus and nitrogen), pathogens (fecal coliform bacteria), ammonia, pesticides, and oil and grease.
- Lake Walcott Subbasin Assessment and Total Maximum Daily Loads – approved by the EPA in June 2000 (covers the Snake River between American Falls Dam and Milner Dam). Pollutants of concern are sediment, dissolved oxygen, nutrients, pesticides, and oil and grease.
- American Falls Subbasin Total Maximum Daily Load Plan: Subbasin Assessment and Loading Analysis – Public comment period closed in August 2004 (covers the Snake River from the Bingham/Bonneville County Line to American Falls Dam). Pollutants of concern are sediment, nutrients, bacteria, and dissolved oxygen.

The following TMDLs address the Snake River from King Hill, Idaho, downstream to the confluence of the Salmon River:

- Snake River-King Hill - C.J. Strike Reservoir Watershed: Subbasin Assessment and TMDLs – currently under internal review by the Idaho Department of Environmental Quality (covers the Snake River from King Hill downstream to C.J. Strike Dam). Pollutants of concern are sediment, nutrients, and pesticides.
- Mid Snake River/Succor Creek Subbasin Assessment and Total Maximum Daily Loads – approved by the EPA in January 2004 (covers the Snake River between C.J. Strike Dam downstream to the confluence with the Boise River). Pollutants of concern are nutrients, dissolved oxygen, sediment, temperature, and bacteria.
- Brownlee Reservoir (Weiser Flat) Subbasin Assessment and Total Maximum Daily Loads – approved by the EPA in November 2003 (covers the Snake River between the Weiser River and Brownlee Dam). Pollutants of concern are sediment, nutrients, and temperature.
- Snake River – Hells Canyon Total Maximum Daily Loads – approved by the EPA in September 2004 (covers the Snake River between where it intersects with the Oregon/Idaho border downstream to upstream of the confluence with the Salmon River). Pollutants of concern are bacteria, nutrients, nuisance algae and dissolved oxygen, pesticides, pH, sediment, temperature, and total dissolved gas. A mercury TMDL has been postponed to 2006 due to lack of water column data.

Most of the TMDLs would not be considered fully implemented at this time. TMDLs set timelines for evaluation of attainment, not necessarily attainment due dates. TMDLs and their associated implementation plans are understood to be in effect until attainment of the TMDL and/or beneficial uses are met. In some cases, the maximum daily loads may not be met within the 30 years of this consultation. Implementation, however, should be ongoing for at least the entire 30 years or until the water body no longer appears to be impaired, whichever occurs first. TMDLs do have periodic review schedules in place (usually about every five years) when water quality status will be reevaluated and implementation plans may be updated.

The implementation phase of these TMDLs should result in improved water quality for the Snake River within and downstream from these reaches. Implementation includes numerous activities with the goal of reducing pollutant loads to the established TMDL limits. Although most implementation recommendations are voluntary, individuals and groups have made sincere efforts to improve water quality conditions.

Many canal companies and irrigation districts have taken proactive steps to reduce non-point source sediment and nutrient loading. Two examples of the efforts that these organizations have made are the Twin Falls and North Side Canal Companies. The Twin Falls Canal Company has installed about 120 sediment detention basins over the last 14 years to reduce sediment moving from their systems into the Snake River. The North Side Canal Company has been reducing their return flows, thereby reducing their nutrient and sediment loads to the Snake River. They have achieved nearly a zero discharge back to the Snake River by automating their systems and increasing the reuse of their tailwater. The efforts associated with implementation of the TMDLs have reduced sediment and nutrient loading to the mid-Snake River.

4.8 Effects Conclusion

4.8.1 Future O&M in the Snake River System above Milner Dam

Reclamation has determined that future O&M in the Snake River system above Milner Dam may affect and is likely to adversely affect Utah valvata in the Snake River and Henrys Fork above American Falls Reservoir, in American Falls Reservoir, below American Falls Dam, in Lake Walcott, and below Minidoka Dam.

Adverse effects to Utah valvata in the Snake River above American Falls Dam include unquantified effects due to stranding and mortality from flow fluctuations.

Adverse effects to Utah valvata in American Falls Reservoir include stranding and mortality when the reservoir is drawn down to an elevation lower than successive previous years' elevations. An elevation of 4,311.4 feet should be used as a benchmark. This is expected to occur in 26 percent of years (see Figure 4-9 on page 94) and dewater up to 65 percent of potential habitat (see Figure 4-8 on page 94)

Adverse effects to Utah valvata below American Falls Dam include stranding and mortality, ranging from 2 to 50 percent, when flows begin to drop below 5,500 cfs in 42 percent of years, and then down to 350 cfs in 5 percent of years.

Adverse effects to Utah valvata in Lake Walcott include stranding and mortality of less than 1 percent of the population annually when the reservoir is drawn down at the end of the irrigation season.

Adverse effects to Utah valvata below Minidoka Dam include stranding and mortality in the spillway below the dam during the annual dewatering period, and stranding and mortality when flows in the mainstem Snake River are less than 400 cfs about 5 percent of the time.

4.8.2 Combined Effects of Seven Proposed Actions in the Snake River above Brownlee Reservoir

Reclamation has determined that future O&M in the Snake River system above Milner Dam; future operations in the Little Wood River system; future O&M in the Owyhee, Boise, Payette, and Malheur River systems; and future provision of salmon flow augmentation from the rental or acquisition of natural flow rights may affect but are not likely to adversely affect the Snake River physa, Bliss Rapids snail, and Idaho springsnail.

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Chapter 5 BALD EAGLE

5.1 Status

The USFWS currently lists the bald eagle (*Haliaeetus leucocephalus*) as threatened in the lower 48 states. The USFWS initially listed the bald eagle as an endangered species in 43 lower states and as a threatened species in the remaining 5 lower states. Bans on DDT and other persistent organochloride pesticides, habitat protection, and a growing public awareness of the bald eagles' plight helped bald eagle populations steadily increase. This increase led the USFWS to reclassify the bald eagle in 1995 from endangered to threatened in all lower 48 states (60 FR 35999).

The bald eagle population continues to grow, and numeric delisting goals for the region have been met since 1995. In July 1999, USFWS published a proposed rule to remove the bald eagle from the list of endangered and threatened wildlife in the lower 48 states (64 FR 36453). Though recovery goals are being met, there has been no further formal action to delist the species.

5.2 Distribution

5.2.1 Historical Distribution

Historically, the bald eagle used most of the North American continent for breeding, nesting, and foraging (USFWS 1986). The wintering range included most of the breeding range from southern Alaska and Canada to the south (USFWS 1986).

5.2.2 Current Distribution

In 1998, bald eagles nested in all but 2 of the lower 48 states (64 FR 36453).

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 (California, Idaho, Montana, Nevada, Oregon, Washington, and Wyoming) (USFWS 1994). Occupied breeding territories surveyed in Oregon increased from 20 in 1971 to 416 in 2003 (Isaacs and Anthony 2003). The number of occupied territories in Idaho increased from 11 in 1979 to 147 in 2003

(Sallabanks 2003b). These numbers are all-time highs for both states. Within the action area in Wyoming, the number of active territories has remained constant at 37 in the last three years because the habitat is likely saturated (Patla 2004).

Wintering bald eagles primarily use open ice-free water near concentrated food sources. Mid-winter bald eagle surveys have tracked wintering populations. Wintering populations are difficult to assess because the weather and concentrations of food on which they depend can vary significantly year to year. However, the Pacific Northwest supports a significant portion of wintering bald eagles in the lower 48 states (USFWS 1986).

5.3 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. Figure 5-1 shows a bald eagle approaching its nest. A clutch of one to three eggs is laid and incubated mostly by the female for about 35 days. The young fledge in 72 to 75 days. Often, the older, stronger bird kills its younger, weaker sibling in the competition for food. Bald eagles require 4 to 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.

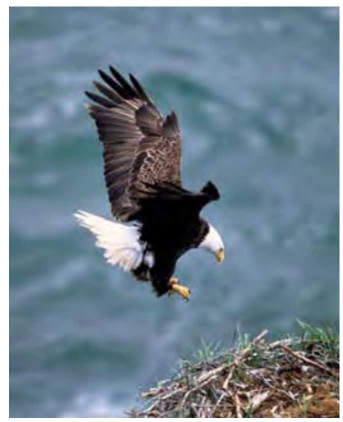

Photo by USFWS

Figure 5-1. Nesting bald eagle.

5.4 Habitat Requirements

5.4.1 Nesting Habitat

In the Pacific Northwest, bald eagles typically nest in multi-layered coniferous stands with old-growth trees and 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). However, the species of tree used for nesting varies. In Idaho, nests are typically found in large cottonwoods, ponderosa pines, and Douglas firs (USFWS 1986). Wyoming nests have been reported in a variety of forest types, including old-growth ponderosa pine and narrow strips of forest vegetation surrounded by rangeland. Bald eagles generally avoid building nests 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.

5.4.2 Wintering Habitat

Bald eagles winter in the Pacific Northwest from approximately November through March and are primarily associated with open, ice-free water near concentrated food sources (such as anadromous fish runs or high concentrations of waterfowl). Important habitat features include perch trees that 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 diurnal perch sites (USFWS 1986), although both are invariably near concentrated food sources. Roost sites tend to provide more protection from weather and tend to be located in unevenly-aged forest stands with some old-growth forest structure. Conifers might be 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.

5.4.3 Foraging Habitat

Throughout their range, bald eagles are opportunistic foragers. In the Pacific Northwest, bald eagles consume a range of foods, including a variety of fish, waterfowl, jackrabbits, and mammalian carrion (USFWS 1994). Bald eagles tend to prefer both game and non-game fish species, but this diet depends 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).

5.5 Factors Contributing to Species Decline

The use of DDT and other organochloride pesticides, shooting, poisoning, and habitat degradation have primarily caused the decline in bald eagle numbers. Most of the factors that prompted the listing of the bald eagle have been eliminated or greatly improved, and this has led to the recovery of bald eagle populations in most of its historical range. The United States banned the use of DDT and related pesticides in the early 1970s, and except for geographically isolated areas, the concentration of its residues and other contaminants in the environment affecting bald eagles has declined significantly (64 FR 36453). Shooting and poisoning of bald eagles have been greatly reduced since the passage of the Bald Eagle Protection Act in 1940 and increases in public awareness. The threat of lead poisoning from eating waterfowl wounded with lead shot has been reduced since the 1991 requirement to use non-toxic shot in waterfowl hunting.

Based on increasing population trends, neither nesting nor wintering habitats appear to be limiting, and there are no indications that availability of these habitats will be limiting in the near future (64 FR 36453).

Human disturbance to bald eagles, especially at nest sites, is a continuing threat and may increase as both bald eagle and human populations expand. Numerous studies have documented that human disturbance will flush most bald eagles from nest sites (64 FR 36453). Repeated disturbances may cause the nest to fail. Electrocution is also an ongoing problem in some areas where power lines have not been modified to prevent raptor electrocution.

5.6 Recovery Efforts

After initial ESA listing, the USFWS initiated a recovery program for bald eagles and divided the lower 48 states into five bald eagle recovery regions. Separate recovery teams composed of species experts in each geographic area prepared regional recovery plans. The teams established recovery goals and identified tasks to achieve those goals. The Snake River basin is within the Pacific Recovery Region that includes California, Idaho, Montana, Nevada, Oregon, Washington, and Wyoming. The Pacific Bald Eagle Recovery Plan (PBERP) was approved in 1986 (USFWS 1986).

The PBERP numeric delisting goals have been met since 1995 (64 FR 36453). These delisting requirements include:

- A minimum of 800 nesting pairs.
- 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.
- Breeding population goals met in at least 80 percent of the management zones.
- Stable or increasing wintering populations.

Productivity in the Pacific Recovery Region has averaged about 1.0 young per occupied breeding area since 1990 (64 FR 36453). The average success rate for occupied breeding areas exceeded 65 percent for the 5-year period ending in 1999. For 1998, six of the region's seven states reported an average success rate of 75 percent. The number of occupied breeding areas exceeded 800 in 1990 and has continued to increase, with an estimated 1,480 occupied breeding territories in 1998.

The bald eagle population in the Pacific Recovery Region is currently five times larger than when the recovery team developed the Pacific Recovery Plan.

The plan goal for distribution among management zones is not yet fully achieved for all areas; however, these zone targets were based on estimates made at the time, and some zones that still lack nesting may not contain preferred habitat (64 FR 36453) As of 1999, 28 of 37 (76 percent) of the 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.

5.7 Current Conditions in the Action Areas

The bald eagle occurs within the action areas for all 11 proposed actions.

It is difficult to quantify the effects of past operation of Reclamation projects on bald eagles. The decline in bald eagle numbers from organochloride pesticides and other factors prior to the beginning of the species recovery in the 1970s was so overriding throughout the bald eagle's range that effects from O&M of Reclamation's dams and reservoirs were largely difficult to discern. Organochloride pesticide residues and other toxic and persistent chemicals that led to the bald eagle's steep decline across the United States are no longer a problem except in a few geographically isolated areas (64 FR 36453).

In general, the construction and past operation of Reclamation and other Federal and private dams have altered the native riparian habitats in much of the action areas. Dams have altered flood cycles and allowed development to occur in the former floodplain, which may have reduced the number of large cottonwood trees used by eagles as perches in some downstream river reaches.

Conversely, reservoirs typically provide a plentiful source of prey for bald eagles. Indeed, breeding territories tend to be clustered around some reservoirs. Although pre-Reclamation dam information is not available, the storage of water has likely enhanced foraging habitat for nesting bald eagles in areas like Lake Cascade, Anderson Ranch Reservoir, and Arrowrock Reservoir since there are comparatively fewer bald eagle breeding territories in unaltered river reaches above the reservoirs.

The drafting of Reclamation reservoirs for irrigation and other project purposes during the summer does not provide ideal habitat for some fish species. This is particularly pronounced during drought years when Reclamation reservoirs usually experience substantial drawdown. Reduced reservoir volume directly affects the amount of aquatic environment for all organisms in the food web (USBR 2003), and reduction in the food base may limit the availability of fish as bald eagle prey.

In spite of seasonal drawdowns, Reclamation reservoirs do support abundant bald eagle prey in the form of fish and waterfowl. Even though deep drawdowns during drought periods have contributed to fish kills in reservoirs such as Lake Cascade (IDEQ 1996) and Anderson Ranch (Megargle 2004), this does not affect all species, and these reservoirs continue to support viable sport fisheries and relatively high number of productive bald eagle breeding territories. State fish and wildlife agencies also augment the bald eagle food supply with the annual stocking of native and non-native gamefish in and below reservoirs, and this likely has mitigated some of the adverse effects of drawdowns to bald eagle prey. Overall, there appears to be no direct correlation between drought periods and bald eagle occupancy or productivity in the action area.

The deep drafting of reservoirs during drought periods has also been shown to benefit wintering bald eagle foraging in the Boise River. Kaltenecker and Bechard (1995) and Salow and Hostettler (2004) indicated significant bald eagle predation on fish in braided shallow sections of exposed reservoir bottoms during extreme drawdowns.

Though bald eagles are sometimes tolerant of human activity, disturbance has been identified as a potential problem, particularly for breeding bald eagles (64 FR 36453). Disturbing eagles near their nests early in the breeding season can adversely affect bald eagle productivity. As bald eagle and human populations increased, so have human/eagle interactions. Interactions between eagles and recreationists are a potential problem at some Reclamation reservoirs, especially in areas where the adjacent private land has been developed.

Reclamation has prepared resource management plans (RMPs) for Reclamation-administered lands surrounding American Falls, Ririe, Cascade, and Black Canyon Reservoirs (USBR 1995a, 2001b, 2002, 2004). These RMPs address only land management and water-related recreation use and do not address operation of the reservoirs. For each of these planning processes, Reclamation consulted with USFWS under Section 7 of the ESA. All of the Reclamation RMPs prescribe management actions that preserve or enhance bald eagle habitat where applicable, with special protection for bald eagle nests. In addition to protective measures in the RMPs, Reclamation cooperated with other agencies to prepare site specific breeding territory management plans for nests at Arrowrock Reservoir and Lake Cascade (USFS et al. 1990; Perkins and Kaltenecker 2003, 2004; Kimball and Bechard 2002).

In the Snake River above Milner Dam, Reclamation is not a cooperator in any existing management plan. The nest on Ririe Reservoir is the only nest on Reclamation-managed land in this area, and there is not enough information available for this nest area to develop a specific plan. The Ririe RMP discusses this nest and describes a process for protection if recreation impacts occur (USBR 2001b). The nest is currently being monitored under a contract with the Fort Hall Business Council of the Shoshone-Bannock Tribes.

The USFS, also subject to Section 7 consultations for their resource management planning documents, manages much of the land surrounding the reservoirs in the action areas. Some site-specific territory management plans have been prepared. These documents provide guidance for protection of bald eagle breeding and important foraging areas.

The annual reports of Beals and Melquist (1995, 1996, 1997, 1998, 1999, 2000) and Sallabanks (2002, 2003a, 2003b) document bald eagle breeding success in Idaho. Isaacs and Anthony (2003) document breeding success in Oregon. Patla (2004) compiled productivity reports for the years 2001 through 2003 to describe breeding success in Wyoming. The following subsections incorporate data from these references without further citations.

5.7.1 Snake River above Milner Dam

The Snake River above Milner Dam supports the largest breeding population of bald eagles in the State of Idaho and a significant population of wintering bald eagles. The breeding population in this area has increased steadily since 1970 (GYBEWG 1996). In 1979, there were an estimated 11 occupied nest sites in Idaho. In 1996, there were 46 known occupied breeding territories in eastern Idaho alone and 90 sites statewide. Currently there are 57 territories that are routinely active in the Snake River basin above Idaho Falls, Idaho, and another 37 in Wyoming (there are additional nests in Wyoming within Management Zone 18 that are not part of the Snake River basin) (Whitfield et al. 2003). Table 5-1 presents occupation and production data for bald eagle territories in the Snake River basin above Idaho Falls, Idaho.

Table 5-1. Bald eagle territories in the Idaho and Wyoming portions of Management Zone 18, Greater Yellowstone Ecosystem, in 2003.

Management Zone 18	Idaho	Wyoming
Number of territories	57	43
Number occupied	56	42
Percent occupied	0.98	0.98
Number of young produced	56	39
Number of young/occupied territory	1.00	0.93

On the Idaho portion of the Snake River above Milner Dam, a series of 13 routes have been surveyed on an annual basis during the National Mid-Winter Bald Eagle Count (Steenhoff 1997). While wintering populations of bald eagles in Idaho have been monitored regularly since 1980, the information gained from this survey has limitations in its use. The total number of eagles for these 13 routes collectively has ranged from a low of 49 to a high of 241. Many variables, including weather conditions and inconsistency of route surveyors, make the interpretation of the data difficult. It is not possible at present to identify a clear trend for wintering bald eagle use of the Snake River in Idaho.

Anecdotal data presented in the 2002 Annual Productivity Report for the Greater Yellowstone Ecosystem (Whitfield 2002) indicated that wet, cool spring and low reservoir levels appear to have reduced overall productivity for 1993 until 2002 for Palisades and Island Park Reservoirs. This is the only mention of low reservoir levels affecting productivity in the annual reports reviewed. Sallabanks (2003b) reports that only the Hoffman nest on Palisades Reservoir was not occupied and that 5 of the 8 nests associated with Palisades and Island Park Reservoirs were successful even though the reservoirs were drawn down to their lowest elevations in several years. There are no definitive trend data available that show that reservoir drawdown has adversely affected breeding bald eagles in this area.

Snake River in Wyoming

Bald eagle populations have increased along the Snake River in Wyoming. Nesting surveys conducted between 1978 and 2003 by Wyoming Game and Fish Department (WGFD) and others show that breeding territories have greatly increased from an estimated 9 in 1978 to 36 regularly active nest areas along the Snake River, including 3 on Jackson Lake, 2 on the Salt River, and 1 on the Hoback River in 2003 (Harmata and Oakleaf 1992). Reclamation has no facilities on the Salt River, and Reclamation's operations do not hydrologically influence the Salt River.

It appears that fluctuating Jackson Lake reservoir elevations have had a benign effect on bald eagle use. Nothing in the literature indicates the 10-foot operational fluctuations affect the reservoir's three breeding territories, and in fact, during the 1985-to-1989 dam reconstruction drawdown of 35 feet, a bald eagle established a new and productive territory along Third Creek within a quarter mile of the reservoir's high water mark and one mile from the dam and construction area.

As indicated earlier, there is a possibility that the available nesting habitat may be saturated. Harmata and Oakleaf (1992) anticipated that increased human populations and recreational use will reduce bald eagle nesting habitat in the near future.

Because Jackson Lake ices over during winter, it is not known as a bald eagle wintering area. In the Snake River downstream from Jackson Dam, most of the breeding pairs are year-long residents and depend on the Snake River fish and waterfowl population as a main source of food. During the bald eagle nesting season, river levels have been adequate to maintain sufficient habitat for fish and waterfowl prey. The riverine environment and surrounding prey habitat provide an abundant prey base for nesting eagles. Past project operations have not precluded the increasing bald eagle nesting populations in this area.

An agreement with the State of Wyoming allows for reservoir releases that benefit the downstream fishery during winter months when conditions are the most critical. During low winter flows, this agreement provides for the release of flows necessary to maintain the fishery. Additionally, Reclamation has an informal agreement with Wyoming to maintain winter flows from the dam at less than 600 cfs to prevent the formation of frazzle ice, which can adversely affect the fishery.

Snake River from the Wyoming State Line to the Henrys Fork Confluence

The mainstem Snake River, with its extensive cottonwood forest, provides excellent wintering and breeding habitat. The number of eagles using the area for both wintering and breeding has steadily increased over the last 20 years.

Based on mid-winter counts, use of the mainstem has ranged from as few as a dozen eagles to as many as 70. As the population of eagles in the Greater Yellowstone Ecosystem has increased, winter use on the mainstem has also steadily increased. The cottonwood forest along the river provides virtually unlimited hunting perches and roosting opportunities immediately adjacent to the river, and the excellent fishery provides an abundant source of food. Of the mainstem nests, one was not occupied, three were unsuccessful, and the rest were successful.

Current monitoring activities include a total of 23 breeding territories along the mainstem river and Ririe Reservoir. Table 5-2 on page 120 shows several nests in the action area; it also shows that there is no discernable difference in bald eagle occupancy and success of nests associated with Palisades, Island Park, or Henrys Lake.

In the mainstem Snake River below Palisades Dam, low winter flows have been theorized to benefit native cutthroat trout; however, when flows drop below 1,200 cfs (as occurs during low water years) and temperatures are low, the shallow water in the side channels can ice over. Fish in these channels then become unavailable to foraging eagles. This is considered a minor loss as there remains a large fishery forage base in the main channel as well as forage sources in adjacent areas such as big game carrion.

Table 5-2. Bald eagle breeding territory occupancy and production in the Snake River system above Milner Dam within the State of Idaho from 1996 to 2003.

Nesting Territory	Nest Production [1]							
	1996	1997	1998	1999	2000	2001	2002	2003
Palisades Reservoir								
Hoffman East	Y2	Y1	Y0	Y0	Y0	N	Y2	Y0
Hoffman West/Trout Creek		Y2	N	N	N	N	N	Y2
Williams Creek	Y2	N	Y0	Y2	Y2	Y2	Y0	Y1
Van Point North	Y0	Y1	Y1	Y1	Y2	Y2	Y1	Y1
Van Point South		Y1	N	Y2	Y2	N	Y0	Y0
Edwards Creek		N	Y0	Y0	N	N	Y0	Y0
King Creek		N	Y0	Y2	Y2	Y1	Y0	Y0
Island Park Reservoir								
Bishop Lake	Y1	Y3	Y0	Y0	Y0	Y1	Y0	Y0
I.P. Bills Island	Y1	Y0	Y0	Y0	Y1	Y1	Y0	Y2
Henrys Lake								
Henrys Lake	N	Y0	Y1	Y1	Y2	Y1	Y1	Y1
Staley Springs	Y1	Y2	Y1	Y0	Y0	Y0	Y0	Y0
Summary Totals								
Young Produced	7	10	3	8	11	8	4	7
Occupied Territories	6	8	9	10	9	7	10	11
Successful Territories	5	6	3	5	6	6	3	5
Young / Occupied Territory	1.2	1.3	0.3	0.8	1.2	1.1	0.4	0.6
Young / Successful Territory	1.4	1.6	1.0	1.6	1.8	1.3	1.3	1.4

1 N is 'not occupied;' Y0 is 'occupied but no young fledged;' Y1 is 'one young fledged.'

High spring flows that inundate waterfowl nesting habitat probably do not measurably affect the presence or overall production of waterfowl. Waterfowl appear to be abundant along this reach throughout the year in most years and appear to be numerous enough to be a substantial portion of nesting bald eagles' diet.

Flood control operations from Palisades Reservoir operations may have reduced the availability of large black cottonwood trees bald eagles use for perching and nesting. Mature trees are currently available, but the reduction of seasonal flooding and building of new alluvial seed beds may be reducing germination of new trees. Following the 1997 flood, this does not appear to be nearly as significant. Additionally, within the proposed action, Reclamation will provide spring freshets that mimic natural flow conditions when possible (depending on water year type and carryover). The benefit of this strategy is currently being researched.

Henrys Fork and Tributaries

With its many rivers, streams, and lakes, the Henrys Fork drainage is well suited as bald eagle breeding habitat. Major aquatic resources include the Henrys Fork, Buffalo River, Henrys Lake, and Ashton, Island Park, and Sheridan Reservoirs. Excellent fishery and waterfowl habitat provide abundant foraging opportunities for reproducing eagles. Similar to the description for Jackson Lake reservoir drawdowns, nests at Island Park Reservoir and Henrys Lake were successful in 2003 even though the reservoirs were drawn down to low levels.

Nesting bald eagles extensively use the Henrys Fork drainage. The 24 known breeding territories in 1996 increased to 29 territories in 2003. Of these, 28 were occupied, 12 were successful, and 20 young were produced.

Records for wintering bald eagles in the Henrys Fork drainage are incomplete, which makes the available statistical analysis somewhat suspect. However, from the records that do exist, an average of 20 eagles can be found wintering along the Henrys Fork. Regulated winter flow releases from Island Park Reservoir have caused flows to drop below 200 cfs in about 33 percent of the years on record. At flows this low, juvenile fish can become dewatered, and over-winter survival of young-of-the-year rainbow trout is reduced in Box Canyon. This is likely an insignificant effect on the availability of forage fish in winter along the approximately 70-mile extent of the Henrys Fork.

There are no known records of nesting bald eagles at Grassy Lake. However, it is expected that migrating or dispersing eagles likely forage at this reservoir.

Snake River and Tributaries from the Henrys Fork to Milner Dam

This reach of the mainstem Snake River supports a large number of wintering bald eagles. Since 1980, mid-winter counts have documented as many as 100 eagles in this reach with an average of about 60 eagles. Above American Falls Reservoir, the mature cottonwood forests provide an abundance of day and night roosting opportunities adjacent to foraging areas on the Snake River. The river provides substantial fish and waterfowl populations as a source of food. Cottonwood habitat is limited below American Falls Dam.

The nest at Ririe Reservoir was not active in 2003, but an immature eagle was observed in Willow Creek. This suggests that there may be a second nest in the Ririe Reservoir vicinity (Whitfield et al. 2003). Reservoir drawdown at Ririe Reservoir does not appear to be a significant factor in this nest productivity. A large fishery and a protected wildlife management area remain in close proximity, and a low reservoir level provides additional space between the nest site and on-water recreation activities.

Winter project operations have little effect on bald eagles. Winter mortality of big game from an adjacent winter range provides carrion as an additional food source for nesting bald eagles early in the spring.

Ten recently active breeding territories have been identified upstream from Milner Dam, and they produced 15 young in 2003. These include a new breeding territory on Bird Island in Lake Walcott and a new nest in the Ferry Butte territory.

5.7.2 Snake River from Milner Dam to Brownlee Reservoir

The PBERP identifies one target breeding territory for this reach of the Snake River (the PBERP does not give specific locations for nests). This reach contains two historical bald eagle territories: one near Milner Dam and the other near Blue Lakes Country Club near Twin Falls. However, monitoring of these sites ended in 2002 after ten consecutive years of not being occupied.

This reach of the Snake River receives significant winter use. Complete counts conducted for a recent 10-year period record between 25 and 56 eagles on the river upstream from Brownlee Reservoir (Steenhoff 1997). Most of the wintering eagles are in the reach from Milner Dam to Grandview.

5.7.3 Snake River from Brownlee Reservoir to the Columbia River and the Columbia River to its Mouth

The PBERP identifies one target breeding territory for Brownlee Reservoir on the Idaho side. A new nest was discovered in 2003 on Birch Creek, a Brownlee Reservoir tributary near Farewell Bend, Oregon. There are three breeding territories in the Hells Canyon reach of the Snake River below Brownlee Dam: two on the Idaho side of the river below Oxbow Dam and one on the Oregon side above Oxbow Dam. All three are relatively new (the Idaho territories were discovered in 1998 and 2003 and the Oregon territory was discovered in 1999). All three nests have been very productive, fledging at least one young every year since their discovery. There are no known breeding territories on the Snake River below Hells Canyon Dam (Stinson et al. 2001; Davidson et al. 2004).

Bald eagles winter in substantial numbers in this reach of the Snake River and associated reservoirs with higher numbers in the Hells Canyon reach than in downstream areas (Isaacs et al. 1992; Stinson et al. 2001; Davidson et al. 2004). Eagles tend to concentrate around the reservoirs where reliable food sources such as fish, waterfowl, mammalian carrion, and ground squirrels are present, rather than the unimpounded river reaches (Holthuijzen 2003). Trees and cliffs used for perching are plentiful in the Hells Canyon reach, and 46 night roosts have been located

(Holthuijzen 2003). In the lower reaches, the vegetation is primarily shrub steppe, with few perches and potentially insufficient food supply (Davidson et al. 2004).

Clark and Maret (1998) identified potential problems for fish-eating wildlife and a potential human health risk from elevated concentrations of DDT and its metabolites and mercury in fish at Brownlee Reservoir. Dombrowsky et al. (2000) reviewed the data from Clark and Maret's study and conducted a screening analysis to evaluate the potential for adverse effects to fish-eating wildlife at Brownlee Reservoir. Their analysis indicated that even using conservative assumptions, the potential effects to fish-eating wildlife associated with the presence of the selected chemicals in fish tissue is low to non-existent with the exception of DDT/DDE. A more detailed analysis of the bioavailability of DDT/DDE is needed to assess the true potential for adverse ecological effects.

As noted in other areas, the number of wintering bald eagles varies considerably from year to year. From 1988 to 2000, the Idaho mid-winter bald eagle survey from Brownlee Dam to Hells Canyon Dam ranged from 11 eagles in 1992 to 104 eagles in 1996 (National Biological Information Infrastructure 2004). Holthuijzen (2003) conducted winter surveys on the Snake River from Weiser, Idaho, to the Salmon River confluence from 1993 to 1998 and found a high of 152 eagles in 1994 and a low of 68 eagles in 1998. Most of the eagles were observed in the reservoir pools and within a few miles below Hells Canyon Dam.

Bald eagles both nest and winter along the Columbia River. In 2003 there were 96 occupied breeding territories reported for the Columbia River Recovery Zone (Zone 10), an increase of 31 territories since 1999. Nearly all of the breeding territories and most wintering birds are found in lower reaches of the river below The Dalles (Stinson et al. 2001).

Bald eagle use of the lower Snake and Columbia Rivers is likely related to prey availability (resident fish and waterfowl) and other habitat factors such as the availability of perches and winter roost trees. The presence of breeding bald eagles and significant numbers of wintering eagles in the Hells Canyon reservoirs are due to an abundance of warmwater fish species as well as some salmonids and nongame species (Richter and Chandler 2001). Fish habitat in this reach is most influenced by Idaho Power's operation of its three dams. Reclamation's operations, including providing flow augmentation water, has not affected the reservoir levels in Brownlee Reservoir (the only reservoir in the Hells Canyon Complex with significant storage) since the shaping agreement at Brownlee Reservoir with Idaho Power was not renewed in 2001. Flow augmentation water is passed through the Hells Canyon Complex, and fluctuations in Brownlee Reservoir elevation are due mostly to flood control operations, fall Chinook flows, and power demands (Idaho Power 2003).

Reclamation's operations have not likely influenced flows and habitat for resident fish and waterfowl below Hells Canyon Dam. Flow augmentation provides an increase in late summer, but this is probably inconsequential for bald eagles that winter along the Snake River below Hells Canyon. It is reasonable to expect that any measurable effect to fish habitat would be most pronounced in the areas immediately below Hells Canyon and diminish with distance downstream. It is therefore unlikely that Reclamation's current operations above Brownlee Reservoir affect breeding and wintering bald eagles or their prey base in the lowest reaches of the Snake and Columbia Rivers.

5.7.4 Little Wood River Reservoir

The IDFG Conservation Data Center has no records of bald eagle winter or breeding use of the reservoir. There is an unoccupied historical nest located about 20 miles southwest on Silver Creek; this nest has not been active for quite some time and is no longer monitored. The only known breeding territory within Zone 17 of Idaho's portion of the PBERP is about 12 to 15 miles south at Carey Lake. Two young were produced from the 2003 nesting attempt.

5.7.5 Boise River System

The Boise River system experiences significant bald eagle use. Table 5-3 presents basin-wide yearly totals for young and territories. The subsections below provide bald eagle use in the river reaches and reservoirs with greater detail.

Upper Boise River and Anderson Ranch, Arrowrock, and Lucky Peak Reservoirs

Table 5-3 shows bald eagle territories, occupancy, and breeding success for Arrowrock and Anderson Ranch Reservoirs since 1995. Productivity has fluctuated with young per occupied nest ranging from 0 in 1999 to 1.5 in 2001. Fluctuations in productivity can be attributed to a variety of environmental factors. There appears to be no correlation with yearly variations in operation in the past (dry/wet years) that would indicate prey availability is significantly affected and is limiting bald eagle productivity.

Arrowrock Reservoir currently supports three breeding territories (including the two new territories occupied in 2000 and 2002). Two breeding territories are located on Anderson Ranch Reservoir and another is located just upstream near Featherville (Kaltenecker and Bechard 1995). The Boise River/Anderson Ranch area had one existing breeding territory when the PBERP was developed; the plan identifies two additional target recovery breeding territories for this area.

Table 5-3. Bald eagle breeding territory occupancy and production in the Boise and Payette River systems from 1995 to 2003.

Nesting Territory	Nest Production [1]								
	1995	1996	1997	1998	1999	2000	2001	2002	2003
Arrowrock Reservoir									
Arrowrock	Y0	Y1	Y2	Y1	N	Y1	N	Y2	Y1
Grouse Creek						Y3	Y2	N [2]	N [2]
Upper South Fork Arrowrock								Y0	Y0
Anderson Ranch Reservoir									
Powerline	Y1	Y?	Y1	Y2	N	Y2	Y2	?	Y1
Featherville	Y2	Y1	Y?	Y1	Y0	Y1	Y2	Y1	Y0
Camas Arm (1 and 2)				Y1	Y0	Y0	Y0	N	Y1
Lake Lowell									
Lake Lowell 1	Y0	Y2	Y0	N	Y1	Y1	Y1	Y0	Y0
Lake Lowell 2							Y2	Y0	Y0
North Fork Payette River below Payette Lake									
McCall Airport		Y2	Y2	Y0	N	Y1	Y0	Y1	Y1
Hait Ranch	Y0	Y1	Y2	Y2	Y2	Y2	Y2	Y2	Y0
Lake Cascade									
Donnelly	Y1	Y0	Y1	Y1	Y2	Y1	Y2	Y1	Y1
French Creek	Y1	Y1	Y3	Y3	Y2	Y1	Y2	Y1	Y2
Poison Creek	Y2	Y1	Y1	Y1	Y2	Y0	Y0	N [3]	Y0
Hurd Creek	N	Y1	Y1	Y1	Y0	Y0	Y0	N	N
Buttercup	Y2	Y2	N	Y2	N	Y2	Y2	Y2	Y2
Gold Fork	N	N	N	N	Y2	Y2	Y0	Y1	Y2
Sugarloaf	Y0	Y2	Y1	Y0	Y0	Y2	Y0	Y1	Y1
Raspberry				Y2	Y0	Y2	Y2	Y2	Y2
Island/Hot Spring Park							Y0	Y3	Y0
North Fork Payette River below Lake Cascade									
Cabarton	N	Y0	Y2	Y2	Y4	Y3	Y0	Y0	Y1
Boulder Creek						Y2	Y1	Y1	Y2
Smith's Ferry						Y0	Y0	Y0	Y0
Deadwood Reservoir									
Deadwood Reservoir		Y2	Y2	Y1	Y2	Y1	Y2	Y1	N
Summary Totals									
Young Produced	9	16	18	20	17	27	22	19	17
Occupied Territories	10	14	13	15	13	20	21	18	20
Successful Territories	6	11	11	13	8	15	12	13	12
Young / Occupied Territory	0.90	1.14	1.38	1.33	1.31	1.35	1.05	1.06	0.85
Young / Successful Territory	1.50	1.45	1.64	1.54	2.13	1.80	1.83	1.46	1.42

1 N is ‘not occupied;’ Y0 is ‘occupied but no young fledged;’ Y1 is ‘one young fledged.’

2 Tree blew down in 2001 after breeding.

3 Nest tree blew down in 2001.

Reclamation and USFS have jointly prepared management plans for the Arrowrock territory (Perkins and Kaltenecker 2003) and Upper South Fork of Arrowrock territory (Perkins and Kaltenecker 2004).

The upper Boise River, including the Middle and South Forks and Anderson Ranch, Arrowrock, and Lucky Peak Reservoirs, is considered an important wintering area for bald eagles. In their 2-year study of wintering bald eagles in the upper Boise River, Kaltenecker and Bechard (1995) found fairly heavy use at Anderson Ranch Reservoir (up to 50 eagles documented) and the South Fork Boise River below Anderson Ranch Dam (2 to 25 eagles). Arrowrock and Lucky Peak Reservoir areas also receive significant bald eagle use (up to 15 eagles). Eagles begin arriving in late October with peak numbers in late January or early February. Wintering bald eagles are usually gone by the end of March.

Wintering bald eagles in this area primarily eat fish early in the winter and big game carrion as winter progresses. River and reservoir icing in most years likely prompts this shift as fish become more difficult to capture and as deer and elk carcasses increase later in the winter (Kaltenecker and Bechard 1995). The bald eagles also take waterfowl as prey.

Lower Boise River

The Boise River downstream from Lucky Peak Dam is an important winter habitat for bald eagles with as many as 35 individuals counted in a single year (USFWS 1996; Riggins and Hansen 1992). Several studies of wintering bald eagles downstream from Lucky Peak Reservoir have been conducted, with most of the effort concentrated on the reach between Lucky Peak Dam and the city of Boise. Studies have shown that bald eagles usually arrive in early November, have the highest concentrations in January and February, and leave by late March. Very little is known about bald eagle use from Eagle Island to the mouth of the Boise River.

Large cottonwoods throughout the reach are important for eagle perching and visual buffers from human activity (USFWS 1996). Wintering eagles tend to perch throughout the area; they prefer wide areas of the river and pools in well-vegetated areas with high numbers of perches, and they seem to avoid areas of high human use. The Barber Pool area, immediately upstream from the city of Boise, appears to have special importance as a communal night roost.

Bald eagles wintering along the lower Boise River eat fish, waterfowl and other birds, and mammals. Hatchery rainbow trout appear to be important, but other fish species are also taken. Water temperature, nutrient, dissolved oxygen, and sediment problems in the lower Boise River, downstream from Star to the mouth, stem from various land use activities occurring in the watershed. This section of the lower Boise

River is generally unsuitable for coldwater fish species in many years. Wintering eagles likely turn to warmwater fish and waterfowl for forage.

Lake Lowell

Lake Lowell, located within the Deer Flat National Wildlife Refuge, is an important area for bald eagles. The lake has abundant prey (fish and waterfowl), suitable nesting and perching trees, and is relatively free of human disturbance for much of the year. Bald eagles nest and winter at Lake Lowell. Table 5-3 on page 125 shows the history for two breeding territories. These territories were not successful in 2002, 2003, and 2004 for unknown reasons (Fenzel 2004).

Reclamation operations at Lake Lowell during dry years have affected the gamefish population. During these dry years, the lake does not fill, and the woody hiding cover around the lake needed by small fish is not inundated. Also, the early spring drawdown in these dry years exposes fish eggs. These problems were particularly severe during the drought of the late 1980s and early 1990s when dam safety reasons prompted lower operational levels for the lake.

Deteriorating water quality from agricultural return flows and other causes may also limit some kinds of fish in the lake. This can impair the lake's warmwater gamefish populations, but other nongame species such as carp persist in high numbers. Taylor and Bechard (1991) observed resident adult and newly fledged eagles in August feeding mostly on carp and waterfowl and using a mudflat area near the nest site.

As in other areas of the valley, wintering bald eagles begin arriving at Lake Lowell in late October; numbers have been as high as 10 to 20 birds over the last 10 years (Ryan 1997). The number of birds using Lake Lowell in the winter largely depends on ice conditions. Prior to ice formation, wintering bald eagles have been observed perching in large open cottonwoods, on mudflats, and on the shoreline. Taylor and Bechard (1991) found that after ice forms over most of the lake, eagle numbers decrease, and the eagles concentrate near the open water near the New York Canal inlet. Wintering eagles primarily prey on waterfowl with the remainder of their prey coming from fish.

Water quality problems at Lake Lowell have been noted for many years. Lake Lowell is on the 1998 Idaho 303d list of water quality impaired water bodies for dissolved oxygen and nutrients. Water quality deterioration is related to nutrient loading and water exchange rates (USBR 2001a). The lake is highly eutrophic and susceptible to both algae blooms in the summer and fall and low dissolved oxygen in the deeper water layers. Bacteria contamination is also a problem at times. Sources of nutrients into the lake include agricultural drainage, urban runoff, domestic wastewater, and natural causes (USBR 2001a).

In 1998, Reclamation and the USFWS cooperated on a study to analyze and evaluate alternatives to improve water quality at Lake Lowell (Burch and King 2000). Water, sediment, and fish tissue were analyzed in this study for a variety of organic and inorganic contaminants. The study detected DDT and its metabolites, heptachlor, and dieldrin in sediments. Total DDT was detected at several sites in concentrations that fall into the "level of concern" category, which could potentially cause contamination in fish, and thus, piscivorous birds.

Mercury concentrations above the chronic freshwater criteria were found in some sampling sites within the lake water during one of two sampling periods. It was theorized that mercury present in the water column during the first sampling may have been due to an algae bloom ongoing at that time. Mercury was not detected in the water of any of the drains and canals that flow into the lake nor was it detected in the lake sediments.

Mercury was also detected in all six species of fish analyzed. Although the concentrations of mercury were below the levels that would cause adverse effects to fish, because mercury bioconcentrates and biomagnifies, these concentrations could be harmful to piscivorous predators such as bald eagles.

The harmful effects to piscivorous birds such as the bald eagle from DDT and mercury are generally related to low reproductive success (USBR 1998). As noted in Table 5-2 on page 120and information provided by Fenzel (2004), bald eagles have occupied their breeding territories but have been unsuccessful the last four years, and this fact does arouse suspicion. However, mercury and DDT have likely been present in fish and lake sediments for a long time, and the nests have been successful previously. There has been no evidence in the nest failures that would point to contaminant problems in breeding eagles (Fenzel 2004). Whether mercury and DDT are affecting bald eagle breeding at Lake Lowell is unknown.

Wintering bald eagles are less susceptible to contaminant problems since they only spend a portion of the year foraging at Lake Lowell, and their diet consists primarily of waterfowl rather than fish (Taylor and Bechard 1991). Most waterfowl are not year-round residents at Lake Lowell and are less likely to contain DDT and mercury in levels of concern, assuming they reside in uncontaminated areas the remainder of the year.

5.7.6 Payette River System

The Payette River system experiences significant bald eagle use. Table 5-3 on page 125 presents basin-wide yearly totals for young and territories for Lake Cascade, the North Fork Payette River, and Deadwood Reservoir. The subsections below describe bald eagle use in the river reaches and reservoirs in greater detail.

Lake Cascade and North Fork Payette River

Since the first discovery of the Donnelly nest site in 1976, Lake Cascade on the North Fork Payette River has become recognized as an important area for nesting bald eagles in Idaho. Lake Cascade is located within PBERP's Zone 15. The objective for Zone 15 is to have at least four breeding pairs producing 1.0 fledgling per occupied site. As Table 5-3 on page 125 illustrates, Lake Cascade has nine active breeding territories. Home ranges of the nine bald eagle breeding pairs encompass almost the entire reservoir with foraging concentrated in the shallow areas along the shoreline and in the upper tributary arms (Kimball and Bechard 2002). The North Fork Payette River has three territories below Cascade Dam, two of which were new in 2000, and two territories between Lake Cascade and Payette Lake.

Nesting birds at Lake Cascade usually arrive in late winter and lay eggs in March. Eggs hatch from mid-April to early May (USFWS et al. 1990). Parents and young eaglets remain in the nest area until early September. Some records indicate that bald eagles are absent during winter because most of the lake ices over; however, a few eagles are sometimes found around open water on the east side near the Hot Springs Creek inlet. Wintering birds may also be found along the North Fork Payette River, primarily in the Cabarton reach.

Bald eagles primarily prey on fish at Lake Cascade and North Fork Payette River. Lake Cascade was formerly one of the most productive fisheries in Idaho, annually yielding about 600,000 gamefish, mainly yellow perch and rainbow trout. Since the mid-1990s, predacious pikeminnow and competition with nongame fish such as suckers caused the perch fishery to collapse (however, fish are still abundant in the lake). Eagles also rely on dead fish found along the shoreline during late winter and late summer die-offs (USFWS et al. 1990). The lake attracts large flocks of water birds that also provide potential prey sources, especially during early spring and fall migrations.

Poor lake water quality poses a threat to the health of the fishery and the bald eagle prey base. High nutrient levels (mostly phosphorus) have caused algae blooms and fish kills from oxygen depletion. Bacterial pollution is also a concern. Nutrients and bacteria originate from agriculture, forest practices, urban wastewater and stormwater, and recreational use. Water quality improvement programs have recently reduced phosphorus input to the lake.

In 1990, the USFWS, Reclamation, and the USFS jointly prepared the Cascade Reservoir Bald Eagle Management Plan (USFWS et al. 1990). The purpose of the plan is to give Reclamation and the USFS site-specific management direction for the bald eagle breeding territories. Reclamation incorporated these management strategies in its 1991 Cascade Reservoir Resource Management Plan and the update of the plan in 2002 (USBR 2002). Both plans concentrate on Lake Cascade land management activities to maintain and improve bald eagle productivity. Based in part on consultation with USFWS under Section 7 of the ESA, Reclamation designated wildlife management areas and conservation/open space areas to protect nest sites and important foraging areas from human activity.

In 1995, Reclamation issued an EA/FONSI for the management of uncontracted storage space in Lake Cascade and Deadwood Reservoir (USBR 1995b). Reclamation's recommended plan for the long-term management of uncontracted storage in these reservoirs was to retain the storage in Reclamation ownership to maintain a 294,000-acre-foot minimum pool in Lake Cascade to protect water quality, fisheries, wildlife (including bald eagles), and lake recreation. The remaining acre-feet of uncontracted Lake Cascade space, based on an annual evaluation by concerned agencies, will be designated for salmon flow augmentation.

Reclamation formally consulted with the USFWS under Section 7 of ESA for the management of the uncontracted space. In its biological opinion, the USFWS concluded that incidental take may result from the proposed action; however, as long as the effects of annual reservoir drawdown are subject to annual review, the level of impact is not likely to result in jeopardy to bald eagles. Reclamation has met annually with USFWS and others to coordinate reservoir operations in accordance with the consultation requirements.

In 2002, Reclamation cooperated with Boise State University to prepare updated nest site management plans for the Sugarloaf and Gold Fork territories and the newly discovered Island/Hot Spring territory (Kimball and Bechard 2002). These plans were updated due to the potential re-opening of the nearby State airstrip at Lake Cascade. Plans to consider re-opening the airstrip are currently being evaluated.

Some operational aspects of Payette Lake are coordinated with the operation of Lake Cascade. Specifically, Lake Reservoir Company is able to hold Payette Lake high throughout the summer because Reclamation can deliver Payette Lake irrigation storage from Lake Cascade. In the fall, Payette Lake is drafted and this extra water is held in Lake Cascade. This results in flows below Payette Lake that are essentially equal to inflow and relatively stable throughout the summer. In the fall, flows in the North Fork are increased, resulting in an abnormal hydrologic pattern.

It is unknown how this operation affects bald eagle prey species in the North Fork; however, this reach continues to support two relatively productive bald eagle breeding territories.

Deadwood Reservoir

Deadwood Reservoir is also in the PBERP Zone 15. It has a recovery target of one breeding territory, and it currently supports one breeding territory. This nest was first documented in 1996 (see Table 5-3 on page 125). The breeding bald eagle pair has produced at least one young every year since 1996 except for 2003 when the territory was unoccupied and an alternate nest was discovered. These birds probably forage on the plentiful kokanee, whitefish, and trout in the reservoir and on waterfowl.

Because it has a high elevation, Deadwood Reservoir ices over early and is not suitable as winter bald eagle habitat.

South Fork and Mainstem Payette River

The only recent breeding territory for this area is within the Montour Wildlife/ Recreation Management Area. This nest has not been occupied for many years and is now considered a historical nest. The PBERP goal for the Garden Valley/Lowman area of Zone 15, which includes this river reach, does not include target breeding territories and lists the wintering population as 10 eagles.

The South Fork Payette River from Lowman to Banks, most of which lies downstream from the Deadwood River confluence, receives fairly heavy bald eagle use in the winter. Winter counts since 1987 have ranged from 2 to 16 eagles (Steenhoff 1997). Similar to the upper Boise River area, this reach is a critical big game winter range. Carrion is probably an important food source for bald eagles, especially in late winter. Bald eagles also are found along the mainstem Payette River with winter counts ranging from 4 to 20 eagles in the reach from Emmett to Payette.

5.7.7 Owyhee River System

The Owyhee River, including Lake Owyhee, is within the PBERP's Zone 16. The target is one breeding territory on the river for recovery; however, there currently are no known bald eagle breeding territories at Lake Owyhee or on the Owyhee River (Isaacs and Anthony 2003).

Larson (1993) indicated that between 20 and 30 bald eagles are found wintering at the reservoir and on the lower river, and bald eagles migrate through the area in spring and fall. The ODFW (1997) conducted one-day vehicle surveys during January from 1994 to 1997; these surveys revealed zero to one bald eagle along the river downstream from the dam and near Owyhee State Park. The low number of bald eagles during these one day surveys may be due to the variability in numbers of wintering bald eagles from year to year and within a given year depending on weather, local prey availability and other factors.

While low winter releases appear to sustain rainbow trout, brown trout, nongame fish, and waterfowl, Larsen (1993) considers low winter flows the greatest limiting factor for fish in the Owyhee River. Low flows in the river concentrate potential prey such as fish and waterfowl in deeper pools, although these pools often freeze over. Wintering eagles are particularly attracted to the ice-free water, available perches, and an abundance of waterfowl at the Snively Hot Springs on the Owyhee River. The ODFW stocks the river with rainbow trout fingerlings in the spring. Some of these fish do survive through the summer, which probably augments the number of fish available to wintering eagles. Owyhee Reservoir is also an important resting area for migrating waterfowl (Larson 1993).

The lower end of the river supports warmwater fish, which are also limited by low flows between irrigation seasons. However, the reservoir or parts of the reservoir remain ice-free in most years and available for foraging. Mammal carrion is also available in the general area of the reservoir.

Storage for irrigation and operations for flood control probably has caused some negative effects on cottonwood regeneration downstream from the dam. However, in some years, over 2,000 cfs have been released for flood control, and this has allowed some regeneration to occur. Currently, there appears to be adequate large perching trees and cliffs for eagle use in the upper river reaches.

Water quality problems at Lake Owyhee include high levels of suspended particulates, nutrient-caused algae blooms, and elevated concentrations of mercury in sediment, water, and fish tissue (Larson 1993; Craft et al. 2000). Mercury in fish is a concern for piscivorous birds like bald eagles since it can bioaccumulate and biomagnify in tissues of these species. The sources of the mercury in Owyhee Reservoir appear to be from mining in the Jordan Creek watershed and local runoff from areas near the reservoir with naturally high mercury content. Suspended particulates appear to be the primary external loading vector (Craft et al. 2000).

The degree to which wintering bald eagles rely on fish living in Owyhee Reservoir and whether they have been affected by mercury bioaccumulation to the degree that reproduction is affected is unknown. There is no specific information available regarding the diet of bald eagles at and below Lake Owyhee. In some areas, wintering bald eagles have been shown to rely on waterfowl and mammalian carrion to a greater degree than fish during the winter when this alternate prey is available (Taylor and Bechard 1991). Larson (1993) notes that bald eagles are attracted to ice-free areas of the Owyhee River below the dam where waterfowl is abundant. Significant numbers of migrating waterfowl are available at the reservoir during spring and fall. There are also areas of Owyhee Reservoir that are used as winter range by mule deer (Larson 1993), and winter-kill carrion is probably available to bald eagles in these areas. The availability of prey other than fish at the reservoir, and the fact that wintering birds are only present for a few months of the year, would tend to limit the amount of mercury intake.

5.7.8 Mann Creek Reservoir

Bald eagles do not nest at Mann Creek Reservoir. Some winter use likely occurs at the reservoir and along the Weiser River below the confluence with Mann Creek; however, this area is not part of the annual mid-winter survey. The lack of suitable perches at the reservoir and the small size of Mann Creek likely limit bald eagle use.

5.7.9 Malheur River System

There are no known bald eagle breeding territories within the Malheur River system. The PBERP target for the Malheur River basin area is one breeding territory each at Beulah and Bully Creek Reservoirs. Nest sites at these reservoirs may be somewhat limited since there are no large conifers and few large open-story cottonwood trees.

Bald eagles are present in the winter at Beulah and Bully Creek Reservoirs and along the Malheur River downstream. Mid-winter one-day ODFW surveys (1997) from 1988 to 1997 found between 1 and 11 bald eagles along the Malheur River between Beulah Reservoir and Vale, Oregon. Winter counts at Bully Creek Reservoir from 1994 to 1997 ranged from zero to two eagles. No winter count information is available for Warm Springs Reservoir. Although some winter use may occur, the lack of perches and roosts may limit the winter suitability of Warm Springs Reservoir.

5.7.10 Powder and Burnt River Systems

PBERP goals for this area are five breeding territories, one each for Phillips Lake, Unity and Thief Valley Reservoirs, and the Powder and Burnt Rivers.

Bald eagles nest at both Phillips Lake on the Powder River and Unity Reservoir on the Burnt River (Isaacs and Anthony 2003). The breeding territory at Phillips Reservoir has been occupied since 1989 and has been very productive, fledging one or two young each year since 1990. The territory at Unity Reservoir was first known to be active in 1984 and had been occupied most years. This territory was very productive at its original nest site, even through very dry years in the late 1980s and early 1990s (Isaacs and Anthony 2003). Since the nest was relocated to its present site in 1995, it has been successful only in 1998 and 1999.

Isaacs et al. (1992) studied wintering bald eagles in northeast Oregon, including the Powder and Burnt River systems. Winter counts and estimates from 1988 to 1990 in Baker County, which included bald eagles using the Powder and Burnt Rivers as well as adjacent agricultural areas, ranged from 0 to 15 eagles with the highest average count of 12 eagles occurring in early March. In January and early February, bald eagles were most common along the rivers and reservoirs. In late February and March, bald eagles were most common in agricultural areas such as Baker Valley, downstream from the town of Baker City, and Keating Valley, downstream from Thief Valley Reservoir. This shift in use is likely related to changes in food abundance, food availability, and age structure of the wintering eagle population. Counts at Phillips Lake and Unity Reservoir ranged from zero to four eagles.

5.8 Effects Analysis

The area of analysis for bald eagles includes the action areas for all 11 proposed actions. The following subsections identify river reaches and reservoirs where the proposed actions may have a hydrologic influence. Section 5.9 summarizes Reclamation's determination for each proposed action.

5.8.1 Snake River System above Milner Dam

Bald eagles in these river reaches and reservoirs are in the action area for future O&M in the Snake River system above Milner Dam.

Snake River in Wyoming

Under the proposed action, the Jackson Lake water surface elevation will continue to fluctuate. However, as under current conditions, these operational effects appear to have a completely benign effect on the bald eagle. Reclamation will continue to release water to benefit the downstream fishery during winter months. This includes increasing releases when winter inflow to the reservoir drops below 280 cfs (if the WDGF requests release of their contracted storage water) and an informal commitment not to release more than 600 cfs to prevent the formation of frazzle ice, which can adversely affect the fishery.

The Snake River below Jackson Dam will continue to support sufficient habitat for fish and waterfowl prey during the eagle breeding season, and the year-long resident bald eagles will continue to have an abundant prey base.

Snake River and Tributaries from the Wyoming State Line to the Henrys Fork Confluence

Palisades Reservoir

Under the proposed action, Reclamation will continue to draw down Palisades Reservoir. There are no definitive trend data available that show that either reservoir drawdowns or winter operations that will occur under the proposed action will affect breeding or wintering bald eagles in this area. As described in Section 5.7.1, the anecdotal data about low reservoir levels reducing overall productivity at Palisades Reservoir (Whitfield 2002) are juxtaposed with the report that at Palisades Reservoir, only the Hoffman nest was not occupied and that 4 of the 7 nests were successful even though the reservoir was drawn down to its lowest elevations in several years (Sallabanks 2003b); in 2004, 6 of the 7 nests were active (Alfred 2004; see also Table 5-2 on page 117).

The fishery and waterfowl populations will remain an adequate food source for wintering bald eagles, and carrion will also be available on adjacent lands when the reservoir freezes over (between December and March). A fish kill has not occurred at Palisades Reservoir since construction in 1956, probably due to the relatively lower summer air temperatures and fact that several live streams enter the lower end of the reservoir and maintain water quality, mainly dissolved oxygen. Additionally, the reservoir is 125 feet deep at the bottom of the conservation pool and 80 feet deep at the top of the dead pool. Use of powerhead space to make up a shortfall in flow augmentation will not cause water quality or quantity conditions to cause a fish kill that would adversely affect nesting bald eagles.

Snake River below Palisades Dam

The proposed action will influence the hydrology of the Snake River below Palisades Dam. Low winter flows, like those minimum flows described in the historical record at the Snake River near Irwin gage (see Appendix C), will occur in the mainstem Snake River and will reduce the river's wetted perimeter by drying up the side channels. This will force fish overwintering in these channels to move into the mainstem. However, this is not likely to limit the eagles' foraging opportunities. As under current conditions, the eagles will still have foraging access to a large fishery in the main channel and to big game carrion in adjacent areas.

High spring flows occasionally inundate waterfowl nesting habitat, but this probably does not have a measurable impact on the presence or overall production of waterfowl. Waterfowl appear to be abundant along this reach of the Snake River throughout the year in most years. There is no available information to indicate that a reduction in water fowl breeding success has an effect on breeding bald eagles ability to find sufficient forage.

Flood control operations at Palisades Reservoir have been reported to cause an adverse effect on the long-term maintenance and replacement of riparian habitat generally and cottonwood trees specifically (Moseley 2000; Murphy 2004; Hauer et al. 2004). In the long term, this type of reduction would limit the availability of perching, roosting, and nesting sites along the floodplain. Under the proposed action, operations at Palisades Dam will not alter the current flood frequency, and flooding (24,500 cfs or greater) will continue to occur at a rate of about one year in seven. Additionally, Reclamation will be unable to prevent events similar to the 1997 flood.

Less severe flooding may occur in the proposed action when Reclamation provides spring freshets to mimic natural flow conditions. These flow magnitudes will likely provide the flooding and sediment mobilization necessary to continue the building of new alluvial seed beds and the germination of new trees (Hauer et al. 2004). It should be noted that flows above flood stage are not needed every year to maintain or even create riparian habitat. Hauer et al. (2004) indicate that flows between 19,000 and 25,000 cfs occur in 17 out of 45 years and provide sufficient energy to cause erosion and avulsion and maintain the shifting habitat mosaic. Cottonwoods pre-dating the construction of Palisades Dam and currently used for perching, roosting, and nesting may be lost due to age (Merigliano 1995), but flows in the proposed action will help retain or slow the loss of the riparian habitat and cottonwood stands. Merigliano (1995) estimated cottonwood recruitment (or lack thereof) and reported that in 40 years, the overall area of cottonwood habitat below Palisades will be reduced by 21 percent, and the majority of trees will be between 50 and 200 years old; however, this analysis was done prior to the 1997 flood. Based on the current condition of the existing riparian habitat, recent major flood events, and newly established cottonwood stands (Rice 2004; Williamson et al. 1998), a significant reduction in available perching, roosting, and nesting in the next 30 years is not likely to occur.

Henrys Fork and Tributaries

Effects of the proposed action on the Henrys Fork drainage will be similar to effects on the mainstem Snake River. An abundant waterfowl and fishery resource will continue to provide a good forage base for the more than 20 bald eagle breeding territories in this area. Similar to other fluctuating reservoirs in eastern Idaho and western Wyoming, reservoir drawdowns appear to have an immeasurable and likely insignificant effect on bald eagles because of the abundance of other prey in the occupied territories (see Table 5-2 on page 120).

Under the proposed action, flow regulations downstream from Island Park Reservoir may insignificantly affect the long-term availability of rainbow trout for bald eagles.

The potential for winter flows to drop below 200 cfs (and subsequently dewater juvenile fish habitat) slightly decreases under the proposed action (from 33 percent to 31 percent). Flows at 200 cfs or greater provides a significant increase in winter habitat for juvenile rainbows (Benjamin and Van Kirk 1999). This could provide bald eagles with an unquantified beneficial effect on future availability of forage fish. Under the proposed action, the Henrys Fork will continue to maintain a quality trout fishery and the two-percent difference in maintaining the 200-cfs winter flow will have an insignificant effect. The fishery will not be reduced by the proposed action such that it is limited as a food source for bald eagles.

Snake River and Tributaries from the Henrys Fork to Milner Dam

The Ririe Reservoir on Willow Creek and the Snake River from the Henrys Fork to Milner Dam, American Falls Reservoir, and Lake Walcott will continue to support an abundance of waterfowl and fish. The nesting eagles within this area also benefit from this abundant forage base. The proposed action is unlikely to adversely affect the food base for bald eagles in this reach.

The numbers of wintering bald eagles in this area have maintained or increased since 1980. Flood control operations have a greater effect on limiting the replacement of the cottonwood forest in the reach. Spring freshets released from Palisades Dam will have a beneficial but limited effect on reshaping the riparian habitat in this considerably larger reach of the Snake River. Releases from Palisades Reservoir have no effect on Ririe Reservoir or Willow Creek. As in the Snake River below Palisades Dam, nesting and perching trees will remain available for at least the next 30 years.

5.8.2 Snake River from Milner Dam to Brownlee Reservoir

Bald eagles in this reach occur in at least part of the action areas for all 11 proposed actions. This effects discussion considers the combined effects of these 11 actions.

This reach of the Snake River supports an abundance of waterfowl and fish. Reclamation’s releases for salmon flow augmentation will continue to increase flows in this reach during the summer; this will help maintain and improve habitats for fish and waterfowl, and it will continue to supply an adequate food base for wintering eagles along the river and the nesting territory near Brownlee Reservoir. This beneficial effect will be especially evident in the reach immediately below Milner Dam.

5.8.3 Snake River from Brownlee Reservoir to the Columbia River and the Columbia River to its Mouth

Bald eagles in this reach occur in at least part of the action areas for all 11 proposed actions. This effects discussion considers the combined effects of these 11 actions.

The model predicts that the combined effects of the proposed actions will decrease winter inflows to Brownlee Reservoir but increase spring and summer inflows. This combined effect would be no more than a 448-cfs decrease in average monthly inflow in the winter and early spring from current operations. During the driest years Brownlee Reservoir inflows could increase by as much as 1,100 cfs in July (at the 90-percent exceedance) compared to current operations.

These hydrologic increases and decreases will not likely have any measurable effect on the bald eagle prey base in the Hells Canyon Complex and areas downstream. The changes to Brownlee Reservoir inflows are relatively minor when compared to existing inflows, and Brownlee Reservoir elevations are not likely to be affected at all since flow augmentation is assumed to be passed through the three reservoirs. The 11 proposed actions will have no effect on the levels of DDT/DDE in fish at Brownlee Reservoir or the exposure to these chemicals by breeding and wintering bald eagles. Changes in flows below Hells Canyon Dam are also be unlikely to have a measurable effect on resident fish habitat and prey abundance and availability for bald eagles since changes would be very minor compared to existing flows.

5.8.4 Little Wood River System

Little Wood River Reservoir is in the action area for future operations in the Little Wood River system. However, this proposed action will have no effect on the species because the species is not known to occur in this area.

5.8.5 Boise River System

Bald eagles in these river reaches and reservoirs are in the action area for future O&M in the Boise River system.

Upper Boise River and Anderson Ranch, Arrowrock, and Lucky Peak Reservoirs

Anderson Ranch, Arrowrock, and Lucky Peak Reservoirs

The number of bald eagle breeding territories in the Boise River system has continued to increase since 1995 (see Table 5-3 on page 125), which reflects both the range-wide recovery of the species and the benefits of an abundant prey base at Anderson Ranch and Arrowrock Reservoirs and downstream river reaches. As described in Section 5.7.5, there appears to be no correlation with yearly variations in operation in the past (dry/wet years) that would indicate prey availability is significantly affected and is limiting bald eagle productivity.

The model predicts that the Anderson Ranch reservoir pool will never fall below 43,000 acre-feet, and the winter (October to March) minimum pool will be at least 106,000 acre-feet in 95 percent of the years. At Arrowrock Reservoir, the model predicts that end-of-month reservoir contents in September, typically the month of lowest reservoir elevation, will be at least 28,000 acre-feet in all years, and will be at least 40,000 acre-feet in 95 percent of the years. Lucky Peak Reservoir would have an average pool in October, the lowest month, of at least 67,000 acre-feet in 95 percent of the years modeled and will never drop below its 29,000-acre-foot inactive capacity. Conditions related to maintenance of Lucky Peak Dam and the powerplant are not incorporated into the model, are not part of the proposed actions, and are outside of the scope of this consultation.

These minimum pool levels will continue to support an adequate fish and waterfowl prey base and benefit both breeding and wintering bald eagles. Reservoir levels below administratively established conservation pools or inactive/dead storage capacities are extremely unlikely to occur over the 30 years. Lower drawdowns in the Boise River reservoirs during drought periods will continue to temporarily benefit wintering eagle foraging by making fish more concentrated and vulnerable to capture; however, the predation levels are not expected to appreciably reduce the numbers of fish available to breeding eagles in spring and summer. Based on past operations, the low pools described above will continue to support sufficient fish for bald eagles in years following deep drawdowns.

Fish kills can occur due to anoxic conditions; however, these have been limited to a single species (kokanee) in Anderson Ranch Reservoir and likely do not significantly reduce the total numbers of fish in the reservoir.

South Fork Boise River

Releases from Anderson Ranch Dam to provide minimum flows in the South Fork Boise River of at least 300 cfs in the fall and winter and at least 600 cfs during the remainder of the year meet the current recommendations for protection and enhancement of resident fish. The model predicts releases of at least 293 cfs in 95 percent of all years with releases never dropping below 114 cfs. While this flow regime may be optimal for some fish species, it will occur infrequently and will continue to maintain sufficient fish prey, which, in addition to carrion, will continue to support breeding and wintering bald eagles in the South Fork Boise River.

Flood control operations at Anderson Ranch Reservoir may have some long-term effect on the regeneration of black cottonwood trees used by bald eagles for perching along the South Fork Boise River. Although mature trees are currently available, the reduction in seasonal flooding also reduces the building of new alluvial seed beds and germination of new trees. The magnitude of the loss of mature cottonwoods over 30 years is undetermined. Flood control releases will still occur in wet years; the model predicts June monthly average flows of at least 3,000 cfs, which is roughly double normal summer releases, in 15 percent of the years modeled. This may provide some cottonwood regeneration. The overall effect to bald eagles will likely be insignificant because conifers and rock outcrops are also present in much of this reach.

Lower Boise River

The Boise River downstream from Lucky Peak Dam will be operated to deliver irrigation and salmon flow augmentation water, provide flood control, and release between 150 and 240 cfs during the non-irrigation season in most years. The model predicts winter flows measured at Glenwood Bridge of at least 240 cfs in 50 percent of the years modeled, and at least 150 cfs in 83 percent of the years modeled. During successive dry years, when storage allocated to streamflows does not fill, flows may be as low as 80 cfs. This flow regime is not optimal; however, based on past operations, this reach will continue to have adequate prey to support wintering bald eagles.

Flood control operations will limit important side channel habitat for coldwater fish, which bald eagles take as prey (USFWS 1996). Lower overall river flows from irrigation diversions will continue to limit fish habitat (Riggin and Hansen 1992).

Even with the alteration of flows from Reclamation’s reservoir operations, coldwater gamefish species such as mountain whitefish, hatchery rainbow trout, wild rainbow trout, and brown trout as well as nongame species are found in the river reach from Lucky Peak Dam to Star. These fish resources, waterfowl, and mammalian prey have sustained a significant number of wintering bald eagles and are expected to continue to do so.

The black cottonwood community along the lower river is an important habitat component for wintering bald eagles. An example of this is the communal night roost in cottonwood trees near Barber Pool. Flood control operations will continue to limit long-term cottonwood regeneration to some degree.

The model predicts flows of at least 6,500 cfs at Glenwood Bridge to occur 12 percent of the time in April and May; this will likely result in some cottonwood regeneration as flows recede, especially in areas where the river floodplain is broad, such as Barber Pool. This has occurred during other high flow periods in the late 1990s. The exact magnitude of the loss of mature cottonwoods over 30 years is undetermined, but large trees are likely to persist along the river over the period, and impacts to wintering bald eagles are likely to be insignificant.

Effects on bald eagles in the river reach below Eagle Island are difficult to predict since there is a general lack of information on eagle use in this reach. Although several agencies and groups are addressing the reach's water quality problem, there is not likely to be a major change that will significantly alter the prey base for bald eagles over the next several years.

Lake Lowell

Lake Lowell will continue to support both breeding and wintering bald eagles that are attracted to fish, abundant waterfowl, and large cottonwood trees that ring much of the lake. Waterfowl and most fish populations will not be significantly affected. A series of normal to high water years may allow an improved sport fishery and potentially increase the bald eagle prey base.

Operations that affect gamefish populations, especially during drought, will continue. However, Taylor and Bechard (1991) concluded that bald eagles are not adversely affected by the lack of gamefish since they frequently take waterfowl and nongame fish such as carp. These food sources will continue to persist, even in dry years when the lake is lowered considerably. The model predicts that average September lake contents will be at least 10,000 acre-feet in 96 percent of years modeled, and at least 2,500 acre-feet in all years.

There may be a potential for fish kills for some species due to nutrient-related water quality problems; however, the abundance of nongame species such as carp that are tolerant of poor water quality should continue to provide an abundant prey base that benefits both breeding and wintering bald eagles.

It is unknown whether DDT and mercury are having an effect on bald eagle productivity. Burch and King (2000) did not detect either mercury or DDT-related chemicals in drains and canals that flow into the lake. Reclamation's future operations are not expected to exacerbate the contaminant levels in fish and lake sediment.

5.8.6 Payette River System

Bald eagles in these river reaches and reservoirs are in the action area for future O&M in the Payette River system.

North Fork Payette River and Lake Cascade

North Fork Payette River below Payette Lake

Continued operations at Payette Lake, which passes inflow in the summer and increased flows below in the fall as the lake is drafted to its natural elevation, will be similar to past operation. This operation should continue to provide adequate prey benefiting the two productive breeding territories and any wintering birds.

Lake Cascade

The number of breeding bald eagle territories continues to increase at Lake Cascade and the North Fork Payette River, with four new territories added since 1998. In 1995, Reclamation committed to maintaining a 300,000-acre-foot conservation pool at Lake Cascade while using 70,000 acre-feet of uncontracted storage for salmon flow augmentation (USBR 1995b). Productivity has been fairly steady as the number of territories has increased (see Table 5-3 on page 125). This is an indication that prey has been adequate under a variety of operating scenarios.

The model predicts a minimum pool of about 300,000 acre-feet through the winter for 93 percent of the years modeled. During certain severely dry years (expected to occur about 7 percent of the time), up to 30,000 acre-feet of water from Reclamation's uncontracted storage in the Payette River system may be available for rental to irrigators in the Boise Project. Generally, uncontracted storage in Deadwood Reservoir can provide some of this water, and the conservation pool at Lake Cascade will not be affected. However, in some rare instances, Reclamation could deliver as much as 7,000 acre-feet from uncontracted space in the conservation pool. The model predicts that the minimum pool will always be at least 290,000 acre-feet.

The minimum pool and other actions to improve water quality in Lake Cascade under the State of Idaho's TMDL process should ensure an adequate prey base to benefit breeding bald eagles. A small, infrequent reduction in the minimum pool during severely dry years is not likely to have a noticeable effect on prey species. Bald eagle production is expected to be similar to current conditions, which exceed Recovery Plan goals.

North Fork Payette River below Lake Cascade

The continued maintenance of a 200-cfs winter minimum flow from Cascade Dam should provide ample prey for the existing three breeding territories; this flow may also support new territories. Bald eagles will continue to benefit from these operations.

Deadwood Reservoir

The model predicts that in nearly all water years, Reclamation will continue to provide irrigation and flow augmentation water while still maintaining a 50,000-acre-foot minimum pool at Deadwood Reservoir. During certain severely dry years (expected to occur about 7 percent of the time), up to 30,000 acre-feet of water from Reclamation's uncontracted storage in the Payette River system may be available for rental to irrigators in the Boise Project. Generally, uncontracted storage in Deadwood Reservoir can provide some of this water, and the conservation pool will not be affected. However, in some rare instances, Reclamation could deliver as much as 6,000 acre-feet from uncontracted space in the conservation pool (the model predicts this may occur in up to 5 percent of water years modeled). The model predicts that the minimum pool will always be at least 44,000 acre-feet.

The maintenance of the 50,000-acre-foot pool meets Riggin and Hansen's (1992) minimum recommendations for protection of fish spawning and rearing habitat. Drafting below 50,000 acre-feet will occur only rarely and will not likely reduce the reservoir fish resource to the extent that fish populations or bald eagle foraging and productivity will be adversely affected. Bald eagles will continue to benefit from the abundant fish in the reservoir.

South Fork and Mainstem Payette River

Reclamation's continued operation of Cascade and Deadwood Dams and natural flows in the South Fork and tributaries will provide a flow regime similar to the past several years. These operations are unlikely to change fish populations, and there should be ample fish prey as well as big game carrion to support wintering bald eagles. The winter flow regime in the mainstem Payette River below Emmett will also be similar to the past, and adequate fish prey for wintering eagles will also be available in this reach.

5.8.7 Owyhee River System

Bald eagles in these river reaches and reservoir are in the action area for future O&M in the Owyhee River system.

With its abundant fishery resource, Lake Owyhee and the Owyhee River will continue to support wintering eagles. Conditions on the reservoir are not expected to change, and there is ample winter carryover to maintain the aquatic ecosystem and fish prey base. The 30-cfs minimum flow from Owyhee Dam during the non-irrigation season (except during times of irrigation shortage when flows would be reduced proportional to the shortage) is an improvement over the past operations when winter releases ranged from 15 to 20 cfs in good water years to 2 to 4 cfs from leakage through the dam during dry years. This increase in winter flows will benefit the fishery in the upper reaches of the river and increase the prey base for wintering bald eagles. It may also keep the river pools ice-free longer, which would also benefit eagle foraging.

Future operations at Owyhee Reservoir are not expected to exacerbate mercury contamination in bald eagles. Because bald eagles spend only a portion of the year at the reservoir and have other prey items available during the winter, their exposure to mercury is lessened. It is doubtful that future operations will expose bald eagles to mercury contamination to the point that adverse effects occur.

The lower end of the river will continue to support warmwater fish and will likely also benefit from increased winter releases. The lower reaches remain ice-free in most years and are available for foraging. Mammal carrion will also continue to be available in the general area of the reservoir.

Storage for irrigation and operations for flood control will limit cottonwood regeneration downstream from the dam. However, occasional storage releases for flood control over 2,000 cfs will continue to allow some regeneration to occur. The adequate large perching trees and cliffs in the upper river reaches will remain, and there are some smaller trees that will be available as they mature over the next 30 years.

5.8.8 Mann Creek System

Bald eagles at this reservoir are in the action area for future O&M in the Mann Creek system.

Winter use of Mann Creek Reservoir is poorly documented but probably limited due to lack of perches, low winter pool, and ice cover. Although deep drafts of the reservoir likely reduce the number of fish during drought years, some fish, especially nongame species, will continue to persist. Their persistence will continue to provide foraging opportunities to small numbers of wintering bald eagles at the reservoir until it ices over.

5.8.9 Malheur River System

Bald eagles in these river reaches and reservoirs are in the action area for future O&M in the Malheur River system.

Warm Springs, Beulah, and Bully Creek Reservoirs will continue to be operated solely for irrigation and flood control with no minimum streamflow requirements below the dams. Relatively few wintering bald eagles have been found in areas surveyed at and downstream from Reclamation facilities in the basin; this is likely due to a lack of suitable perch trees in many areas.

Fish are available in the reservoirs until they ice over. During very dry years when the reservoirs may be completely drained, wintering eagles probably would shift their foraging to river areas downstream where entrained fish are plentiful. Winter streamflows may limit the distribution of wintering eagles to reaches where there are pools or other areas where fish tend to be concentrated; however, bald eagle prey in the form of fish, waterfowl, and big game carrion is generally available. Downstream from Warm Springs Reservoir, the South Fork Malheur River contributes substantially to streamflow in the winter and improves habitat in the mainstem Malheur River for fish and waterfowl prey for bald eagles that may winter in this reach.

While the continued operation of the three reservoirs for irrigation and flood control is not optimal for bald eagles, this operation continues to provide benefits to a limited number of wintering bald eagles.

5.8.10 Powder and Burnt River Systems

Bald eagles in Phillips Lake and the Powder River upstream from Thief Valley Reservoir are in the action area for future O&M in the upper Powder River system. Bald eagles in Thief Valley Reservoir and the downstream Powder River are in the action areas for future O&M in both the upper and lower Powder River systems. In Thief Valley Reservoir and the downstream Powder River, the effects discussion considers the combined effects of the two proposed actions. Unity Reservoir and the Burnt River are in the action area for future O&M in the Burnt River system.

The presence of a successful breeding pair of eagles at Phillips Lake is an indication that Reclamation's past operations have maintained suitable populations of prey (fish and waterfowl) to sustain these birds and their offspring. The bald eagle pair is expected to continue to benefit from this operation and maintain a productive breeding territory.

Reclamation will continue to operate Phillips Lake and Thief Valley and Unity Reservoirs as in the past. All three reservoirs will be drawn down significantly for irrigation, especially in dry years; and winter flows below the dams will not be optimal for fish and waterfowl preyed upon by bald eagles. However, even during dry years, the reservoirs and rivers below will likely still benefit breeding bald eagles at Phillips Lake and Unity Reservoir by providing ample fish prey.

Although the productivity of the breeding territory at Unity Reservoir has been sporadic, it may be due to other factors, such as a less-than-suitable nest site.

Production has fallen off since a new nest site was chosen in 1995. There does not seem to be any correlation between drought and breeding success for this territory since there were productive years during very dry periods and low reservoir levels, and there have been unproductive years during and after relatively good water years.

Isaacs et al. (1992) found moderate numbers of bald eagles wintering throughout the Burnt and Powder River valleys, including near Unity Reservoir and Phillips Lake from 1988 to 1991, a period of prolonged drought. These birds relied on a variety of prey, especially in the Baker Valley where they were observed foraging in agricultural areas for mammalian prey in late winter and spring. The bald eagle prey base in the Burnt and Powder River systems will continue to be maintained similar to current levels.

5.8.11 Cumulative Effects

Within the action areas, the cumulative effect of urban sprawl, industrial and housing developments, and human disturbance from recreation will likely continue to threaten bald eagles. This is especially true near Boise and Eagle. The black cottonwood community along the lower Boise River is a critical habitat component for wintering bald eagles. In addition to Reclamation's and the Army Corps of Engineers' flood control operations, river channelization and adjacent land development through Boise will continue to limit long-term cottonwood regeneration. The magnitude of the loss of mature cottonwoods over the next 30 years is undetermined, but large trees are likely to persist along the river over this period.

Nesting eagles at Lake Cascade also face increasing amounts of recreational use and development of nearby lands, which will add to the human disturbance of some nesting sites and foraging areas. Although somewhat tolerant of human activity, disturbances may reach a point where productivity is affected or nests are abandoned.

The forage base for bald eagles at most reservoirs and many river reaches in the action areas will continue to be augmented through the stocking of gamefish by state fish and wildlife agencies.

5.9 Effects Conclusion

Reclamation has determined that future operations in the Little Wood River system will have no effect on breeding or wintering bald eagles.

Reclamation has also determined that future O&M in the Snake River system above Milner Dam, Boise River system, Payette River system, Owyhee River system, Mann Creek system, Malheur River system, upper and lower Powder River systems, Burnt

River system, and future provision of salmon flow augmentation from the rental or acquisition of natural flow rights may affect but are not likely to adversely affect breeding or wintering bald eagles in their respective action areas.

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Chapter 6 BULL TROUT

6.1 Status

The status of Pacific Northwest bull trout (*Salvelinus confluentus*) populations have been under Federal agency review for over eighteen years. On September 18, 1985, the USFWS published a notice of review that designated bull trout as a candidate species. Several environmental groups petitioned bull trout for listing throughout its entire range under the ESA's endangered status in October 1992. In January 1994, the IDFG closed all Idaho waters to bull trout harvest except Lake Pend Orielle and the Lower Clark Fork River. In 1996, restrictive angling regulations protected most bull trout populations throughout the State of Oregon.

In 1994, the USFWS found that the 1992 petition was not warranted due to insufficient data regarding threats, status, and population trends of the Canadian and Alaskan population segments. However, the Columbia and Klamath River basins' population information was sufficient to warrant listing, and the USFWS listed bull trout populations in these basins as threatened in June 1998 (63 FR 31647).

Bull trout populations within this distinct population segment have declined from historical levels and are generally considered to be isolated and remnant. The USFWS rationale for Federal listing included habitat degradation and fragmentation, blockage of migratory corridors, poor water quality, poor past management practices, and the introduction of non-native competitors such as brook trout (*Salvelinus fontinalis*) (63 FR 31647). Although some strongholds still exist, bull trout generally occur throughout the Columbia River basin in isolated subpopulations in headwater lakes or tributaries where migration has been precluded.

The USFWS began the 5-year status review of bull trout in January 2004. The purpose of the review is to ensure that the species has the appropriate level of protection under the ESA and to improve management and conservation of the species (USFWS 2004). During the status review, further work on the recovery plan for the Columbia and Klamath River basins was suspended. The public comment period for this process was extended to January 1, 2005. Completion of the review should occur in the spring of 2005 (USFWS 2004).

The USFWS designations for bull trout critical habitat do not include waterways in the action areas for this consultation (69 FR 59996).

6.1.1 Previous Biological Opinions and Ongoing Implementation Activities

1999 Biological Opinion

The *Biological Opinion on the Bureau of Reclamation Operations and Maintenance Activities in the Snake River Basin Upstream of Lower Granite Dam* (USFWS 1999) included three reasonable and prudent measures (RPMs) and associated terms and conditions for bull trout for Reclamation to address in order to comply with Sections 4(d) and 9 of the ESA:

1. Reduce the incidence of bull trout entrainment due to reservoir operations. The terms and conditions for this RPM are to:
    a. Immediately implement interim measures to reduce entrainment from project operations.
    b. Initiate studies necessary to develop long-term entrainment reduction solutions.
    c. Reinitiate consultation with USFWS based on the findings of the above investigations to implement long-term entrainment reduction solutions at Reclamation facilities.
2. Within existing authorities and voluntary partnerships, work toward ensuring reservoir operations do not result in de-watering of Reclamation reservoirs to the extent that adfluvial bull trout resident there during part of their life history are stressed or killed. The terms and conditions for this RPM are to:
    a. Initiate water quality monitoring efforts to determine minimum pool necessary to support adfluvial bull trout in Beulah, Deadwood, Anderson Ranch, and Arrowrock Reservoirs.
    b. Initiate an investigation of alternatives for creating a minimum fisheries pool in Reclamation reservoirs that now support resident/adfluvial bull trout.
    c. Implement a method to ensure that a minimum fisheries pool is available in Reclamation reservoirs where bull trout are resident in the Snake River basin under high, low, and average water year scenarios.
3. Investigate methods to provide safe fish passage around Reclamation dams for bull trout. The terms and conditions for this RPM are to:
    a. Initiate research necessary to evaluate feasibility of providing passage at Agency Valley, Anderson Ranch, Arrowrock, and other dams where bull trout are not able to complete their life history requirements because of blocked migration due to passage barriers.
    b. Reinitiate consultation based on the findings to implement a long-term bull trout passage solution at Reclamation facilities in the Snake River basin.

Conservation Recommendations of the 1999 biological opinion included:

1. Engaging land managers, water users, state agencies, and other affected parties in a dialogue aimed at formulating cooperative land and water management plans in watersheds surrounding Reclamation projects.
2. Continuing to participate in ongoing life history investigations for bull trout in the Malheur, Boise, Powder, and Payette systems.
3. Investigate opportunities (in combination with item 1 above) to establish a year-round flow in the North Fork Malheur River downstream from Beulah Reservoir and possibly in the Deadwood River downstream from Deadwood Dam.

The RPMs of the 1999 biological opinion were extended in 2001 to allow coverage for incidental take under the ESA through 2004. None of the RPMs were changed when the extension was implemented.

2001 Biological Opinion

The USFWS (2001) issued a biological opinion to address specific effects of the Arrowrock Dam valve rehabilitation project that began in 2001. Reclamation has completed this construction project; Reclamation discusses these multiple effects in its biological assessment (2000) and environmental impact statement (2001a). Although the RPMs in the 2001 biological opinion were specific to the Arrowrock Dam construction project, the first and second RPMs were identical to the 1999 biological opinion's second and third RPMs. The RPMs in the 2001 biological opinion for the Arrowrock Dam construction project included:

1. Within existing authorities and voluntary partnerships, work toward ensuring reservoir operations do not result in de-watering of Reclamation reservoirs to the extent that adfluvial bull trout resident there during part of their life history are stressed or killed. Terms and conditions for this RPM are to:
    a. Initiate water quality monitoring/modeling efforts to determine water quality parameters and conservation pool necessary to support adfluvial bull trout in Anderson Ranch and Arrowrock Reservoirs.
    b. Initiate an investigation of alternatives for creating a conservation fisheries pool in Arrowrock Reservoir.
    c. Implement a method to ensure that a conservation pool is available in Arrowrock Reservoir under high, low, and average water year scenarios.
2. Investigate methods to provide safe fish passage around Arrowrock Dam for adult and juvenile bull trout. Terms and conditions for this RPM are to:
    a. Initiate research necessary to evaluate feasibility of providing passage at Arrowrock Dam where bull trout are not able to complete their life history requirements because of blocked migration due to their inability to migrate upstream past the dam once they are entrained into Lucky Peak Reservoir.

   b. Reinitiate consultation based on findings to implement a long-term bull trout passage solution at Arrowrock Dam.

3. Initiate a capture and transport program in Lucky Peak to mitigate for entrainment. The term and condition for this RPM is to complete discussions with the USFWS and the IDFG on a plan to be implemented immediately to begin capture and transport of bull trout that are entrained at Arrowrock Dam.
4. Complete a water quality monitoring plan for the project. The term and condition for this RPM is to agree to and implement a detailed plan before the onset of the construction project through the year following its completion to ensure that adverse water quality conditions are detected in a timely manner.
5. Form a fish advisory group to advise on responsive actions and to aid in analyzing data collected during the project. The term and condition for this RPM is to create and carry out appropriate information and advisory meetings for this project. A fish advisory group that can convene quickly and/or on a regular basis is the best way to avoid major losses to bull trout or other fish and wildlife during the construction phase of the Arrowrock project.
6. Conduct population estimates in Arrowrock Reservoir prior to and following the construction project. The term and condition for this RPM is to create population estimates to determine the project impacts.
7. Continue radiotelemetry studies in Arrowrock and Lucky Peak Reservoirs. The term and condition for this RPM is to monitor movements and mortality of bull trout in the reservoir to determine vulnerability to capture and entrainment during and after the completion of this project.
8. Continue, as directed by the Fish Advisory Group, to operate weirs on the North and Middle Forks of the Boise River. The term and condition for this RPM is to operate weirs during the construction project. Weirs on the North and Middle Forks of the Boise River will help generate population estimates and allow the capture of bull trout and their transport if hostile conditions occur in the reservoir during the project.

Reclamation has initiated numerous tasks and studies in compliance with the terms and conditions of these two biological opinions. Table 6-1 and Table 6-2 show the specific terms and conditions, related studies and tasks performed for the Boise, Deadwood, and Malheur River watersheds, time periods, status updates, and available reports. This chapter provides information from these studies.

In addition, Reclamation has continued to work with the Boise, Malheur, and Wallowa-Whitman National Forests, Burns Paiute Tribe, and the ODFW to collect distribution, migration timing, population size, and environmental effects information for bull trout within the Boise, Deadwood, Malheur, and Powder River basins under these two biological opinions. This work is ongoing. Table 6-1 and Table 6-2 cite the available reports; Section 6.7 summarizes the general study results.

Table 6-1. Description of work completed for the 1999 and 2001 biological opinions (USFWS 1999, 2001) in the Boise and Deadwood River watersheds.

Biological Opinion	RPM and T&C [1]	Project or Task	Time Frame	Purpose	Status	Reports Available
1999	RPM 1, T&C b	Boise Basin Bull Trout Population Genetic Analysis	2000-2003	Describe the genetic population structure and diversity, evaluate entrainment risks and extent with the Arrowrock and Lucky Peak Projects.	Completed. Final report available.	Whiteley et al. 2003.
1999	RPM 2, T&C c, CR 2	Boise and Deadwood Rivers Population and Habitat Monitoring	1999-2002	Monitor trends in migration and abundance with changes in habitat and environment.	Completed. Final reports available. Cooperative monitoring still underway.	Salow 2004b, 2004d; Salow and Cross 2003.
1999; 2001	RPM 1, T&C b, RPM 7	Lucky Peak and Arrowrock Adult Telemetry Study	2002-2005	Document levels of entrainment, mortality, and migration patterns.	In progress, interim report available.	Salow and Hostettler 2004.
1999; 2001	RPM 1, T&C b, RPM 7	North Fork Boise River Juvenile Telemetry Study	2001-2003	Tag and track juvenile-size bull trout to determine movement patterns in the river system prior to reservoir rearing and in the reservoir during rearing.	Completed. Interim report complete. Final expected December 2004.	Hostettler 2003.
1999; 2001	RPM 2, T&C b, RPM 7	Arrowrock Reservoir Habitat Use and Prey Investigation	2003-2005	Tag and track bull trout to determine habitat used and principal prey base in the reservoir during rearing and overwintering.	Project proposal completed. Year one tracking in progress.	Stiefel 2003.
1999; 2001	RPM 2, T&C a, RPM 4	Water Quality Monitoring and Planning	2002-2005	Sample, analyze, and report water quality conditions where bull trout are present.	Completed.	USBR 2003b, 2004a, 2004c.
2001	RPM 3	Lucky Peak Trap and Transport	2000-current	Capture and return bull trout entrained through Arrowrock Dam into Lucky Peak Reservoir.	Completed 4 years. Interim report available. Annual work continues.	Salow 2002.
2001	RPM 5	Creation of Fisheries Advisory Team for Arrowrock	2001-2004	Create advisory team to help plan, implement, and monitor impacts of construction project on bull trout.	Completed. Meetings held annually. Progress reports submitted to team.	Salow 2003, 2004a .
2001	RPM 6, RPM 8	Arrowrock Population Estimates	1999-2006	Determine reservoir population changes related to construction and drawdown.	In progress. 5 years completed.	Salow 2001, 2004c.

1. RPM is Reasonable and Prudent Measure; T&C is Term and Condition; CR is Conservation Recommendation.

Table 6-2. Description of work completed for the 1999 biological opinion (USFWS 1999) in the Malheur River watershed.

RPM and T&C [1]	Project or Task	Time Frame	Purpose	Status	Reports Available
RPM 1, T&C a	Entrainment Investigations	1999-2003	Describe alternatives to reduce entrainment at Agency Valley Dam.	Completed. Final report available.	Memorandum to files.
RPM 1, T&C b	Entrainment Reduction	1999-2004	Describe measures taken to reduce entrainment from Agency Valley Dam.	Completed. Final reports available. Cooperative monitoring still underway.	Schwabe and Perkins 2003.
RPM 1, T&C c	Reinitiate Consultation	1999-2001	Notify USFWS of changes resulting from RPM 1 and T&C 2.	Completed.	Memorandum sent to USFWS.
RPM 2, T&C a	Beulah Reservoir Water Quality Modeling	1999-2003	Sample, analyze, and report water quality conditions.	Completed.	USBR 2002.
RPM 2, T&C a	Reservoir Habitat Use and Prey Investigation	1999-2004	Tag and track bull trout to determine habitat used and principal prey base in the reservoir during rearing and overwintering.	Completed.	Gonzales 1998; Schwabe et al. 2001, 2002; Schwabe and Perkins 2003; Petersen et al. 2003.
RPM 2, T&C b	Conservation Fishery Pool Investigation	1999-2004	Describe alternatives to prevent draining of Beulah Reservoir to low levels.	Completed.	USBR 2001b.
RPM 2, T&C c	Ensure Conservation Pool at Beulah Reservoir	1999-2004	Provide a conservation pool for Beulah Reservoir.	Reclamation leased 2,000 acre-feet in 2001.	Memorandum to USFWS.
RPM 3, T&C a	Provide Passage for Entrained Fish	1999-2004	Capture and return bull trout entrained through Agency Valley Dam into the North Fork Malheur River.	Annual trap and haul continues. Updates provided in annual reports.	Schwabe and Perkins 2003; Reclamation comments on USFWS Recovery Plan.

1 RPM is Reasonable and Prudent Measure; T&C is Term and Condition

6.2 Distribution

6.2.1 Historical Distribution

Bull trout were present throughout the Snake River basin and in the eastern section of Idaho upstream from Shoshone Falls. The species is reported to have been widely dispersed throughout the basin, limited only by natural passage and thermal barriers. In this drainage, their historical range approximates that of spring, summer, and fall Chinook salmon (Thurow 1987; Rieman and McIntyre 1993) and possibly included the Owyhee River basin and other tributaries upstream as far as Salmon Falls Creek. They are not known to have occurred in the Snake River upstream from Shoshone Falls, the Wood River system, Birch Creek, or any stream in Idaho that drains the Centennial Mountains between Henrys Lake and the Bitterroot Range. An isolated population exists in the Little Lost River near Howe, Idaho, between the Lost River and Lemhi mountain ranges (Batt 1996).

In eastern Oregon, bull trout were present in the Grand Ronde, Malheur, and Powder River systems, but were not known to occur in the Burnt River system. Data on the bull trout's historical distribution in the Malheur River drainage is limited and dates from the ODFW observations beginning in 1955 (Buchanan et al. 1997). Before the construction of dams, bull trout could access the Snake River from the Malheur and North Fork Malheur Rivers. Anadromous salmon and steelhead historically spawned in the upper Malheur River basin (NPCC 2002). The lower Malheur River was most likely too warm for bull trout spawning or juvenile rearing but would have provided migration and overwintering habitat (Hanson et al. 1990 in Buchanan et al. 1997).

The Snake Hells Canyon subbasin lies within the historical native range of bull trout, although no clear documentation of the historical distribution of bull trout within the subbasin exists (Nez Perce Tribe 2004). According to Buchanan et al. (1997), there is no historical documentation of bull trout in the Powder River basin prior to the 1960s. It is suspected that they were widespread in the upper Powder River drainage and seasonally connected to the Snake River. Historical information about the distribution of bull trout below Hells Canyon Dam in the mainstem Snake River was very limited (Chandler 2003). Buchanan et al. (1997) reported that the IDFG observed bull trout at the mouth of Sheep, Granite, Deep, and Wolf Creeks between Hells Canyon Dam and the Imnaha River.

The distribution of bull trout may have paralleled the distribution of potential prey such as whitefish and sculpins. In several river basins where bull trout evolved with populations of juvenile salmon, bull trout abundance declined when juvenile salmon prey declined or were eliminated (Ratliff 1992).

6.2.2 Current Distribution

The USFWS draft *Recovery Plan for Bull Trout* (2002) specifies 22 recovery units for bull trout in the Columbia River basin and uses suspected historical function to delineate them. Currently, work on this draft recovery plan has been suspended for the 5-year status review as described in Section 6.1, and critical habitat was not designated in any of the action areas. However, both the draft recovery plan and the critical habitat designation contain thorough discussions of habitat requirements. Use of these documents allows Reclamation to eliminate redundancy and to provide a framework for delineation based on the populations of bull trout that occur in the action areas and the past work that has been completed. Figure 6-1 shows the known bull trout distributions and upstream migratory, spawning, and rearing habitats in the middle and upper Snake River basins. The following sections describe the units and subunits that occur within the action areas.

Southwest Idaho Recovery Unit

The Southwest Idaho Recovery Unit includes the Boise, Payette, and Weiser River basins in Idaho delineated on the basis of biology and life history needs. The populations these watersheds support represent regional “metapopulations.” A metapopulation is a network of populations that have some degree of intermittent or regular gene flow among geographically separate units (Gilpin and Hanski 1991).

The Arrowrock Core Area includes the Middle Fork and North Fork Boise Rivers upstream from Arrowrock Dam to the headwaters and the South Fork Boise River to Anderson Ranch Dam. The Anderson Ranch Core Area includes the South Fork Boise River upstream from Anderson Ranch Dam to the headwaters. Lucky Peak Core Area includes Lucky Peak Reservoir and the Mores Creek watershed.

Reclamation reservoirs in southern Idaho that are known to have bull trout associated with them are Arrowrock Reservoir (mainstem Boise River), Anderson Ranch Reservoir (South Fork Boise River), Lucky Peak Reservoir (mainstem Boise River), and Deadwood Reservoir (Deadwood River in the Payette River basin). One bull trout was reported in Lake Cascade in 2004 (Esch 2004). The USFWS identifies these reservoirs and watersheds for bull trout recovery because they support essential bull trout habitat elements; provide the best available habitat with the best opportunity to be restored to high quality; provide for replication of strong subpopulations within its boundaries; are large enough to incorporate genetic and phenotypic diversity; are small enough to ensure that the component populations effectively connect; and are distributed throughout the historical range of the species in Idaho (USFWS 2002).

Most of the data used for bull trout recovery and population assessments to date come from recently collected information using electrofishing and snorkeling techniques.

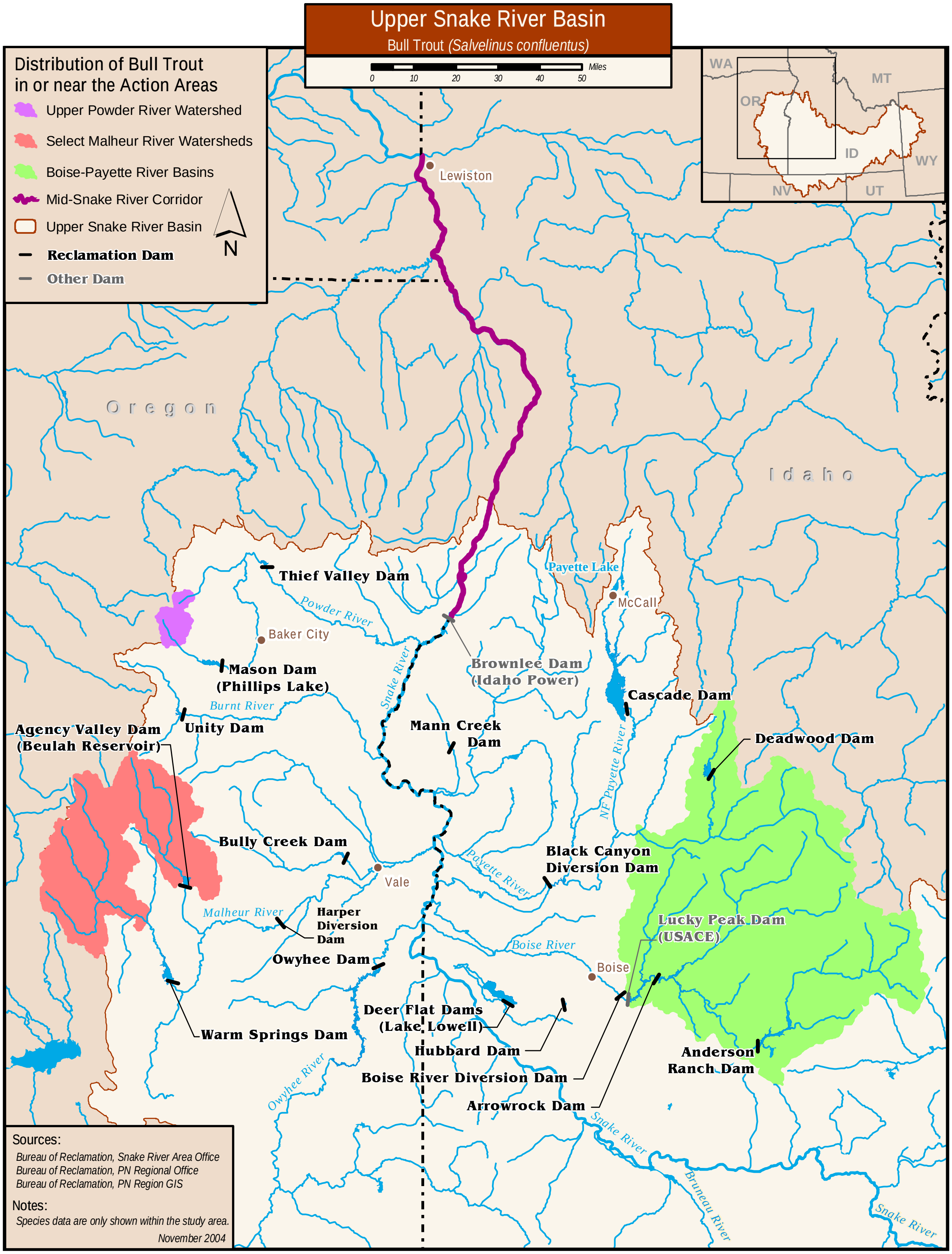

Figure 6-1. Known bull trout distributions in the watersheds associated with Reclamation facilities in the upper Snake River basin.

Comprehensive long-term monitoring data for bull trout populations do not exist for the Southwest Idaho Recovery Unit (USFWS 2002). Bull trout have been documented in the numerous tributaries, mainstem rivers, and reservoirs within the Payette and Boise River systems (Corley 1997; Dunham and Rieman 1999; Flatter 2000; Partridge 2000; Rieman and McIntyre 1995; Salow 2001, 2003, 2004b; Salow and Cross 2003; Salow and Hostettler 2004; Zurstadt and Jimenez unpublished), but their distribution is somewhat more restricted in the Payette River system (BNF 2003).

Boise River Recovery Subunit

Arrowrock and Lucky Peak Reservoirs and the North and Middle Forks of the Boise River and Mores Creek – Arrowrock Reservoir constitutes an important overwintering and foraging area for a relatively strong population of migratory bull trout. Subadults and adults migrate into Arrowrock Reservoir from upstream tributaries of the North and Middle Forks of the Boise River. The reservoir serves as important bull trout habitat from October through late spring and early summer, with a small number of fish that remain in the reservoir and mainstem South Fork Boise River downstream from Anderson Ranch Dam over the entire summer (Salow and Hostettler 2004). Many of these fish migrate out of Arrowrock Reservoir and into upstream riverine areas from February through June where they find cooler water temperatures and available spawning habitat. This migratory component is very important to the overall health and long-term persistence and recovery of this fish species as they allow for re-establishment of populations in reaches where bull trout have been extirpated (Rieman and McIntyre 1993; Whiteley et al. 2003).

The Boise River basin has been surveyed extensively for bull trout. The Boise National Forest and Reclamation conducted habitat and abundance surveys for bull trout throughout the Mores Creek, Middle Fork, and North Fork Boise River watersheds from 1999 through 2003 (Salow and Cross 2003; Salow 2004d). Greatest densities of bull trout were found in headwater streams of the North Fork Boise River including McLeod, McPhearson, Ballentyne, and Big Silver Creeks and upper Crooked River (see Figure 6-2). Bull trout were found in high numbers in the Middle Fork Boise River, the Queens and Little Queens Rivers, and Black Warrior and Decker Creeks (see Figure 6-3). A small population of bull trout was found in 2000 and 2001 in Mores Creek (a tributary to Lucky Peak Reservoir). Subsequent surveys have not found these fish (USBR unpublished). Entrainment occurs at Arrowrock Dam releasing fish into Lucky Peak Reservoir. Bull trout have been captured in gill net efforts in Lucky Peak Reservoir under a trap and transport program, which was initiated in year 2000 (Salow 2002). Analysis of population structure through use of microsatellite loci found no evidence that bull trout rearing in Mores Creek were a distinct population segment (Whitely et al. 2003). These fish were likely offspring of bull trout entrained through Arrowrock Dam that use the Mores Creek area for spawning and rearing habitat.

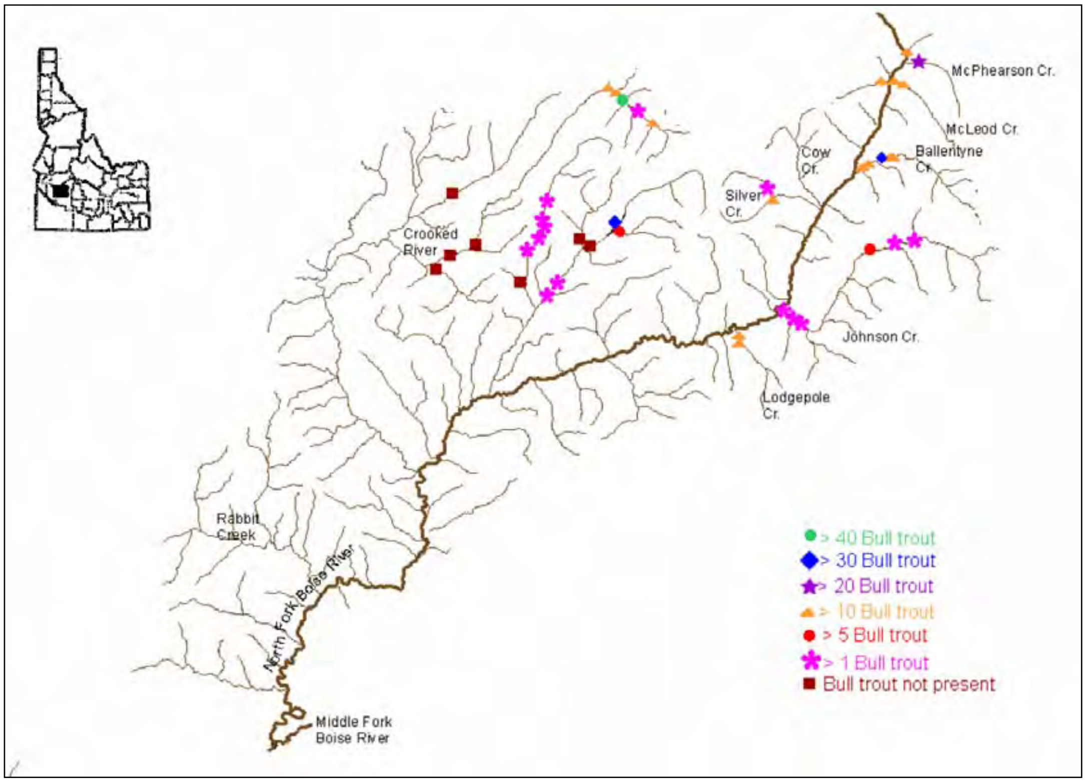

Figure 6-2. Distribution of bull trout within the North Fork Boise River watershed (Salow and Cross 2003).

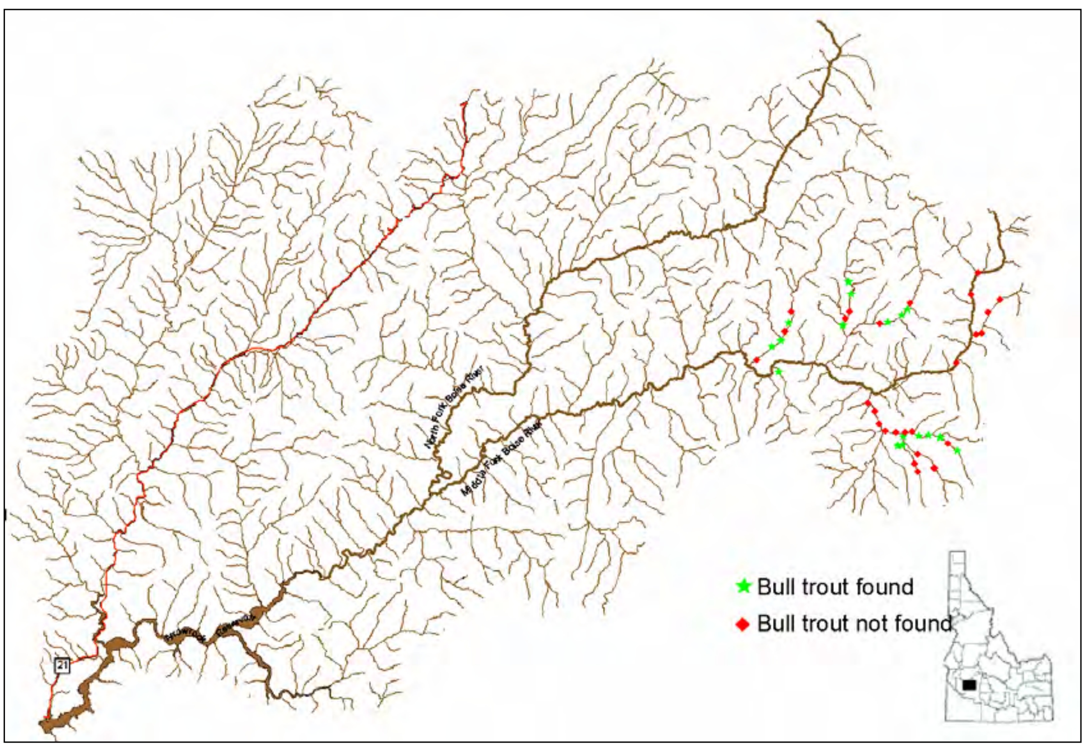

Figure 6-3. Distribution of bull trout within the Middle Fork Boise River watershed (Salow 2004d).

South Fork Boise River Downstream from Anderson Ranch Dam – To assess the health and abundance of the South Fork Boise River fishery downstream from Anderson Ranch Dam, the IDFG conducted electrofishing surveys during the fall in 1993, 1994, and 1997. Small numbers of bull trout were captured during this survey work. It is not known whether these bull trout were adfluvial (migrating up the South Fork Boise River from Arrowrock Reservoir), fluvial (residing in the South Fork), or passed through Anderson Ranch Dam; however, based on data collected in subsequent telemetry studies, it is presumed these fish originated in the North and Middle Forks of the Boise River.

Bull trout were found to use the South Fork Boise River downstream from Anderson Ranch Dam year-round as both overwintering and summer rearing habitat during radiotelemetry studies conducted in 2001 to 2003 (Salow and Hostettler 2004). Spawning within the mainstem river has not been documented, but a resident population of bull trout exists in Rattlesnake Creek, which is a tributary to the South Fork Boise River (Flatter 1999). Approximately 50 percent of the radio-tagged bull trout from the Middle and North Fork Boise Rivers enter the South Fork Boise River each fall for some period of the winter; two fish remained within the South Fork or moved between the South Fork and Arrowrock Reservoir throughout the following summer (Salow and Hostettler 2004).

Anderson Ranch Reservoir and South Fork Boise River upstream from Anderson Ranch Reservoir – Reclamation assisted IDFG in a radiotelemetry study and population estimate of bull trout at Anderson Ranch Reservoir from 1998 to 1999. The study found that Anderson Ranch Reservoir bull trout exhibited similar migratory behavior to the Arrowrock Reservoir bull trout, leaving the reservoir in late spring and spawning in the upper South Fork Boise River tributaries (Partridge 2000). The estimate of bull trout numbers in Anderson Ranch Reservoir from 1999 to 2000 was 370 individuals, with a range in length from 215 to 737 millimeters (mm) (Partridge 2000).

In 2002, backpack electrofishing was used by Fairfield Ranger District to sample for the presence of bull trout in some of the substantial perennial tributaries of the South Fork Boise River. Thirty-nine sites were sampled, with only one bull trout collected in these surveys (215 mm in length from Shake Creek).

Densities and distribution within the eastern section of the South Fork Boise River drainage has been conducted by Fairfield Ranger District. A total of 283 bull trout were sampled in the Boardman Creek drainage, while 93 bull trout were sampled in the Skeleton Creek drainage. More than 70 percent of the bull trout sampled in these drainages were shorter than 150 mm in length, and less than 5 percent were greater than 200 mm in length. Using multiple pass depletion methods for population estimation, population size was interpolated and expanded to the unsampled reaches of the monitored streams. A total bull trout population in excess of 6,200 (about 1,600 greater than 150 mm in length) was calculated in the Boardman Creek drainage prior to 2002 spawning. The comparable estimate for the Skeleton Creek drainage is about 2,200 (about 700 greater than 150 mm in length).

Weirs with trap boxes operated from late August through late October captured 85 outmigrating bull trout at the Boardman Creek weir and 69 outmigrating bull trout at the two Skeleton Creek weirs. Nearly all bull trout trapped were traveling downstream. Only one of the bull trout captured at the weirs was less than 150 mm in length, but only 9 were greater than 300 mm total length. For the three weir sites combined, 77 percent of the downstream migrants were from 175 to 249 mm in length (Kenney 2003).

Spawning and rearing populations of bull trout have been documented in the headwater streams above Anderson Ranch Reservoir. Tributaries throughout the North Fork and Middle Fork Boise Rivers and the South Fork Boise River upstream from Anderson Ranch Dam were surveyed in 2001 to analyze habitat and determine abundance and genetic structure of bull trout. Bull trout were found to be genetically different from the remainder of the Boise River basin in the South Fork Boise River upstream from Skeleton Creek. Two hypotheses may explain this difference: the foundation population for this group of fish originated in the Salmon River watershed and was colonized at a different time, or the Upper South Fork (Big Smoky Creek watershed) may have been isolated from the remainder of the system for some time prior to the construction of Anderson Ranch Dam by landslides similar to what has been documented in the Salmon River through geologic time (Whiteley et al. 2003). Skeleton Creek fish (upstream from Anderson Ranch Dam) had alleles found in North and Middle Fork populations but were not closely related in genetic distance.

Payette River Recovery Subunit

The Upper South Fork Payette River Core Area includes the Deadwood River downstream from Deadwood Dam and the South Fork Payette River. The Deadwood River Core Area includes the Deadwood River upstream from Deadwood Dam. The North Fork Payette River Core Area includes the Kennally Creek and Gold Fork Creek potential local populations. Although private diversions isolate these populations, bull trout could potentially use Lake Cascade as overwintering habitat.

Deadwood River and Reservoir – Reclamation and the USFS have recently used multiple-pass electrofishing and stream habitat surveys to identify populations of bull trout in several tributaries throughout the Deadwood River basin (see

Figure 6-4). Most populations are composed of small bull trout that appear to be resident. Although bull trout larger than 300 mm total length have been encountered in the mainstem Deadwood River and within the mouths of tributary streams, they appear to be extremely rare in the headwaters (Salow 2004b).

The adfluvial population of bull trout that uses Deadwood Reservoir appears to have significantly low densities relative to historical conditions. Small numbers of bull trout greater than 300 mm in total length were sampled in gill net surveys of Deadwood Reservoir. In 1997, the IDFG initiated bull trout studies at Deadwood Reservoir to determine the distribution and abundance of the adfluvial bull trout. Results from this study showed that bull trout were extremely difficult to capture. Only ten fish were caught in trap and gill nets and four were fitted with radio transmitters. Due to the small sample size, no conclusions could be made on the size, condition, or movement of bull trout in Deadwood Reservoir and its tributaries (Allen 1998).

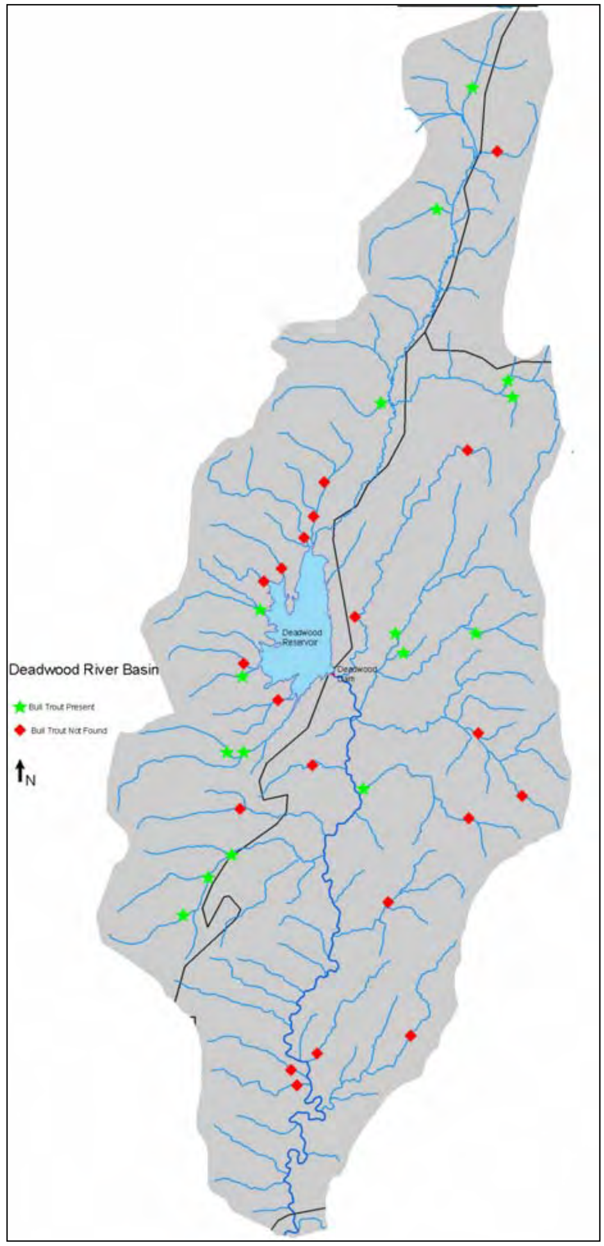

Figure 6-4. Bull trout distribution from multiple-pass electrofishing surveys in 2003 in the Deadwood River basin (Salow 2004b).

Limited data exist to document distribution of fluvial bull trout within the Deadwood River downstream from Deadwood Dam (Allen 1998). The IDFG conducted survey work in the summer of 1998 in the Deadwood River downstream from Deadwood Dam to better determine the presence of bull trout and the condition of the habitat in that stream reach between the dam and the South Fork Payette River. The IDFG found no bull trout during this survey (Allen 1998). Large bull trout have been reported as captured by anglers immediately downstream from Deadwood Dam in

October (Kimball 2001) and in the South Fork Payette River below the confluence of the Deadwood River in June (Rieber 2003).

North Fork Payette River and Lake Cascade – One population of bull trout is known to exist in the North Fork Payette River system, in Gold Fork Creek upstream from Lake Cascade (Apperson 2002), but this population is very small, and private diversions without fish passage limit the population's access to Lake Cascade. This population is outside the action areas discussed in this assessment.

Weiser River Drainage

Several tributaries of the Weiser River have been documented to have bull trout; however, these drainages are outside of the action areas discussed in this assessment.

Malheur River Recovery Unit

The Malheur River Recovery Unit includes the mainstem and North Fork Malheur River. This unit contains one core area, the Malheur Core Area, which includes two local populations located in the headwaters of the North Fork Malheur River and Upper Malheur River subbasins, and the mainstem Malheur River from headwaters downstream to Namorf Dam, respectively.

Current distribution of bull trout includes the North Fork Malheur River (including Beulah Reservoir) and the upper Malheur River upstream from Drewsey (see Figure 6-1 on page 161). Bull trout have not been documented in Warm Springs Reservoir. In 1955, bull trout were observed as far downstream as Wolf Creek (35 miles upstream from Warm Springs Reservoir) during chemical poisoning of the Middle Fork Malheur River (Hanson et al. 1990 in Buchanan et al. 1997). Bull trout occur in several headwater tributaries and in the Malheur River as far downstream as Bluebucket Creek. Elevated stream temperatures, low streamflows and low reservoir volumes, and lack of fish passage facilities at irrigation diversions (NPCC 2002) limit bull trout in the Malheur River from Bluebucket Creek to Warm Springs Reservoir (a distance of about 45 miles); there has been no recent documentation of bull trout in this reach.

Spawning and juvenile rearing takes place in some headwater tributaries of both systems as well as in the upper mainstem North Fork Malheur River. Bull trout in the North Fork Malheur River also migrate to and overwinter in Beulah Reservoir (Schwabe et al. 2000).

Hells Canyon Complex Recovery Unit

The Hells Canyon Recovery Unit includes basins in Idaho and Oregon, draining into the Snake River and its associated reservoirs from below the confluence of the Weiser

River downstream to Hells Canyon Dam (USFWS 2002). This recovery unit includes Hells Canyon, Oxbow, and Brownlee Reservoirs on the Snake River, which are all operated by Idaho Power.

Powder River Core Area

Current distribution of bull trout in the Powder River basin is in headwater tributaries of the Powder River 8 to 17 miles upstream from Phillips Lake and 20 to 25 miles upstream from Thief Valley Reservoir in the Elkhorn Range. All bull trout inhabiting the Powder River basin are thought to be resident fish (USFWS 2002). To date, no bull trout have been documented in either Phillips Lake or Thief Valley Reservoir (Buchanan et al. 1997; USFWS 2002). Historical dredge mining along most of the Powder River upstream from Phillips Lake severely degraded those reaches' habitats; this likely limits the current bull trout distribution to the headwater tributaries (USFWS 2002).

Hells Canyon Complex Reservoirs

Current distribution of bull trout in the Hells Canyon Complex is in Oxbow Reservoir, the Oxbow Bypass Reach, and Hells Canyon Reservoir (Chandler 2003). No bull trout have been documented above Brownlee Dam (Chandler 2003). Bull trout occur in several tributaries to the Hells Canyon Projects, including the Wildhorse River, Indian Creek, and Pine Creek.

Imnaha-Snake River Recovery Unit

The Snake River basin downstream from Hells Canyon Dam to the Imnaha River supports two bull trout subpopulations: Sheep Creek and Granite Creek. Both of these subpopulations are in tributaries on the Idaho side that flow directly into the Snake River. Bull trout from both of these tributaries spend part of their life history in the mainstem Snake River (USFWS 2002). Chandler (2003) identified that bull trout use the mainstem Snake River during the winter and migrate into the tributaries in the spring either for spawning or for thermal refuge.

6.3 Life History

Bull trout exhibit two distinct life history forms in the Snake River basin: migratory and resident. Migratory fish emigrate from the small headwater streams where they emerged and reared as juveniles to larger rivers (fluvial forms) or lakes (adfluvial forms). Resident fish remain in the spawning and rearing streams throughout their entire lives (Pratt 1992). Migratory bull trout may live for several years in larger rivers or lakes, and grow larger than resident forms before returning to the tributaries to spawn (Rieman and McIntyre 1993). They can live 11 years or longer and can be sexually mature after as early as 4 years of age. Growth differs little among life-history strategies during their first years of life in headwater streams, but it diverges as migratory fish move into larger and more productive waters. Resident and migratory life-history forms of fish may live together, but it is unknown if they represent a single population or separate populations. Migratory forms of bull trout appear to use much of the river basin in which they are located throughout their life cycle (see Bjornn et al. in Batt 1996; Hostettler 2003; Salow and Hostettler 2004).

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 re-establish segments of populations that have disappeared.

Migratory bull trout spawn between August and November. The incubation period for bull trout is long, and fry may take up to 225 days to emerge from the gravel (Fraley and Shepard 1989). Migratory bull trout usually emigrate from their rearing streams at 2 to 3 years of age when they are 150 to 200 mm in total length; however, younger fish may occasionally emigrate earlier (Elle et al. 1994). They move downstream to preferred habitats within larger rivers or lakes and find feeding sites (Hostettler 2003). After entering the river or lake, juvenile bull trout grow rapidly, often reaching over 426 mm in total length by the time they are 5 to 6 years old, depending on available food and habitat within the system (Salow 2001).

Adfluvial bull trout associated with Reclamation facilities have been documented to reside primarily in reservoirs and controlled rivers for about 6 months during the period from November to June; however, fish have been documented to spend as much as 20 months within these areas before returning to headwater streams to spawn (Salow and Hostettler 2004). They remain in spawning habitats until the first week of September when they begin the downstream migration after spawning to the mainstem river and enter reservoirs before December (Salow and Hostettler 2004). Juvenile bull trout remain in the upper watersheds for 3 to 5 years before migrating to larger streams and reservoirs (Hostettler 2003). Bull trout do, however, remain in mainstem, regulated rivers and occasionally move into reservoirs during the summer months. This migration may be in part to avoid high summertime water temperatures in some areas or insufficient water levels during drought years (Salow and Hostettler 2004).

Variation in the timing of migration 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 et al. in Batt 1996). It is possible that four or more age-classes could comprise any spawning population, with each age-class including up to three emigration strategies for migration (Rieman and McIntyre 1993). This theory supports the idea that the multiple life-history strategies found in bull trout populations represent important diversity within populations.

6.4 Habitat Requirements

Bull trout have more specific habitat requirements than other native trout species, mainly because they require water that is especially cold with clean cobble or gravel size substrate for spawning and development of embryos and alevins. Available reservoir habitat, bank stability, winter precipitation, drought, substrate type, available cover, cold water temperature, and the presence of migration corridors consistently appear to influence bull trout distribution and abundance (see Allan et al. in Batt 1996; Dunham and Rieman 1999; Salow 2001; Salow and Cross 2003). Available refugia are important to spawning adult fish as they are prone to predation by mammals and raptors during spawning (Salow and Hostettler 2004). Eggs are extremely vulnerable to siltation problems and bedload movement during the long incubation period.

Water temperature is a critical habitat characteristic for bull trout. Temperatures above 16 °C are thought to limit bull trout distribution (Dunham et al. 2003). Optimum water temperatures for growth in fry are thought to be 13.2 °C (Selong et al. 2001). Researchers recognize water temperatures influence bull trout distribution more consistently than any other factor. However, it is unknown if all life stages are influenced by temperature or only a particular life stage.

Bull trout are described as having voracious appetites, making them vulnerable to angling injury or mortality (Post et al. 2003). 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 (Pratt 1992). Mountain whitefish and kokanee trout are two of the bull trout's preferred prey (Knowles and Gumtow 1996; Vidergar 2000).

6.5 Factors Contributing to Species Decline

The causes of this decline of bull trout are many. These include migration barriers and diversions; forest and past fisheries management practices; habitat fragmentation and degradation through grazing and road construction; poor water quality caused by development, road construction and mining; and introduction of non-native competitive species (USFWS 2002). Sections 6.5.1 through 6.5.7 describe the current threats described in the USFWS draft *Recovery Plan for Bull Trout* (2002).

6.5.1 Passage Barriers and Stream Diversions

Dams, irrigation diversions, and other waterway alterations have interrupted bull trout migration (USBR 2003a). Dams without adequate fish passage have resulted in some populations with migratory life histories switching to resident life histories. Migratory bull trout formerly linked resident bull trout to much of the species' gene pool; currently, some resident populations are isolated, vulnerable to habitat degradation, and susceptible to a loss of genetic diversity (USBR 2003a). If a barrier occurs 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 (USBR 2003a). Private irrigation diversions on tributaries above Lake Cascade limit bull trout migratory corridors (Apperson 2002).

Construction of water storage structures appears to have been a significant factor in the reduction of bull trout range and distribution (USBR 2003a). From about 1908 to about 1950, dams were constructed on historical or current bull trout streams in the Boise, Payette, and Malheur River drainages. Construction and operation of dam and diversion facilities have modified streamflows, changed stream temperature regimes, blocked migration routes, entrained bull trout, and changed bull trout forage bases. Reclamation dams that may have affected bull trout migration in the past but do not currently have documented populations of bull trout include Warm Springs Dam, Mason Dam, and Thief Valley Dam.

The operation of dams often requires substantial drawdowns of the reservoir pools, especially during drought years, to accomplish the intended and authorized project purposes. Reduced reservoir volume directly affects the amount of aquatic environment for all organisms in the food web (USBR 2003a). Extreme drawdowns reduce the production of phytoplankton, zooplankton, rooted littoral vegetation, and aquatic insects. Reduction in the food base may reduce the prey available for predator species like bull trout, although some forage fish populations may be more concentrated and more readily available as prey (USBR 2003a). Extreme reductions in reservoir volume may force bull trout and other fish species into riverine habitats.

Drought results in reduced summer streamflows, increased stream temperatures, and reduced reservoir elevations. Increased water temperatures will predictably reduce spawning success and survival of bull trout (Knowles and Gumtow 1996).

6.5.2 Forest Management Practices

Fires, insects, and timber harvest require specific management to reduce the impacts to fisheries. Catastrophic fire events can drastically alter water quality, water temperature, abundance and deterioration of woody debris, bank vegetation, and streamflow characteristics. Wildfire has been documented to affect bull trout populations (Rieman et al. 1997). Salvage timber sales have a high potential to affect isolated bull trout populations.

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 nearly pristine streams. Road construction for timber harvest and fire control measures leads to increased siltation, channelization, and loss of habitat complexity and may have lead to declines in bull trout historically.

6.5.3 Livestock Grazing

Livestock grazing occurs on both private and federally owned areas within the Southwest Idaho, Malheur River, and Hells Canyon Complex Recovery Units. Past practices may have contributed to reduced riparian vegetation, increased siltation, and nutrient loading where animals had long-term access to streams.

6.5.4 Transportation Networks

Construction of roads and off-road vehicle use increases siltation, causes stream channelization, and reduces habitat complexity. Roads also permit human access for recreation to areas that previously may have been inaccessible or difficult to access. Boat ramps and streamside roads allow increased angler access, which can negatively affect bull trout populations through increased mortality due to angling injuries and poaching. Roads are often built or managed for fire suppression, livestock access, recreation, recreation site access, and timber harvest. These uses collectively can negatively affect bull trout and their habitat.

6.5.5 Mining

Historically, dredge mining occurred in many watersheds where bull trout are present. Suction dredge mining, though regulated, still occurs throughout much of the Boise River basin and may negatively affect feeding, migration, and overwintering habitat for bull trout.

6.5.6 Residential Development and Urbanization

Small communities (examples in the Boise River basin include Atlanta, Featherville, Pine, and Rocky Bar) request water for hydroelectric projects, irrigation, and municipal uses. Negative impacts from seepage of household chemicals and sewage into water systems may occur as communities continue to grow. Additional road construction and maintenance for access to these remote areas may negatively affect stream channels by siltation and reduction in channel complexity.

6.5.7 Fisheries Management

Brook trout were introduced to Oregon and Idaho in the early 1900s. Brook trout not only compete directly with juvenile bull trout for food but also are genetically close enough to the bull trout to permit hybridization. Brook trout hybrids reproduce, and increased mating between bull trout and brook trout resulting in hybrids reduces the potential for bull trout populations to maintain themselves. The danger is especially acute when there are few bull trout since the hybrids cannot contribute to the bull trout population.

The USFWS (2002) also describes fisheries management as a factor for decline. Transmission of disease and injury by anglers or hatchery stocking can cause declines in bull trout and their prey. Hatchery stocking may introduce whirling disease (caused by the protozoan *Myxobolis cerebralis*), which has caused declines in rainbow trout young of year and juveniles. Additionally, fishes such as smallmouth bass stocked in reservoirs may compete with adfluvial bull trout for prey and expose bull trout to incidental angler harvest or injury. When brown trout 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. Other introduced species that provide forage and have different habitat preferences, such as kokanee, may benefit bull trout.

Anglers formerly viewed bull trout as a “trash fish.” Because they consume juvenile salmon and other game fish, they 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 of other human activities. The remaining populations may suffer from a loss of genetic diversity and may not be able to sustain themselves. Angling and harvest of bull trout influence the current status of this species, which may be vulnerable to over-harvest (Post et al. 2003). Although the direct, legal harvest of bull trout has been eliminated or restricted in most states, incidental take of this species in recreational trout fisheries and by poachers, especially in streams supporting large migratory fish, as well as catch and release mortality, may further affect bull trout abundance (Salow and Hostettler 2004).

Chemical treatments to control non-game fish species may have also adversely affected bull trout throughout their range. Chemical treatment of stream sections may have injured or killed adfluvial bull trout that use rivers and reservoirs for overwintering.

6.6 Recovery Efforts

In 1995, Idaho Governor Phil Batt initiated development of a conservation plan to restore bull trout populations in Idaho. The mission of the Governor's Bull Trout Conservation Plan (released July 1996) is to "…Maintain and/or restore complex interacting groups of bull trout populations throughout their native range in Idaho." The goals of this plan include:

1. Maintain the condition of those areas presently supporting critical bull trout habitat.
2. Institute recovery strategies that produce measurable improvements in the status, abundance, and habitats of bull trout. Concentrate resources and recovery efforts in areas that will produce maximum cost-effective, short-term returns and that will also contribute to long-term recovery.
3. Establish a secure, well-distributed set of sub-watersheds within key watersheds to achieve a stable or increasing population and to maintain options for future recovery.
4. Achieve the above goals while continuing to provide for the economic viability of Idaho's industries.

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.

After the listing of the Columbia and Klamath Distinct Population Segment (DPS) of bull trout in 1998, the USFWS released the draft *Recovery Plan for Bull Trout* (2002) and draft proposal for critical habitat designation (67 FR 71236). Both of these documents used the Oregon and Idaho bull trout plans to develop recovery goals and establish primary constituent elements for critical habitat. Recovery goals outlined in the plan are similar to those stated in the Idaho plan but are more broadly applicable to the entire Columbia DPS as it was listed. These are:

1. To maintain and restore the distribution of bull trout.
2. To maintain and restore habitat for all life history forms.

3. To conserve genetic diversity.
4. To implement recovery actions and assess their success.

Teams of Federal, State, and private individuals were created to develop and implement specific objectives for each recovery unit that was delineated in the recovery plan. Reclamation has been involved with the Southwest Idaho, Malheur, and Hells Canyon Complex Recovery Unit teams (projects located within the area covered by this consultation) and provides data and technical expertise to these teams.

In 1999, the State of Idaho initiated a public education campaign to improve angler awareness of the various resident salmonid species in several areas of Idaho. The program included brochures, stickers, large signs within drainages, and an interaction program to test angler's ability to identify the various resident salmonids. The IDFG continues to support this program through signs, brochures, and active enforcement.

Bull trout are distributed primarily on federally owned land within the action areas. Most Federal agency actions that improve conditions for bull trout are non-discretionary actions conducted in response to reasonable and prudent measures and terms and conditions developed as a part of Section 7 ESA consultations, as opposed to efforts specifically pursued to implement recovery plans.

6.7 Current Conditions in the Action Areas

The USFWS has determined that the Reclamation facilities that affect bull trout within the action areas are Arrowrock, Anderson Ranch, Deadwood, and Agency Valley Dams (USFWS 1999; 67 FR 71236). Reclamation operations that control the conveyance and storage of irrigation water in the Lucky Peak Dam and Reservoir are also considered in this consultation. Construction and operation of these facilities have modified streamflows, changed stream temperature regimes, blocked migration routes, entrained bull trout, and changed bull trout forage bases. Though little information is known about the extent of the impacts to migration of bull trout from these facilities, populations of bull trout have been found upstream, downstream, or adjacent to these facilities.

This consultation includes a discussion of bull trout in the Hells Canyon Complex area. Reclamation did not discuss the potential impacts from Reclamation operations in the upper Snake River basin to bull trout present in reaches of the mainstem Snake River between Oxbow Reservoir and Lower Granite Reservoir in previous consultations. The USFWS, in previous biological opinions, has not indicated any effects to bull trout in the lower Snake River.

6.7.1 Boise River Basin

Bull trout have been found during surveys in headwater streams of the North Fork Boise River, the Yuba, Crooked, and Queens River drainages, and Black Warrior and Mores Creeks (Salow and Cross 2003; Salow 2004d). Additionally, bull trout have been found to inhabit Arrowrock, Lucky Peak, and Anderson Ranch Reservoirs as adfluvial forms (Flatter 2000; Partridge 2000; Salow 2002).

Population structure analysis using genetic markers can help determine how closely groups are related, to determine if groups have been isolated from other groups within the same population, and as an aid to determine migratory components. Through the analysis of microsatellite loci, Whiteley et al. (2003) discuss the weak population differentiation within the Boise River basin with the exception of the South Fork Boise River (upstream from the mouth of Skeleton Creek on the South Fork Boise River). This area stands as an outlier from the remainder of the system and should be considered a separate conservation unit. The weak population differentiation seen in the Middle and North Fork Boise Rivers is most likely due to the frequent disturbance within the system (from fire, flooding, and drought). The weak population differentiation within these streams also stresses the importance of the migratory component of fish within the North and Middle Forks of the Boise River. Bull trout in the Mores Creek watershed, a tributary of Lucky Peak Reservoir, were most likely offspring of entrained bull trout that passed through Arrowrock Dam into Lucky Peak Reservoir from the North and Middle Forks of the Boise River.

Arrowrock and Lucky Peak Reservoirs and the North and Middle Forks of the Boise River

Arrowrock Reservoir constitutes an important overwintering and foraging area for a relatively strong population of migratory bull trout. Bull trout inhabiting Arrowrock Reservoir are adfluvial forms that spend several years in the tributaries (and up to 20 months in the reservoir) until they mature, generally when 5 to 7 years old. Subadults and adults migrate into Arrowrock Reservoir from upstream tributaries of the North and Middle Forks of the Boise River. The reservoir serves as important bull trout habitat from October through late spring and early summer, with a small number of fish that remain in the reservoir and mainstem South Fork Boise River downstream from Anderson Ranch Dam over the entire summer (Salow and Hostettler 2004). Many of these fish migrate out of Arrowrock Reservoir and into upstream riverine areas from February through June where they find cooler water temperatures and available spawning habitat. This migratory component is very important to the overall health and long-term persistence and recovery of this fish species as it allows for re-establishment of populations in reaches that have been extirpated. (Rieman and McIntyre 1993; Whiteley et al. 2003).

Reclamation annually begins drafting Arrowrock Reservoir (usually as part of flood control in April) to a conservation pool of 28,700 acre-feet (the reservoir may be drafted below 10,000 acre-feet in dry years) and holds at this level until Labor Day. In the past ten years, the reservoir volume has fallen below the conservation pool volume twice, during the fall of 1994 and during the fall of 2003 for construction associated with valve replacement. All storage in the reservoir, with the exception of a small volume of dead space created by retirement of the sluice gates in 2004, is usable for irrigation and flood control. The lower pool elevations in Arrowrock Reservoir are a result of Reclamation releasing water to meet irrigation demand to maintain a recreation pool in Lucky Peak Reservoir (USBR 2004b). In normal water years, Lucky Peak Reservoir is kept nearly full from Memorial Day to Labor Day to provide for recreation. However, efficiency dictates that Reclamation store water as high in the river system as possible, and this means that Arrowrock Reservoir's end-of-season volume may be more than the conservation pool, especially during years of above-average runoff. After Labor Day, Lucky Peak Reservoir provides water to meet irrigation demands while Arrowrock Reservoir begins to refill. Generally, Arrowrock Reservoir is at or near its conservation pool through July and August.

When Arrowrock Reservoir is rapidly drawn down to very low levels, some portion of nutrients, food organisms, and fish pass through the dam into Lucky Peak Reservoir; this contributes to the reduction of the self-sustaining fish resource. The rapid summer drafting of Arrowrock Reservoir for irrigation and the low winter reservoir levels likely reduce the reservoir's productivity, provide little littoral region, and consequentially discourage growth and reproduction of aquatic invertebrates and plants. This limits the production and sustenance of aquatic fauna, especially zooplantivores, such as kokanee trout (May et al. 1988), a major prey item for bull trout in other lakes and reservoirs (Vidergar 2000).

Arrowrock Reservoir conservation pool elevations and suitability of water quality conditions for adfluvial bull trout populations depend on the annual fluctuations in weather conditions and impacts of consecutive years of high or low regional stream runoff (USBR 2003b). Currently, bull trout habitat is available through most of the year except July through September in consecutive dry years when temperatures rise and dissolved oxygen levels fall below acceptable levels (USBR 2003b).

The IDFG, with funding from Reclamation, conducted a radiotelemetry and mark recapture study of bull trout at Arrowrock Reservoir from 1996 to 1998 (Flatter 2000). The purpose of the study was to estimate the population size, document entrainment from Arrowrock Reservoir into Lucky Peak Reservoir, and delineate some life history characteristics. Flatter found an estimated 471 bull trout for 1997 and an estimated 345 bull trout for 1998 that were 300 mm or longer. Estimated entrainment rates for bull trout equal to or greater than 300 mm in total length were 42 bull trout for 1997 and 54 bull trout for 1998.

High entrainment rates could be attributed to large flood control releases in the winter, such as those made during the 1997 and 1998 water years. During the period that adfluvial bull trout were overwintering in Arrowrock Reservoir, the reservoir content was dropped from 252,960 acre-feet on December 31, 1996, to 62,120 acre-feet on March 31, 1997. Arrowrock Reservoir was then filled quite rapidly through the end of June.

Flatter (2000) also investigated migration and movement patterns. Adult bull trout were found to migrate from Arrowrock Reservoir into the Middle Fork and North Fork Boise Rivers from May to June and spawn in the upper tributaries in August and September. Not all adult fish migrate in a given year, and mature adfluvial bull trout appear to reside in the reservoir for about 6 months, from November to June. Bull trout will occupy deeper areas of the reservoir where water temperatures are cooler (7 to 12 °C) and move to the surface when surface water temperatures drop to or below 12 °C.

The IDFG also determined whether fish were entrained through the ensign valves or over the spillway of Arrowrock Dam and at approximately what the depth at which the fish were entrained. Flatter (1999) found that of the radio-tagged bull trout entrained through Arrowrock Dam in 1998, four of ten were entrained through the valves, with depths from the surface to the upper valves ranging from 19 to 111 feet when those fish were entrained. Flatter (1999) also found that 6 of 10 bull trout were entrained over the spillway during the same period.

Reclamation conducted work similar to Flatter to determine the extent of entrainment related to the Arrowrock Dam valve rehabilitation project. This work was initiated in 2001 and extended through 2004 to determine entrainment rates before, during, and after the construction project. Because the spillway was not operated during the period of the construction project, all of the bull trout that were entrained did so through the valves. The overall rate of entrainment observed during the construction project was comparable to that observed in Flatter’s work (just over 11 percent compared to 10 to 16 percent). The depths from the reservoir surface at which the fish were entrained during the construction project (15 to 105 feet) were similar to the range found by Flatter. Entrainment occurred primarily at higher than average discharge from the dam near the surface elevation of the reservoir (Salow and Hostettler 2004).

Reclamation altered operations of Arrowrock Dam in 1999 to reduce use of the spillway. Reclamation documented 6 of 118 radio-tagged bull trout entrained in 2002 (5.09 percent, prior to the reservoir draw down for construction) and 6 of 53 radio-tagged bull trout entrained in 2003 (11.3 percent during the construction related draw down). If extrapolated to population level of fish greater than 300 mm, the entrainment estimate would be 24 for 2002 and 69 for 2003 (Salow and Hostettler 2004).

Based on limited data from the Arrowrock Reservoir bull trout investigations, it appears that bull trout moved into Lucky Peak Reservoir over a wide range of Arrowrock Reservoir elevations. Rates of entrainment appear to be positively correlated with high velocity discharge (either over the spillway or through the gates) that occurs near the reservoir surface (Salow and Hostettler 2004).

Beginning in 2000, Reclamation initiated a trap and haul program for the bull trout entrained into Lucky Peak Reservoir, returning them to Arrowrock Reservoir as part of the USFWS terms and conditions identified in their biological opinion for Arrowrock Dam construction activities (USFWS 2001). This trap and haul program will continue until a long-term entrainment reduction solution is determined. Since the implementation of the program, over 60 bull trout have been trapped and returned to Arrowrock Reservoir (Salow 2002).

Rehabilitation of the lower row of valves at Arrowrock Dam began in September 2001 and was completed in 2004. Valve replacement required short-term changes in reservoir operations at Anderson Ranch, Arrowrock, and Lucky Peak Reservoirs. Construction activities have occurred mostly during the non-irrigation season (September through February). Drafting of Arrowrock Reservoir was necessary during the winter of 2003-2004 to allow for work on the upstream side of Arrowrock Dam. Some sediment was released from Arrowrock Dam during the third season of construction, which was complicated by a large wildfire and subsequent landslides on the Middle Fork Boise River (Hot Creek Fire in July 2003). The sluice gates were not operated to pass elevated inflows at any time during the construction project.

Reclamation initiated a large-scale radiotelemetry investigation to monitor the impacts of the reservoir drawdown on the adfluvial population of bull trout in 2001. Major components of this work included documenting mortality rates and associated causes of mortality, reservoir use and timing, and levels of entrainment for adfluvial bull trout using Arrowrock Reservoir. Monthly updates and an interim report with findings to date are available (Salow 2003, 2004a; Salow and Hostettler 2004).

Significant findings to date from this investigation showed that little mortality related to water quality was observed. Mortality rates increased when Arrowrock Reservoir was reduced to a 1,500-acre-foot pool during a replacement of valves on the dam in 2003. The reservoir dewatering and the subsequent channelization of normally inundated areas created unstable stream banks; there was no other cover for fish available, and these banks collapsed frequently. The migratory corridor near Irish Creek provided water depth and channel stability when the reservoir area was inundated to an elevation of 944.9 m (3,100 feet; 38,840-acre-foot volume) (Salow 2004d).

The valve replacement construction project more than doubled mortality rates for post-spawning bull trout. Prior to construction, 22 percent of tagged fish were killed during the post-spawning migration. During the construction project, 47 percent of radio-tagged fish were killed during this time frame. Most mortality was due to increased predation related to poor habitat conditions; no refugia habitat (areas to hide) was available in migratory corridors within the upper reservoir. Estimated numbers of bull trout killed during the construction project (using the 2002 estimate from Table 6-3) would be 157 fish from the North Fork Boise River population and 113 fish from the Middle Fork Boise River population. Impacts to bull trout due to degraded water quality conditions were not found, though it had been anticipated as the primary cause of mortality during the planning process (Salow and Hostettler 2004).

Reclamation and the IDFG have documented bull trout mortality from angling or poaching. Reclamation has worked closely with IDFG staff to fund public signs warning anglers to release bull trout. Additionally, Reclamation works closely with IDFG enforcement staff to document important holding areas for bull trout with public access where poaching is likely. Poaching and angling-related mortality still occur despite informational signs and brochures distributed to anglers (Haynes 2003).

Hybridization between introduced brook trout and bull trout has been documented in several tributary streams in the Boise River basin. Hybridization has been documented in the Crooked River and its tributaries that flow into the North Fork Boise River (Whiteley et al. 2003).

Weir count data is being used to generate population estimates for adult adfluvial bull trout that overwinter in Arrowrock Reservoir and the South Fork Boise River below Anderson Ranch Dam. Reclamation operates weir traps on the North Fork and Middle Fork Boise Rivers to capture post-spawning adult bull trout and juvenile migrants returning to Arrowrock Reservoir. The North Fork Boise River weir was first operated in 1999, and the Middle Fork Boise River weir was first operated in 2002. Continued operation of both weirs has occurred in conjunction with the valve replacement work and will continue through 2005 to monitor the bull trout population. The data are revealing a declining trend in overall population size for the Boise River adult adfluvial population of bull trout (see Table 6-3). Salow (2004c) more completely describes the analyses and biases using weir counts for annual population estimates.

Table 6-3. North Fork Boise River weir trap mark-recapture population estimates (Salow 2004c).

Year	Marked Year 1	Marked Year 2	Recaptured Year 2	Estimate	Standard Deviation
1999	109	121	18	732.72	159.34
2000	143	113	28	577.11	94.59
2001	157	68	23	464.17	78.74
2002	102	49	15	333.20	71.66

Surveys conducted over multiple years found that reduced water levels (winter precipitation and spring runoff) were negatively correlated with reduced fish densities in small, high-elevation tributary streams (Salow and Cross 2003). Additionally, drought appears to have significant negative effects on survival of bull trout, especially with juvenile bull trout migrating within the main river (based on the composition and overall catch rates of juvenile bull trout at weirs in Salow 2004c).

Several other investigations into aspects of bull trout life history are ongoing within the Boise River basin. Reclamation, the Boise National Forest, the IDFG, and Boise State University are cooperating in conducting two radio-tagging and tracking investigations for juvenile and subadult-sized (less than 300 mm in total length) bull trout. The first examines movements, overwintering behavior, and migration patterns in the North Fork Boise River and Arrowrock Reservoir. This project is a 2-year graduate program through Boise State University and is scheduled to be completed in December 2004. Work completed so far indicates that distance of downstream movement in juvenile bull trout is positively correlated to the total length of the fish and that decreases in temperature and increases in flow affect timing of downstream movement (Hostettler 2003). The second study will examine reservoir habitat use, duration of occupancy, and feeding patterns by bull trout. This 2-year study is anticipated to be completed in June 2006.

South Fork Boise River Downstream from Anderson Ranch Dam

To assess the health and abundance of the South Fork Boise River fishery downstream from Anderson Ranch Dam, the IDFG conducted electrofishing surveys during the fall in 1993, 1994, and 1997. Small numbers of bull trout were captured during this survey work. It is not known whether these bull trout were adfluvial (migrating up the South Fork Boise River from Arrowrock Reservoir), fluvial (residing in the South Fork), or passed through Anderson Ranch Dam; however, based on data collected in subsequent telemetry studies, it is presumed these fish originated in the North and Middle Forks of the Boise River.

Radiotelemetry studies conducted from 2001 to 2003 (Salow and Hostettler 2004) showed bull trout using the South Fork Boise River downstream from Anderson Ranch Dam year-round as both overwintering and summer rearing habitat. Spawning within the mainstem river has not been documented, but a resident population of bull trout exists in Rattlesnake Creek, a tributary to the South Fork Boise River (Flatter 1999). Approximately 50 percent of the radio-tagged bull trout from the Middle and North Fork Boise Rivers enter the South Fork Boise River each fall for some period of the winter; two fish remained within the South Fork or moved between the South Fork and Arrowrock Reservoir throughout the following summer (Salow and Hostettler 2004).

Water temperatures recorded downstream from Anderson Ranch Dam (10 to 12 °C) are suitable for adult bull trout occupancy during most of June through October, but the temperatures have lacked the normal stream variation and the natural flow regime of free-flowing streams. Releases from the dam have occurred by passing water through the intake located deep in the reservoir's water column. Generally, mean daily water temperatures below the dam in normal water years have ranged from 3.7 to 11.4 °C. In years where powerhead has been used to supply streamflows (usually consecutive dry years), mean daily water temperatures can get as high as 15.3 °C.

The South Fork Boise River is a regulated stream with a discharge required to meet a variety of needs, including minimum streamflows, power generation, and irrigation demands. Under past and current operations, the lack of a natural hydrograph has altered and possibly reduced channel complexity; altered streamflow (including daily mean flow, peak variation, and timing); altered water temperature mean and natural variation; altered the aquatic community composition; and altered the migratory corridor condition. Streamflow alteration has been found in other impounded systems to affect aquatic fauna and can completely change an aquatic community (Mueller and Marsh 2002; Marotz et al. 1999). The flow regime identified in USBR (2004b) has likely affected the downstream fishery, but the magnitude and extent of the effect has not been studied and is currently unknown.

Maintenance operations at Anderson Ranch Dam that require dewatering the penstock and releasing water over the spillway after May 15 (such as occurred in 2003) cause temperature increases, which may adversely affect bull trout summer habitat and migration patterns. Reclamation has informally consulted on individual maintenance activities that required penstock dewatering. The unique aspects of each maintenance activity may require alteration of seasonal timing, volume, and release elevation. Informal consultations will continue individually for each maintenance activity.

Anderson Ranch Reservoir

Reclamation assisted the IDFG in a radiotelemetry study and population estimate of bull trout at Anderson Ranch Reservoir from 1998 to 1999. The study found that Anderson Ranch Reservoir bull trout exhibited similar migratory behavior to the Arrowrock Reservoir bull trout, leaving the reservoir in late spring and spawning in the upper South Fork Boise River tributaries (Partridge 2000). One notable contrast between Arrowrock Reservoir and Anderson Ranch Reservoir is that the Anderson Ranch study did not document fish entrainment through Anderson Ranch Dam. This lack of entrainment may be due to releases made from a greater depth and infrequent surface spills that occur later in the year.

Reclamation and the IDFG participated in a second radiotelemetry study in the spring of 2002 using temperature-depth archival tags in conjunction with radio tags to examine overwintering reservoir habitat use, movement, and entrainment. No entrainment was documented in this study. Unfortunately, the temperature-depth tags did not remain attached to these fish, and therefore, data could not be collected.

Water quality conditions for adfluvial bull trout populations have depended on the annual fluctuations in weather conditions such as wind and precipitation as well as impacts of consecutive years of high or low regional water levels. Anderson Ranch Reservoir's significant conservation pool (due primarily to the design and operation of the dam) appears to provide adequate water for bull trout (USBR 2004a). The volume of 62,000 acre-feet in the conservation pool is a combination of inactive storage and water held to maintain hydraulic pressure (often referred to as 'power head') to generate power. Under past operations, temperature and dissolved oxygen elements generally met State of Idaho standards for salmonid rearing and suitable thermal habitat (between 2 and 15 °C) through most of the year. However, conditions have become marginal in mid- to late summer, especially in consecutive dry years (USBR 2004a).

Fish kills, primarily of kokanee trout, were observed in August 2001, a drought year. That year, spring runoff was not sufficient to fill Anderson Ranch Reservoir. The effect of multiple years of drought that preceded 2001 led to low water volumes; an anoxic section of water moved through the reservoir and presumably caused the fish kills (Megargle 2004). As Figure 6-5 shows, Anderson Ranch Reservoir water elevations had not reached such low levels since 1993 and 1994; however, no fish

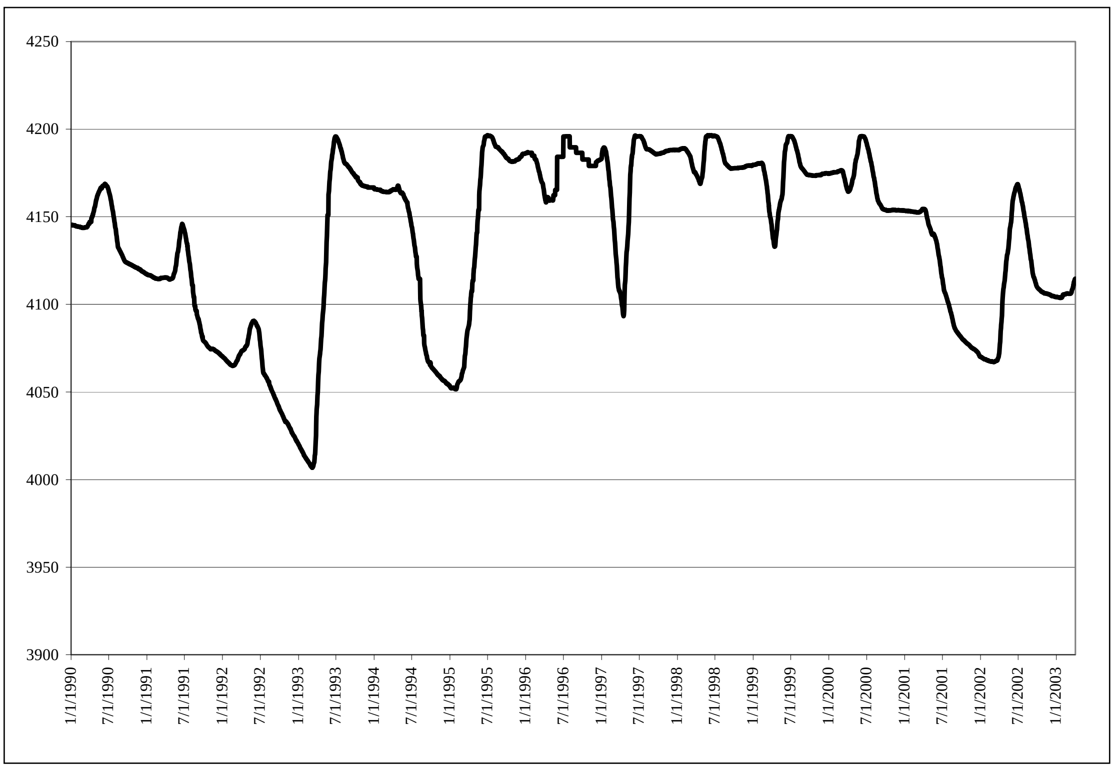

Figure 6-5. Anderson Ranch Forebay elevations, 1990 through 2003.

kills were documented during those years. The anoxic zone of water was presumably caused by the combined factors of the reduced cross winds that would normally allow for surface currents and turnover, high water temperatures caused by unusually high air temperatures, and unusually low water volumes (see Figure 6-5, Figure 6-6, and Figure 6-7). Kokanee trout have been documented in numerous studies as an important prey item for bull trout (Vidergar 2000; Beauchamp and Van Tassell 2001); however, the loss of kokanee trout as a source of prey that occurred in 2001 has had an unknown effect on Anderson Ranch bull trout.

6.7.2 Payette River Basin

Deadwood River and Deadwood Reservoir

Adequate water temperatures and the presence of adequate water volume have been available for bull trout except in consecutive dry years. Deadwood Reservoir has a conservation pool held at 50,000 acre-feet. Under past operations, temperature and dissolved oxygen levels generally met State of Idaho standards for salmonid rearing and suitable thermal habitat (between 2 and 15 °C) through most of the year. However, conditions have become marginal in mid- to late summer, especially in consecutive dry years (USBR 2004c).

Generally, the food base for bull trout has been abundant in Deadwood Reservoir under past and current operations. Kokanee trout and cutthroat trout, both introduced species, are generally abundant, and their densities have fluctuated over time, depending on spawning success. The IDFG operates a weir to capture and monitor upstream movement of kokanee in the fall of each year. Kokanee serve as an important prey item for bull trout in lakes and reservoirs where both species are present (Vidergar 2000).

Anglers have reported poor catch rates for bull trout in Deadwood Reservoir since 1990 (Salow unpublished, Deadwood Reservoir). Few adfluvial bull trout have been documented in Deadwood Reservoir since 1997 (Allen 1998). Chemical treatment of stream sections to remove undesirable fishes in the Deadwood River basin upstream from Deadwood Dam in 1992 may have injured or killed adfluvial bull trout using Deadwood Reservoir for overwintering (Jimenez and Zaroban 1998). The decline in numbers of adfluvial bull trout found in Deadwood Reservoir corresponds to reduced kokanee populations and low reservoir volumes that occurred in the late 1980s and early 1990s. In addition, Atlantic salmon (a competitor with bull trout for prey) were introduced to Deadwood Reservoir in the early 1990s.

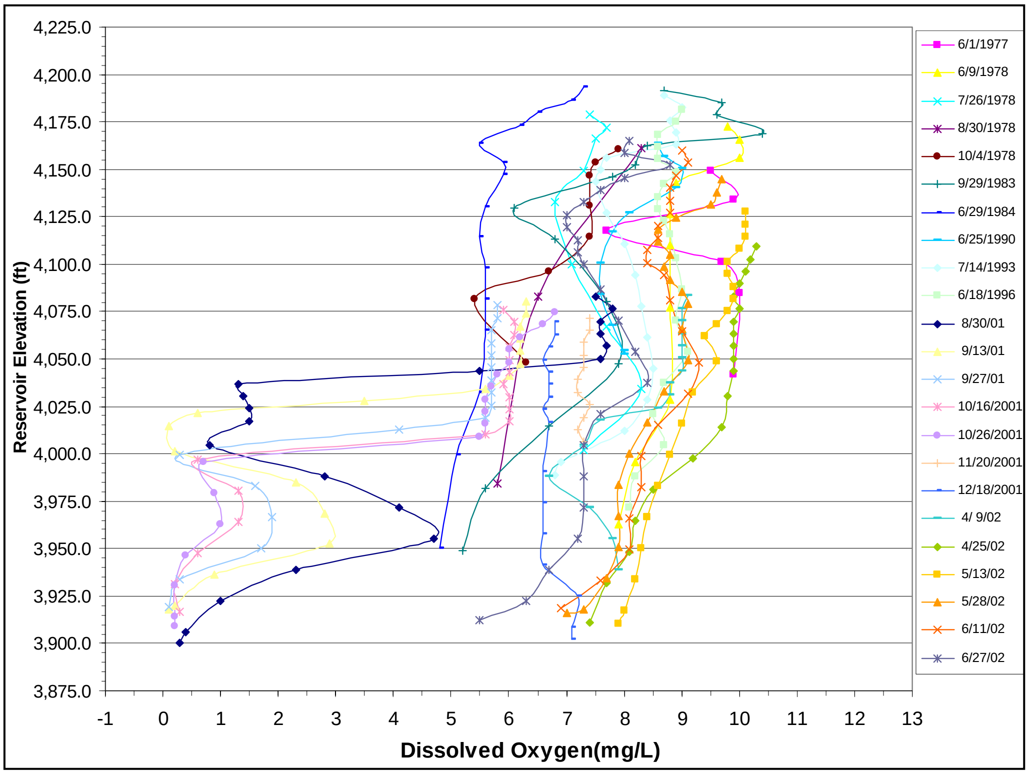

Figure 6-6. Dissolved oxygen reservoir profiles 100 meters in front of Anderson Ranch Dam through a series of years.

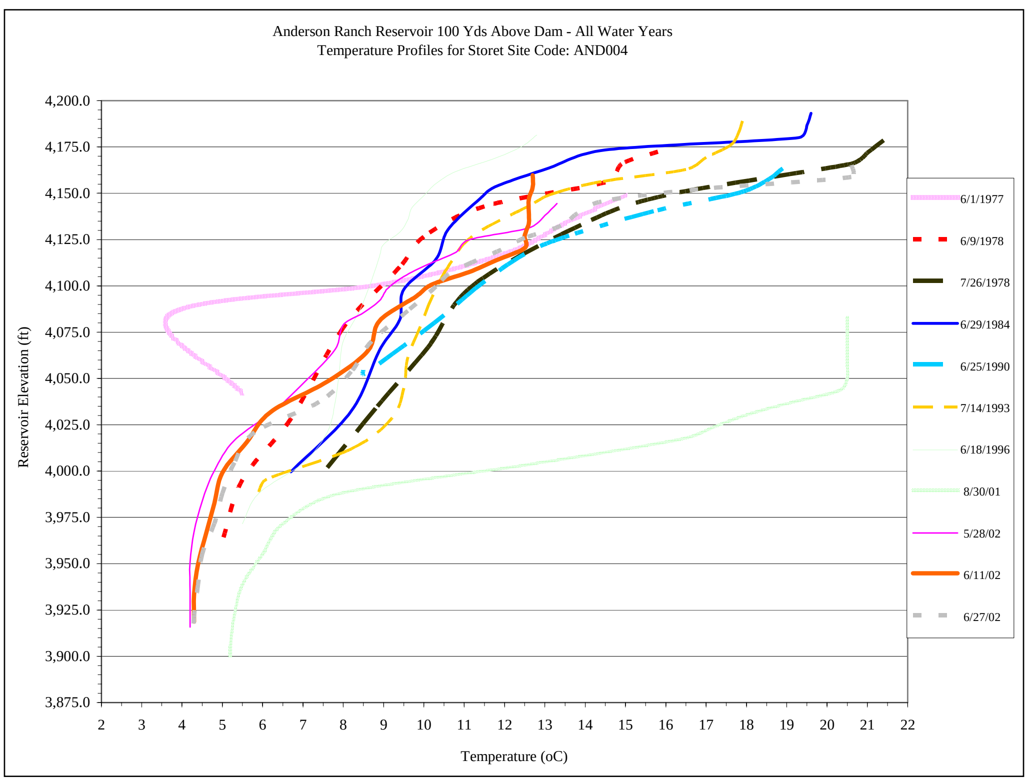

Figure 6-7. Water temperature reservoir profiles 100 meters in front of Anderson Ranch Dam through a series of years.

Since 1996, the Lowman Ranger District of the Boise National Forest has been investigating the relationship between habitat characteristics and resident bull trout abundance in an effort to identify the quality and amount of available resident bull trout habitat within the Deadwood River drainage. This work indicates that stream reaches having large woody debris and higher numbers of plunge and dam pools tend to have higher bull trout densities (Zurstadt and Jimenez unpublished).

The presence of a fluvial bull trout population in the Deadwood River downstream from the dam remains speculative. Similar to the South Fork Boise River below Anderson Ranch Dam, the Deadwood River downstream from the dam may function as an important migratory corridor and summer rearing habitat for bull trout. Unlike bull trout in the South Fork Boise River, most evidence of the presence of bull trout within the mainstem river downstream from Deadwood Dam has been anecdotal. Water temperature downstream from the dam under past and current operations has been substantially colder and has lacked the variability of other unregulated streams within the same areas of Idaho. The change in thermal and flow regimes has most likely altered the aquatic community and has accounted for the paucity of fish and macroinvertebrate fauna observed (Allen 1998; Salow unpublished, Deadwood Reservoir).

Water normally flows over the unregulated spillway at Deadwood Dam in the month of June. If there is a population, historical Deadwood Reservoir releases may have had an adverse effect. Historically, reservoir surface water spilled in June had a temperature of up to 21 °C. Water released through the outlet valves had a temperature as low as 7 °C.

In 1997, Reclamation began releasing water from the outlet valves as water spilled to reduce the extreme difference in water temperature downstream from the dam. This provided summertime water temperatures from 7 to 10 °C below the dam and from 12 to 15 °C near the mouth of the Deadwood River. Although the mixed release regimen increased June and July water temperatures of 7.2 to 10 °C below the dam in the Deadwood River, dry years provided no spill and water temperatures remained very cold. Figure 6-8 shows this interaction in the past several years.

Mixed spill provides a temporary increase in temperatures during the time the reservoir is full; however, in many years, the water temperatures are still much colder and less variable in comparison to watersheds of similar size and elevation within the basin (see Figure 6-9).

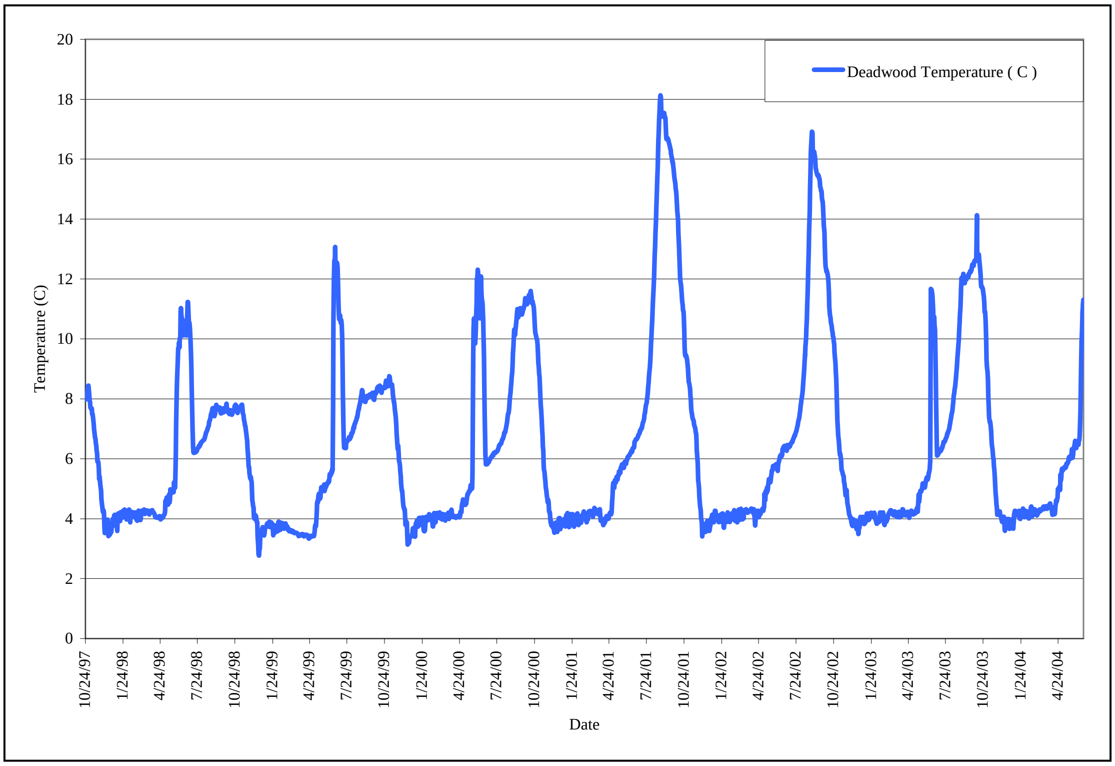

Figure 6-8. Water temperatures in the Deadwood River downstream from Deadwood Dam.

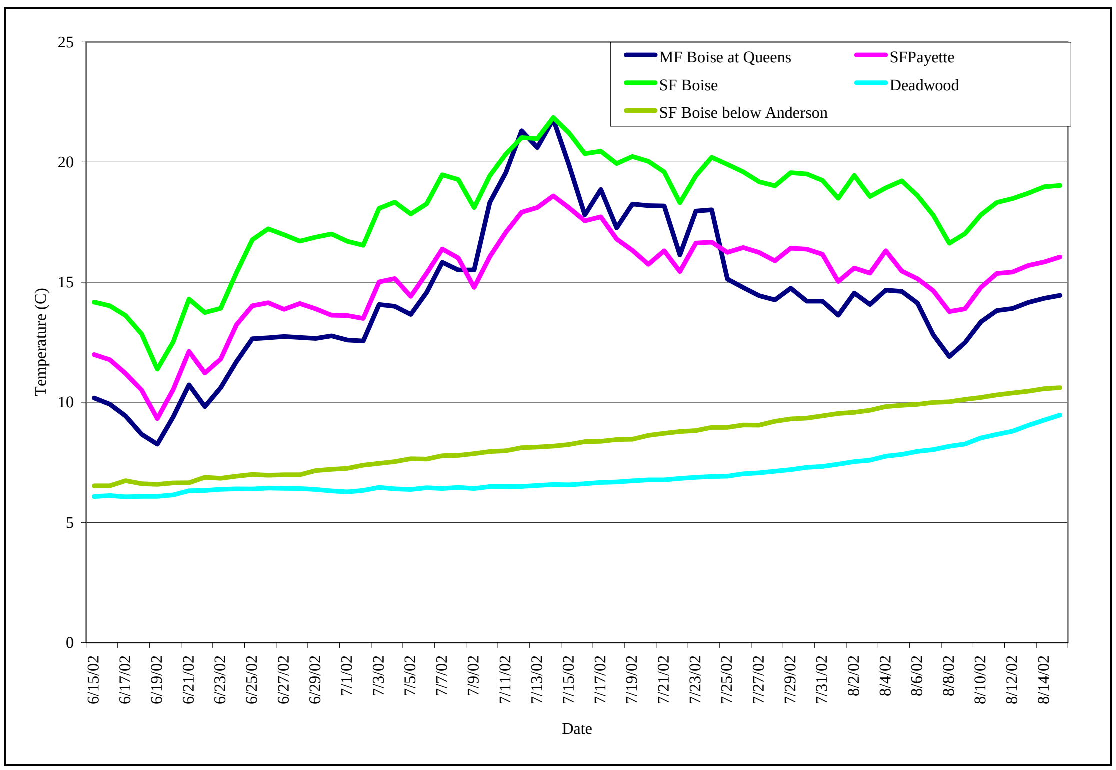

Figure 6-9. Comparison of daily mean stream temperatures in mainstem rivers in the Boise and Payette River drainages.

Under past and current operations, the lack of a natural hydrograph has altered and possibly reduced channel complexity; altered streamflow (including daily mean flow, peak variation, and timing); altered water temperature mean and natural variation; altered the aquatic community composition; and altered the migratory corridor condition. Streamflow alteration has been found in other impounded systems to affect aquatic fauna and can completely change an aquatic community (Mueller and Marsh 2002; Marotz et al. 1999).The flow regime has likely affected the downstream fishery, but the magnitude and extent of the influence has not been studied and is currently unknown.

Reclamation has informally consulted on individual maintenance activities that have occasionally required dewatering of the Deadwood Dam outlet works. Dewatering the outlet works affects the river reach about 650 feet downstream to the mouth of Wilson Creek. The unique aspects of each project may require alteration of seasonal timing, volume, and release elevation. These consultations will continue individually for each project.

Lake Cascade

One bull trout was reported in Lake Cascade in 2004 (Esch 2004). This fish was relatively small (less than 300 mm in total length) and was reported by a former USFWS employee but not photographed. The fish is most likely a fish from the Gold Fork local or the Kennally Creek potential population, which was surveyed extensively in 2002 with only one fish found (Apperson 2002). Because there are no fish passage facilities at the private irrigation diversions on Gold Fork Creek upstream from Lake Cascade, and because the migratory corridor is severely limited during the irrigation season when diversions completely dewater areas of the creek, the fish presumably moved out of the creek in late fall after irrigation diversions were shut down (Apperson 2002).

Although Lake Cascade provides adequate overwintering habitat for bull trout, it is unlikely that bull trout will survive high water temperatures in the lake over the summer (the shallow depth and great width of the lake generally lead to these higher temperatures). Lake Cascade's high levels of nutrients, algal biomass, and decaying benthic layer make the lake eutrophic (USBR 1997a), which may be exacerbated by the low rate of residence time (movement of water through the lake). The lake usually has high surface water temperatures and low dissolved oxygen levels in the summer and early fall months that can kill fish and other aquatic fauna (USBR 1997a).

6.7.3 Malheur River Basin

Bull trout are found in Beulah Reservoir, the North Fork Malheur River upstream from Beulah Reservoir, and the mainstem Malheur River about 45 miles upstream from Warm Springs Reservoir. Reclamation, the Burns Paiute Tribe, the ODFW, the USFWS, and the USFS have monitored headwater streams in the Malheur River for the presence of bull trout and found them in several tributaries to the mainstem rivers. Bull trout populations in the Malheur Recovery Unit are considered "depressed." The population of adult bull trout in the North Fork Malheur River is estimated between 250 and 300 (USFWS 2002).

North Fork Malheur River and Beulah Reservoir

Bull trout were documented by angler harvest in Beulah Reservoir as early as 1959. Recent life history studies provide extensive data on spawning locations and seasonal migrations of bull trout in the North Fork Malheur River (Gonzales 1998; Schwabe et al. 2000). The ODFW initiated sampling efforts in Beulah Reservoir in the spring of 1994, capturing two fish. The ODFW analyzed 81 scale samples from bull trout collected from Beulah Reservoir and the tailrace of the reservoir from 1994 to 2000. These bull trout had fork lengths from 226 and 546 mm and ranged in age from 3 to 8 years old (see Figure 6-10).

Over 75 percent of the bull trout collected from Beulah Reservoir were 4- and 5-year-old fish. Bull trout younger than 3 years have not been documented in the reservoir. Past sampling methodology in the reservoir may not effectively detect a smaller population of age 2 bull trout. In May 2002, a screw trap located less than 0.5 mile upstream from the reservoir pool in the North Fork Malheur River captured two bull trout with fork lengths of 119 and 162 mm. These are potential candidates for age 2+

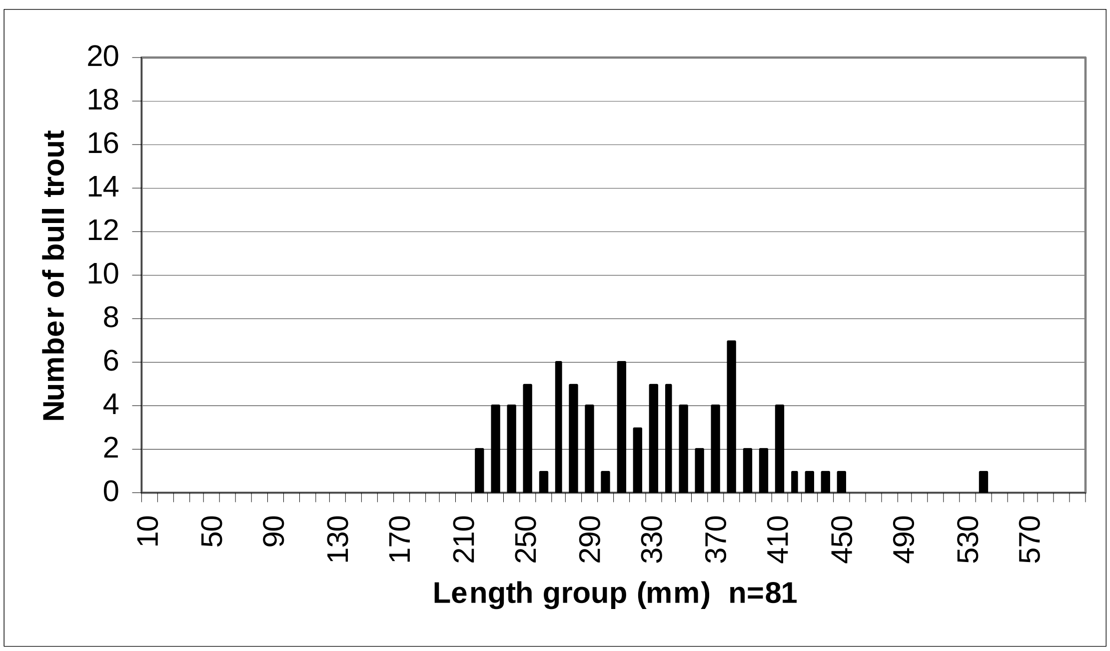

Figure 6-10. Length frequency histogram for bull trout collected in Beulah Reservoir between 1994 and 2000 (Schwabe and Perkins 2003).

and 3+ bull trout, but age class analysis on these fish has not been completed (Schwabe 2003).

Overall, water quality conditions appear to be acceptable during the periods that bull trout are present in the reservoir under past and current reservoir operations. Adult and subadult bull trout may inhabit the reservoir during the fall, winter, and early spring but may exhibit an adfluvial behavior pattern to avoid potential stresses, such as increased water temperature and limited dissolved oxygen (Petersen and Kofoot 2002). It appears that most bull trout, even those not ready to spawn, migrate upstream. Cold water refugia for bull trout are not available in Beulah Reservoir from early to mid-July until early October (USBR 2002), a period when migratory bull trout have left the reservoir and are in the upper watershed near spawning tributaries. Dissolved oxygen levels are also below levels deemed suitable for bull trout during the summer months.

Radio-tagging studies showed that bull trout moved upstream from overwintering areas in Beulah Reservoir into the North Fork Malheur River from mid-April until late May in 1999 (Schwabe et al. 2001). By June, tagged fish were well distributed in the North Fork Malheur River between Beulah Reservoir and the spawning areas. By early August, the majority of tagged fish had moved upstream from the confluence with Crane Creek at RM 42.8 and some had moved into spawning tributaries by mid-July. The peak for migration into spawning tributaries occurred by mid- to late-August (Schwabe et al. 2001). Downstream migration of adult bull trout from spawning tributaries occurred in late September, with a return to Beulah Reservoir between late October and mid-December (Schwabe et al. 2000, 2001). Past and current operations of Agency Valley Dam have not adversely affected migratory corridors upstream from Beulah Reservoir in the upper North Fork Malheur River basin.

Bull trout genetic samples were taken in 1995 from a North Fork Malheur River tributary. Results suggest that bull trout populations from the John Day River basin and northeastern Oregon, including the Malheur River basin, comprise a major genetic lineage (Spruell and Allendorf 1997 in USFWS 2002). Further analysis by Spruell et al. (2002 in USFWS 2002) indicate Malheur River bull trout are more genetically similar to bull trout populations from the Boise, Idaho, and Jarbidge, Nevada, drainages than to other populations in Oregon, and these three populations form a cluster within the Snake River group.

Brook trout have not been documented in the North Fork Malheur River, but a population is in the mainstem Malheur River subbasin. Buchanan et al. (1997) state that “anecdotal evidence suggests the brook trout were stocked by the Oregon Game Commission and volunteers in the high lakes of the Strawberry Mountains during the 1930s.”

Spawning surveys were initiated in the North Fork Malheur River upstream from Beulah Reservoir in 1992 to determine the time and location of spawning bull trout

(Buchanan et al. 1997). Spawning generally occurs from late August through late September. Standardized redd counts from 1996 through 2000 showed an increasing trend (see Table 6-4) from less than 50 to more than 150 redds for the North Fork Malheur population (NPCC 2002) but have recently declined since 2001 (Perkins 2004).

As shown in Table 6-4, several tributaries and the mainstem had the highest redd counts in 2000 since surveys started in 1992. Good water years and the prohibited take of bull trout might be attributable to the increase from 1992 to 2000. The North Fork Malheur River basin, upstream from Beulah Reservoir, had a “no-bait” restriction imposed in 1999 in an effort to increase the survival rate of bull trout captured and released by anglers. Recent declines in observed redds between 2001 and 2003 may be attributable to drought conditions.

From 1950 to 1987, the North Fork Malheur River, its tributaries, and Beulah Reservoir were chemically treated 6 times. In addition, chemical poisoning projects conducted between 1950 and 1987 on the North Fork Malheur River may have killed bull trout, but there is no record of bull trout mortalities (Bowers et al. 1993 in NPCC 2002). Reclamation is not aware of any contaminants that may be present in Beulah Reservoir.

Beulah Reservoir provides overwintering and foraging habitat for migratory bull trout in the North Fork Malheur River. Subadult or adult bull trout likely reside in Beulah Reservoir during winter months (Schwabe et al. 2000). During residence, bull trout are feeding on fish, including stocked rainbow trout, and are exposed to temperatures, dissolved oxygen, and other conditions that change with season or reservoir operation

Table 6-4. Bull trout redd counts in the North Fork Malheur River watershed from 1992 to 2003.

Year	Redds	Reach Length (miles)	Redds per Mile	Population Estimate
1992	2	9.2	0.2	
1993	8	28.2	0.3	
1994	13	24.1	0.5	
1995	9	24.0	0.4	
1996	38	22.3	1.7	80
1997	64	17.6	3.6	134
1998	74	22.6	3.3	115
1999	115	22.3	5.1	242
2000	150	22.3	6.6	321
2001	125	21.5	5.3	263
2002	99	15.4	6.4	208
2003	63	15.4	4.1	126

(Petersen and Kofoot 2002). Limnological data collected by Reclamation (USBR 2002) indicated that under past and present operating conditions, no cold water refugia exists in Beulah Reservoir for bull trout from early to mid-July until early October. Dissolved oxygen levels are also below levels deemed suitable for bull trout during the summer months (USBR 2002). These reservoir conditions result in most, if not all, bull trout migrating out of Beulah Reservoir in the spring to seek cooler water temperatures and spawning habitat. These migratory bull trout are important to the persistence and stability of the North Fork Malheur River population because they may represent unique genetic resources and because large migratory individuals are more fecund than smaller, resident stream fish (Petersen et al. 2003).

Beulah Reservoir has no designated minimum pool, and all the storage space is usable for irrigation and flood control. Except for years when Beulah Reservoir is drained, fish habitat for other aquatic species (including bull trout prey base) is available. Studies conducted between May and late November during 2001, a dry year, indicated potentially high abundances of available prey for bull trout (Petersen and Kofoot 2002).

Summer drawdown and low fall reservoir levels has discouraged growth and reproduction of aquatic invertebrates and plants; this has reduced the productivity of the reservoir and has limited the development of the fish food base for bull trout. Chlorophyll a levels measured from 1999 through 2002 remained low in the winter (when bull trout are present) and spike during the summer and fall (when bull trout are absent). This coupled with low nutrient levels, nitrogen, and total phosphorous concentrations indicate that the reservoir's past and current operations have led to a moderately productive reservoir relative to its ability to support communities of flora and fauna. However, annual recruitment of prey base species from the North Fork Malheur River and Warm Springs Creek have helped ameliorate some of the effects of reservoir fluctuations on the bull trout prey base.

Between 1955 and 1970, Beulah Reservoir was emptied three times (1955, 1961, and 1968) and was treated with rotenone in attempts to remove "trash fish." The relative abundance of common species increased fairly rapidly in between 1957 and 1960 and again between 1966 and 1967, although there was considerable year-to-year variation (Petersen et al. 2003). Since 1936, Beulah Reservoir was drawn down to minimum water levels, or run-of-the-river levels, in summer months during several years. Water levels were at a minimum (less than 1,000 acre-feet or run-of-the-river) for at least one month in 1950, 1973, 1977, and for several years between 1987 and 2003. In 2001, a low water year, Reclamation leased 2,000 acre-feet of water from the Vale Oregon Irrigation District to prevent the reservoir from being completely drained. Though this volume of water was also available in 2002, the reservoir was completely drained in 2002 (and again in 2003) in an effort to control illegally introduced white crappie in Beulah Reservoir.

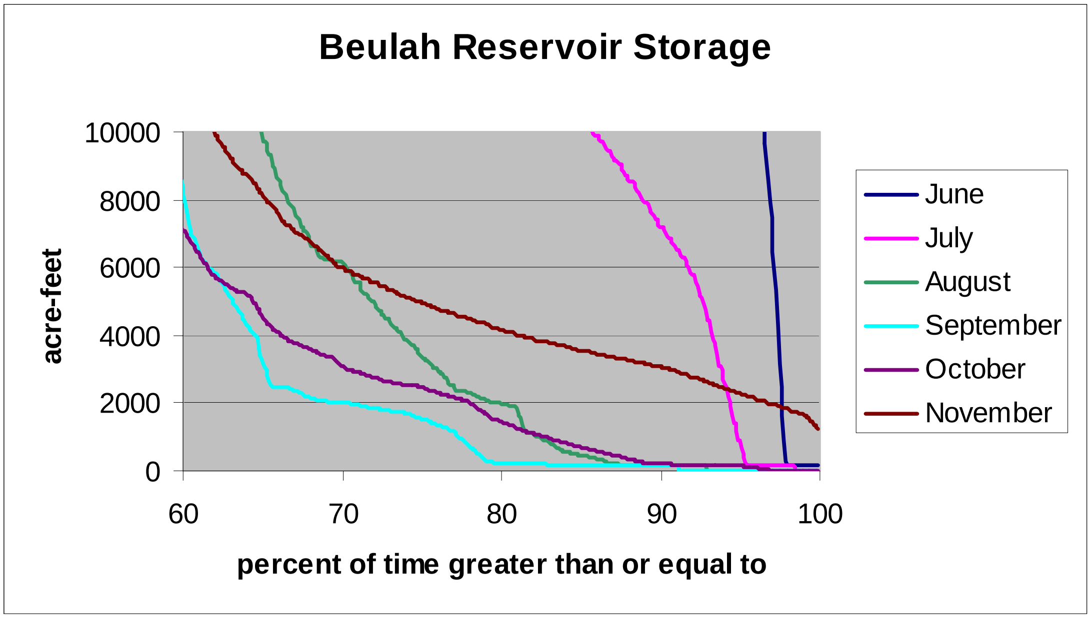

Figure 6-11. Exceedance curve for water storage at Beulah Reservoir from June through November, 1970 through 2003.

Figure 6-11 shows that between 1970 and 2003, the reservoir was drawn down to or below 2,000 acre-feet 2 percent of the time for June, 6 percent for July, 20 percent for August, 30 percent for September, 22 percent for October, and 3 percent for November. However, since migratory bull trout do not return to Beulah Reservoir until late October, and releases for irrigation end around October 15, it appears that the prey base recolonizes with contributions from the North Fork Malheur River and Warm Springs Creek immediately when refill begins. Petersen et al. (2003) indicate that historically, gill net catches of various species in Beulah Reservoir following a reservoir drawdown to river level appear to lag from 1 to 3 years. Beulah Reservoir has been drawn down to this river level in 1988, 1990, 1991, 1992, 1994, 2002, and 2003. Petersen et al. (2003) conclude that the fish community in the Beulah Reservoir vicinity is resilient to repeated reservoir drawdowns.

According to Petersen et al. (2003), Beulah Reservoir fish sampling between May and November in 2001 and between April and July in 2002 yielded 1,330 and 549 individuals of other species (including rainbow trout, suckers, dace, and shiners), respectively, but no bull trout. This lack of bull trout collection may indicate that their numbers are extremely low or that they migrate out of the reservoir prior to sampling efforts (Petersen et al. 2003). Based on temperatures observed and preferences noted in the literature for bull trout, it was not surprising that none were captured.

The Burns Paiute Tribe and the ODFW, with funding from Reclamation, conducted a radiotelemetry study of bull trout at Beulah Reservoir from 1998 (Gonzales 1998) to 1999 (Schwabe et al. 2000). The purpose of the study was to assess life history characteristics and document entrainment through Agency Valley Dam. The significant findings from this study are:

1. Adult bull trout migrate from Beulah Reservoir into the North Fork Malheur River from March through June. During the first year of study, all radio-tagged bull trout (except the two that were lost) left Beulah Reservoir and migrated to upstream locations. In 1999, bull trout that were captured in the tailrace of Agency Valley Dam, radio tagged, and then released in Beulah Reservoir, migrated upstream to known spawning tributaries.
2. The North Fork Malheur River upstream from Beulah Reservoir has three unscreened diversions that operate during periods when bull trout are migrating through the area. Telemetry studies showed that these diversions either delayed the migration of bull trout, or likely resulted in bull trout mortality into an unscreened diversion (Schwabe et al. 2000).
3. In 1999, radio-tagged bull trout released in the tailrace tended to stay within 1.2 miles of the dam. Of the 39 bull trout that were radio tagged and released in the reservoir, 4 were entrained through the dam and/or over the spillway.
4. Mature adfluvial bull trout appear to reside in Beulah Reservoir for about 6 months, from November through June.

Water release over the spillway, whether during flood control operations or to pass inflow when the reservoir is full, has been a significant factor for bull trout entrainment. In 1999, large flood control releases over the spillway in the winter and spring were likely significant contributors to bull trout entrainment. As a result, spillway operations at Agency Valley Dam were changed in 2000. The Vale Oregon Irrigation District agreed to discharge up to 650 cfs of Beulah Reservoir water from the river outlet works, when possible, rather than the spillway, in an effort to reduce bull trout entrainment. Since the existing valves have a maximum release capacity of up to 650 cfs, releases greater than 650 cfs must be made through a combination of both valves and up to 350 cfs over the spillway. Releases greater than 1000 cfs are made exclusively over the spillway for safety reasons. Spillway releases generally occur during flood control operations from February through June.

Following the Agency Valley Dam operational change described above, there has been a substantial decrease in bull trout entrainment documented below Agency Valley Dam. With funding provided by Reclamation, the Burns Paiute Tribe has captured bull trout by angling in the tailrace of Beulah Reservoir since 1998. Captured fish are transported and released into Beulah Reservoir. Between mid-March and mid-June of 1999, 20 bull trout were angled in the tailrace and released above the dam. During the same period in 2000, after operations were changed, five fish were angled and then released above the dam. Since 2001, water levels in Beulah Reservoir have not resulted in spillway releases, and no bull trout have been captured by angling in the tailrace.

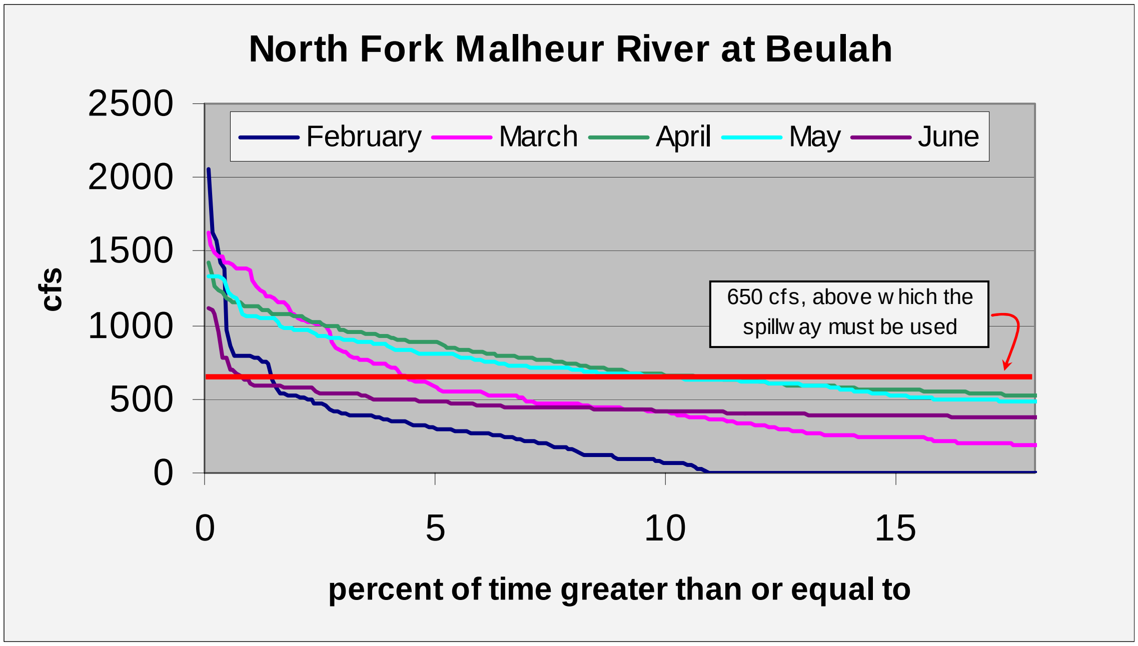

Figure 6-12. Exceedance curve showing the daily flow releases from Beulah Reservoir from February through June, 1961 to 2003.

However, these operational changes have not completely eliminated the risk of entrainment for bull trout. When more than 650 cfs must be released, and the spillway must be used, entrainment is possible. Telemetry studies have shown entrainment occurring during late winter/spring periods when bull trout are present in Beulah Reservoir. Figure 6-12 shows how often the releases from Agency Valley Dam into the North Fork Malheur River have exceeded certain flows during the months from February through June for the period of record from 1961 through 2003. Daily releases exceeded 650 cfs between 0.75 and 11 percent of the time. Daily releases exceeded 1,000 cfs from 0.3 to 2.8 percent of the time. During all the months of May, daily releases exceeded 650 cfs 11 percent of the time; daily releases exceeded 1,000 cfs 1.8 percent of the time.

With the exception of bull trout returned to Beulah Reservoir from annual trap and haul operations conducted in the tailrace, the lack of fish passage facilities at the dam means that bull trout entrained into the North Fork Malheur River are lost to the reproducing population. The survival of entrained bull trout is likely minimal to nonexistent during late spring to early fall. Entrained bull trout are unable to survive elevated water temperatures that are released from Beulah Reservoir during the July-to-September period. Should they go downstream, similar water conditions prevail in the mainstem Malheur River, and these bull trout also likely perish. Unscreened irrigation diversions also entrain and kill bull trout. In 1999, Schwabe et al. (2000) found one radio transmitter in an irrigation ditch approximately 6 miles below Agency Valley Dam.

Warm Springs Reservoir

Bull trout have not been documented in Warm Springs Reservoir. Low streamflow (less than 25 cfs during some summer periods), water temperatures as high as 26 °C from May through September, and a lack of fish passage facilities at irrigation diversions seasonally limit bull trout use from Warm Springs Reservoir to a distance of 35 to 40 river miles upstream (NPPC 2002).

Although Warm Springs Reservoir is over three times larger in volume than Beulah Reservoir, the variable water supply and demand for irrigation withdrawals cause year-to-year and season-to-season fluctuations. Warm Springs Reservoir has been emptied several times in the past, and this emptying is a part of normal operations.

Degraded riparian conditions along the mainstem Malheur River upstream from the reservoir cause high sediment loads. The Malheur Watershed Council and Burns Paiute Tribe (2004) state "the most heavily affected reach within the watershed is the upper Malheur River from the upper end of Warm Springs Reservoir to near Griffin Creek," a distance of about 40 miles. These high sediment loads that eventually reach Warm Springs Reservoir likely contribute to overall poor water quality conditions.

Past and current Warm Springs Reservoir operations have supported a functioning migratory corridor during the overwintering period when bull trout would be present. If present, migratory bull trout would likely return to the reservoir during the refill period and leave prior to unsuitable conditions.

Past and present reservoir operations have adversely affected the abundance of the food base, especially during years when the reservoir was completely emptied. The rapid summer drawdown of Warm Springs Reservoir likely reduced the productivity of the reservoir, providing little opportunity for growth and reproduction of aquatic invertebrates and plants, and the subsequent food base for bull trout. However, similar to Beulah Reservoir, it is likely that annual recruitment of prey species from the Malheur River has helped ameliorate some of the effects of reservoir fluctuations on the prey base.

6.7.4 Powder River Basin

Phillips Lake and Thief Valley Reservoir

Bull trout have not been documented in either Phillips Lake or Thief Valley Reservoir. While information is limited, water quality conditions near Mason Dam in Phillips Lake are good (Nowak 2004), and habitat for bull trout would likely be available through most of the year, with the exception of July through September in consecutive dry years. However, if migratory bull trout are present in the system, they would likely have moved to headwater locations during the July through September period.

Past and current operations at Mason and Thief Valley Dams have likely adversely affected the abundance of the food base, including bull trout forage fish and the zooplankton on which they prey. Phillips Lake and Thief Valley Reservoir have been drafted annually, and during drought conditions, the pools have been taken down to run-of-the-river conditions. The rapid summer drafting of these reservoirs for irrigation and low winter reservoir levels has reduced the productivity of the reservoirs. This has limited the production of aquatic organisms that may have reduced the food base available for bull trout, should they be present.

Information related to bull trout in Thief Valley Reservoir upstream to Mason Dam is scarce since bull trout have not been documented in this reach. Agricultural return flows to the Powder River between Baker City and Thief Valley Reservoir are laden with high levels of nutrients, including coliform levels that exceed state standards (Nowak 2004). Low streamflows from irrigation diversions likely elevate stream temperatures from June through September.

6.7.5 Snake River from Brownlee Reservoir to the Columbia River and the Columbia River below the Snake River Confluence

Chandler (2003) reported that bull trout found in the Oxbow Bypass Reach and Hells Canyon Reservoir appeared to be extremely low in abundance. Chandler (2003) also reported that bull trout populations found in the tributaries to the Complex upstream from Hells Canyon Dam had extremely low numbers, and that they were absent from lower reaches in the drainage. A significant number of bull trout captured in Oxbow and Hells Canyon Reservoirs showed signs of hybridization with brook trout, a result of bull trout and brook trout being present in the tributaries (Chandler 2003).

Below the Hells Canyon Complex, bull trout do not show any signs of hybridization with brook trout (Chandler 2003). Densities of bull trout downstream of Hells Canyon Dam, according to Chandler (2003) studies, “appeared higher” than in the Sheep Creek and Granite Creek drainages. However, Chandler (2003) also points out that densities of bull trout in both Sheep and Granite Creeks were extremely low based on Idaho Power surveys and IDFG long-term surveys.

Rieman and McIntyre (1993) indicated that bull trout populations are known to possess multiple life history forms with complex age structures, behavior, and maturation schedules throughout their range. Idaho Power bull trout studies conducted in the Hells Canyon Complex documented fluvial life histories, indicating that bull trout were migrating from tributaries within the Hells Canyon Complex to the mainstem (Chandler 2003). Migratory bull trout moving from the mainstem into tributaries upstream from Hells Canyon Dam averaged about 250 to 300 mm total length, whereas outmigrants below Hells Canyon Dam were much larger, at 350 to 450 mm total length (Chandler 2003).

Chandler (2003) found that bull trout use the Oxbow Bypass Reach and Hells Canyon Reservoir primarily during late fall and winter. Telemetry studies showed fluvial bull trout within the complex migrating to tributaries between April and early June, where they likely oversummer and then spawn in the fall (Chandler 2003).

Chandler (2003) documented bull trout below Hells Canyon Dam that exhibited "classic fluvial migrations" during the years that they monitored movement. Over half of the bull trout monitored made spring migratory movements downstream to the Imnaha River after wintering in the mainstem Snake River (Chandler 2003). Other bull trout that spawned the previous year but did not exhibit fluvial behavior may have remained in the Snake River throughout the summer. Fluvial bull trout were then documented returning to the Snake River, following spawning in the tributaries, sometime in November and December, and remained in the Snake River from January to April (Chandler 2003).

6.8 Effects Analysis

The area of analysis for bull trout includes these river reaches and reservoirs:

- In the Boise River system, Anderson Ranch Reservoir, the South Fork Boise River downstream from Anderson Ranch Dam to and including Arrowrock Reservoir, Lucky Peak Reservoir, and Mores Creek. This is exclusively in the action area for future O&M in the Boise River system.
- In the Payette River system, Deadwood Reservoir, the Deadwood River downstream from Deadwood Dam, and Lake Cascade. This is exclusively in the action area for future O&M in the Payette River system.
- In the Malheur River system, Beulah Reservoir, the North Fork Malheur River downstream from Agency Valley Dam, and Warm Springs Reservoir. This is exclusively in the action area for future O&M in the Malheur River system.
- In the Powder River system, Phillips Lake and Thief Valley Reservoir. This is exclusively in the action areas for future O&M in the upper and lower Powder River systems.
- In the lower Snake River, including Brownlee Reservoir, in and downstream from the Hells Canyon Complex. This is within the action areas for all 11 proposed actions.

Section 6.9 summarizes Reclamation's determination for each proposed action.

6.8.1 Boise River Basin

The Boise River basin is in the action area for future O&M in the Boise River system.

Arrowrock and Lucky Peak Reservoirs and the North and Middle Forks of the Boise River

Arrowrock Reservoir will continue to serve as an important overwintering and foraging area for migratory bull trout. Water quality, low reservoir volumes, and entrainment of fish will affect the quality and integrity of this adfluvial population and their habitat.

Due to the replacement of the ensign valves at Arrowrock Dam, water quality conditions will improve habitat and benefit bull trout that spend the summer in Arrowrock Reservoir (USBR 2003b). Releases from the new clamshell gates will keep minimum dissolved oxygen levels higher than historical values, though cold water refugia may be reduced slightly earlier in the spring than under past operations.

The drafting of Arrowrock Reservoir will also occur to a lesser extent than it has historically. Figure 6-13 shows a comparison between actual operations from 1990 to 2000 and simulated proposed action operations for a similar series of wet and dry years (the summary tables in Appendices C and D present numerical values for the historical and modeled reservoir contents at Arrowrock Reservoir). Similar to other systems (May et al. 1988), conditions in Arrowrock Reservoir will most likely continue to limit reservoir productivity and fish populations.

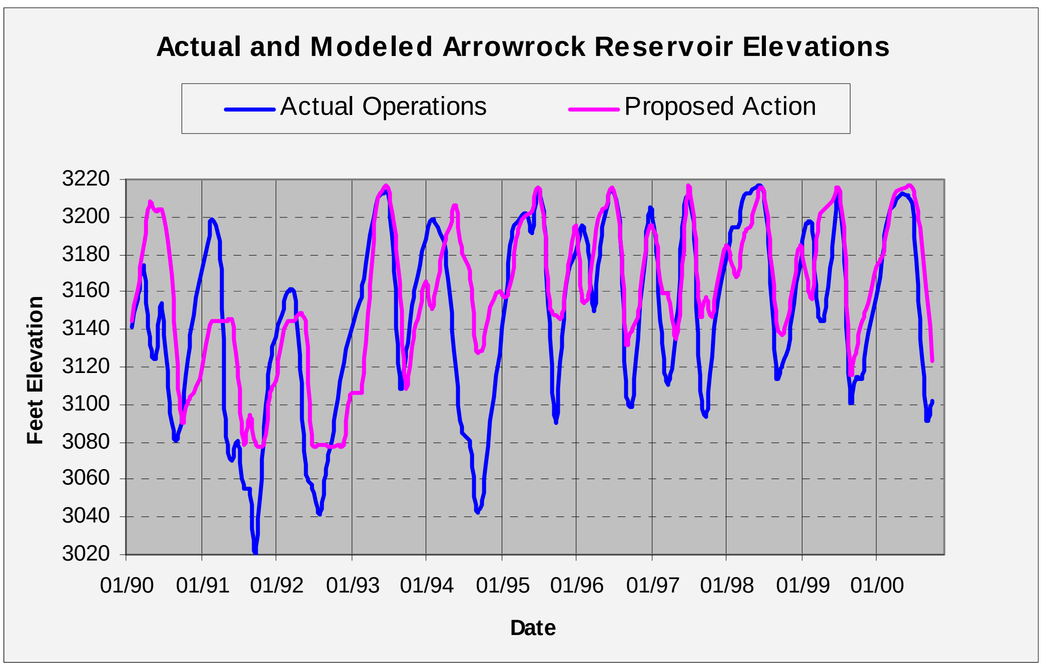

Figure 6-13. End-of-month Arrowrock Reservoir water surface elevations for actual operations from 1990 to 2000 and simulated proposed action operations.

Arrowrock Reservoir's refill operations, which begin on Labor Day under normal water levels, will continue to provide adequate reservoir volumes to support migratory bull trout during the fall migratory period. However, under more extreme water conditions, reservoir elevations may fall to a level low enough to cause harm to bull trout as they enter the reservoir in the fall (September 20 is the earliest bull trout have been documented entering the reservoir). Salow and Hostettler (2004) found that when the reservoir elevation near Irish Creek fell below elevation 3,100 feet (38,840-acre-foot volume), bull trout mortality rates substantially increased from predation by raptors and channel degradation (the extreme conditions cited in Salow and Hostettler (2004) where the reservoir was drafted to a volume of 1,500 acre-feet would not occur under the proposed action). The model predicts the September and October end-of-month reservoir elevation will be at least 3,100 feet over 95 percent of the time. In those 5 percent of years when the reservoir elevation falls below 3,100 feet, bull trout are likely to be adversely affected due to the loss of cover and increased exposure to predators.

High volumes of water discharged from the reservoir surface or just below the reservoir surface during the time when bull trout are using the reservoir may also adversely affect bull trout populations. Salow and Hostettler (2004) found that the rates of bull trout entrainment increased when discharge from the dam occurred within 20 feet of the surface and exceeded 695 cfs. These types of conditions may occur during three general operating seasons. First, entrainment may occur during the irrigation season when discharge is greater than 695 cfs and the reservoir water surface elevation is near or below elevation 3,111 feet; or secondly, during winter operations under these same discharge and reservoir surface elevation conditions. Finally, entrainment may occur when water is discharged over the dam's spillway (typically during spring flood control operations).

The model predicts that winter discharge from October through February will exceed 695 cfs about 43 percent of the time. However, the reservoir's water surface elevation is predicted to be near or below 3,111 feet less than 6 percent of the time. Therefore, entrainment through the clamshell gates in winter is expected to rarely occur.

Operations of Arrowrock Dam to provide for irrigation when the reservoir is at or near 3,111 feet in July and August have caused entrainment to occur. Most bull trout in the Boise River basin upstream from Arrowrock Dam and the South Fork Boise River below Anderson Ranch Dam spend the summer in regulated or free-flowing riverine habitats. However, in past studies, a small proportion of fish have been documented to move into the reservoir in July or August for short periods of time and have become entrained (Salow and Hostettler 2004). Discharge from Arrowrock Dam during July and August is greater than 695 cfs 99 percent of the time and near or below water surface elevation of 3,111 feet about 95 percent of the time. Based on Salow and Hostettler (2004), Reclamation anticipates 2 percent of bull trout that overwinter in Arrowrock Reservoir and the South Fork Boise River downstream from Anderson Ranch Dam would become entrained under these conditions.

During March-through-June flood control operations, entrainment is most probable when the surface spillway passes runoff that exceeds the clamshell gates' capacity. The newly installed clamshell gates have a combined discharge capacity of 6,364 cfs (Bachman 2004). Water will be discharged over the spillway when the reservoir water surface elevation is at least 3,211 feet and reservoir inflow exceeds the gates discharge capacity of 6,364 cfs. The model predicts that Arrowrock Reservoir will be at surface elevation 3,211 feet 55 percent of the time during the spring runoff period. However, the clamshell gates' discharge capacity is predicted to be exceeded just 27 percent of the time for this same period. Therefore, conditions conducive for entrainment are estimated to occur in 27 percent of years for the proposed action. Studies of entrainment in 2002 and 2003 indicate that 4 to 16 percent of the adfluvial bull trout population in Arrowrock Reservoir could be entrained under these conditions.

Entrainment of bull trout through Arrowrock Dam is likely to adversely affect the bull trout population above the dam through the loss of adult spawning fish. However, efforts to reduce or eliminate entrainment from Arrowrock Dam may adversely affect bull trout in Lucky Peak Reservoir and Mores Creek as adult spawning fish are removed from the Lucky Peak pool prior to spawning. Whiteley et al. (2003) found no evidence that the Mores Creek population was a distinct or unique population, but that it was most closely related to fish from the upper Middle and North Forks of the Boise River. This infers that fish in the Mores Creek population were derived from fish entrained through Arrowrock Dam.

The model predicts Lucky Peak Reservoir will fall below 80,000 acre-feet less than 1 percent of the time during winter operations; this will provide substantial winter habitat for bull trout. However, the modeled conditions consider water used for irrigation and flood control. Conditions related to maintenance of Lucky Peak Dam and the powerplant are not incorporated into the model, are not part of the proposed action, and are outside of the scope of this consultation. The large-scale drafting events, which reduce productivity in Arrowrock Reservoir, could flush nutrients and zooplankton that increases productivity in Lucky Peak Reservoir. The clamshell gates will allow deeper releases of colder water into Lucky Peak Reservoir (USBR 2003b). These operations will benefit bull trout populations by increasing productivity, increasing prey availability, and reducing temperatures in Lucky Peak Reservoir.

South Fork Boise River below Anderson Ranch Dam

Salow and Hostettler (2004) found this reach of river to be important overwintering and summer refuge habitat for fluvial and adfluvial bull trout. This river reach also has rainbow trout and whitefish present, and both are important prey items for bull trout (Beauchamp and Van Tassell 2001) and important recreational species (Wade et al. 1977). Reclamation's proposed action includes minimum streamflow of 300 cfs from the fall through winter and 600 cfs from the spring through summer for the benefit and enhancement of resident fish. These minimum streamflow targets below Anderson Ranch Dam were administratively determined; the ramping rates for dam releases and the extent of the effect of the administratively determined flows have not been evaluated for the benefit to the downstream fishery. Bull trout may be adversely affected when low streamflows occur due to drought, when spillway use is necessary during flood control or for maintenance, and when large changes in discharge velocities are made.

Figure 6-14 shows releases at Anderson Ranch Dam for the period from 1994 to 2000 and simulated releases for the proposed action for a similar series of wet and dry years. During a series of consecutive dry years, Reclamation may not be able to meet minimum 300-cfs winter instream flow targets. The model predicts this may occur in about 3 percent of years. Instream flows of at least 114 cfs are expected during these very dry years.

Very low streamflows may increase mortality in bull trout and their prey by the loss of available overwintering habitat. Low streamflows promote the formation of frazzle ice, which can plug fish gills (Annear 1987), limit aquatic insect production in riffle areas, restrict fish movement, and decrease the carrying capacity of the river, especially for fry and juvenile fish, which survive best in backwater and side channel areas with good cobble cover.

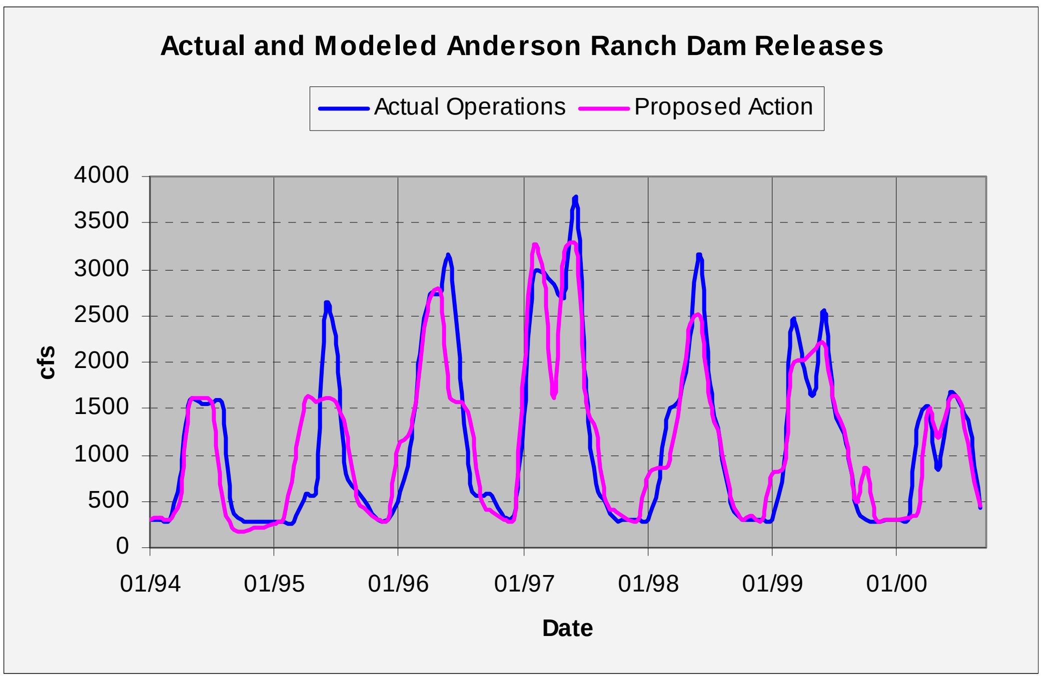

Figure 6-14. Monthly average releases from Anderson Ranch Dam from 1994 to 2000 and the simulated proposed action for similar water conditions.

Forty-four percent of fish tagged in the North and Middle Forks of the Boise River upstream from Arrowrock Reservoir overwintered in the South Fork Boise River downstream from Anderson Ranch Dam (Salow and Hostettler 2004). Reclamation estimated that this 44 percent of overwintering bull trout could be adversely affected when winter streamflows are low (Salow and Hostettler 2004).

As discussed in Section 6.7.1, rapid changes in reservoir discharge velocities may adversely affect bull trout and their prey that occupy the South Fork Boise River downstream from Anderson Ranch Dam (see USBR 2004b for specific rates). The loss of a natural hydrograph and thermal regime has not been studied in the South Fork Boise River, and magnitude of the effect is unknown. The release rates specified remain unchanged from past operations. Routine maintenance requiring the use of the spillway can also adversely affect bull trout and their prey by increasing water temperatures. Routine maintenance activities vary in timing and duration, and Reclamation will discuss these annually with the USFWS to determine necessary measures to reduce harm to bull trout.

Anderson Ranch Reservoir

Three factors have the potential to affect adfluvial bull trout at Anderson Ranch Reservoir: water quality, the subsequent reduction in the prey base, and entrainment through the dam. Figure 6-15 shows reservoir volumes from 1991 to 2000 and simulated volumes for the proposed action for a similar series of wet and dry conditions.

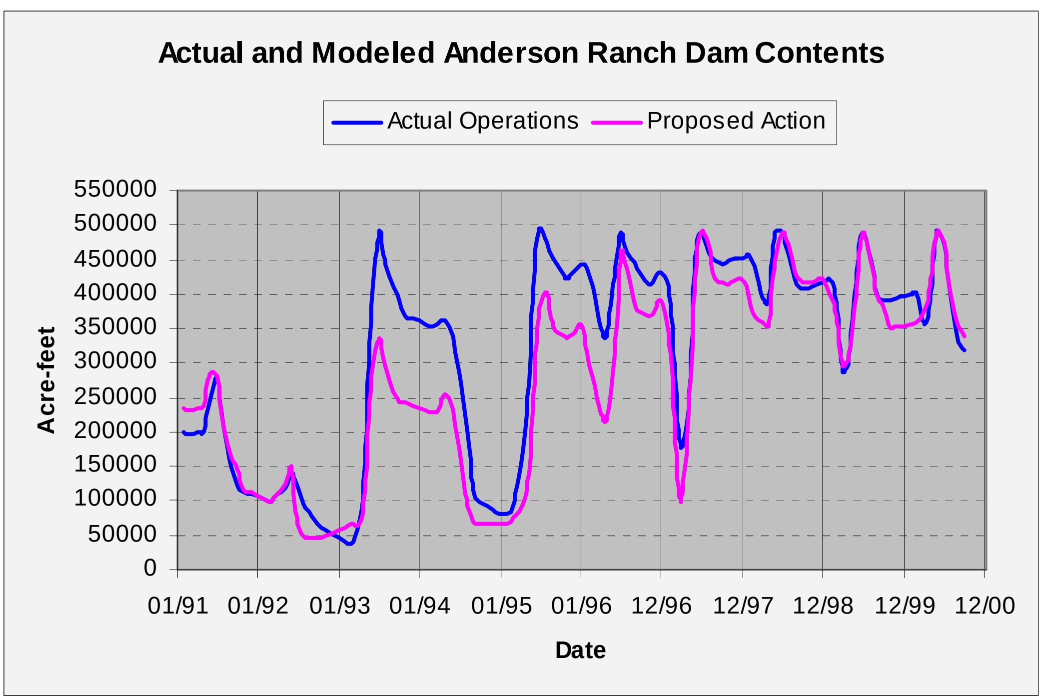

Figure 6-15. Monthly average Anderson Ranch Reservoir volume from 1991 to 2000 and simulated volume for the proposed action for similar water conditions (these include dead and inactive space).

Reclamation (2004a) found that maintaining a 62,000-acre-foot conservation pool at Anderson Ranch Reservoir maintains suitable water quality for adfluvial water suitable for adfluvial bull trout populations. The model predicts the reservoir will be at least 62,000 acre-feet about 98 percent of the time. During these 2 percent of years, reservoir contents will be about 49,000 acre-feet. Water quality problems will continue to occur only during multiple drought years when the water volume drops below the conservation pool and temperature and dissolved oxygen levels in the reservoir become unsuitable to bull trout. These conditions will most likely occur during July and August when most bull trout will have migrated to riverine habitat to spawn or over-summer (USBR 2004a).

Though water quality conditions may not directly affect bull trout in these late summer months, they can adversely affect kokanee trout (Megergle 2004), a principal prey item in many systems with self-sustaining kokanee populations (Vidergar 2000). Loss or reduction in the kokanee prey base could potentially adversely affect bull trout that overwinter in Anderson Ranch Reservoir. The model predicts the reservoir volume will be above 74,600 acre-feet, the lowest reservoir volume during the 2001 kokanee trout kill, about 97 percent of the time. However, water surface elevation and volume alone did not cause the conditions resulting in the 2001 fish kill. Reservoir volumes and elevations have been near or lower than the 2001 level without documented fish kills. Low wind levels (decreasing surface to bottom water exchange) and unusually high temperatures over several weeks may have also contributed to conditions resulting in the kokanee fish kill. These conditions have only been documented in 2001. Therefore, these events are considered rare, and the magnitude of effects would be short-term unless confounded by other conditions (introduced species or chemical treatments).

Under the proposed action, entrainment of bull trout from Anderson Ranch Reservoir to the South Fork Boise River will likely remain extremely low and is not likely to adversely affect bull trout using the reservoir. Entrainment has not been documented, though it may occur at low levels (Partridge 2000). The intake for the Anderson Ranch Dam outlet works and turbines is nearly 200 feet below the spillway crest. The depth of the intake, gradual releases of water from Anderson Ranch Dam, the reservoir's relatively large conservation pool, and the gradual fluctuation of reservoir content all most likely contribute to the low level of bull trout entrainment (Partridge 2000; Salow unpublished, Anderson Ranch Reservoir) and most likely other aquatic fauna.

Using the Anderson Ranch Dam spillway could cause higher levels of bull trout entrainment. Releases over the spillway can occur when the reservoir is nearly full at water surface elevation 4,195 feet. Generally, the spillway is used to maintain sufficient powerhead and prevent damage to the radial gates of the dam (when inflow would exceed the turbine capacity of 1,700 cfs). The model predicts the water surface elevation will be at or below 4,195 feet about 29 percent of the time during the months of April through June. The spillway has been used in 12 years since 1980, or approximately 50 percent of the time historically. The conditions for spillway use depend on both reservoir elevation and magnitude of reservoir inflow. The magnitude of any potential entrainment effects cannot be quantified because entrainment has not been documented at Anderson Ranch Dam.

Generally, conditions are adequate for bull trout survival in Anderson Ranch Reservoir. Adverse affects may occur in 2 percent of years when the conservation pool is not maintained, resulting in poor water quality conditions, and during flood control operations that use the spillway. Operations and conditions that will occur with the proposed action are expected to change little from past operations and conditions.

6.8.2 Payette River Basin

The Payette River basin is in the action area for future O&M in the Payette River system.

Deadwood River downstream from Deadwood Dam

Reclamation's proposed action includes a minimum streamflow target of 50 cfs below Deadwood Dam from the fall through winter for the benefit and enhancement of resident fish. Bull trout may be adversely affected when the discharges of water from the dam are low, unusually cold in temperature, unseasonably variable in temperature, or have large changes in discharge velocity.

Figure 6-16 shows releases below Deadwood Dam from 1991 to 2000 and simulated releases for the proposed action for a similar series of wet and dry years. Low winter

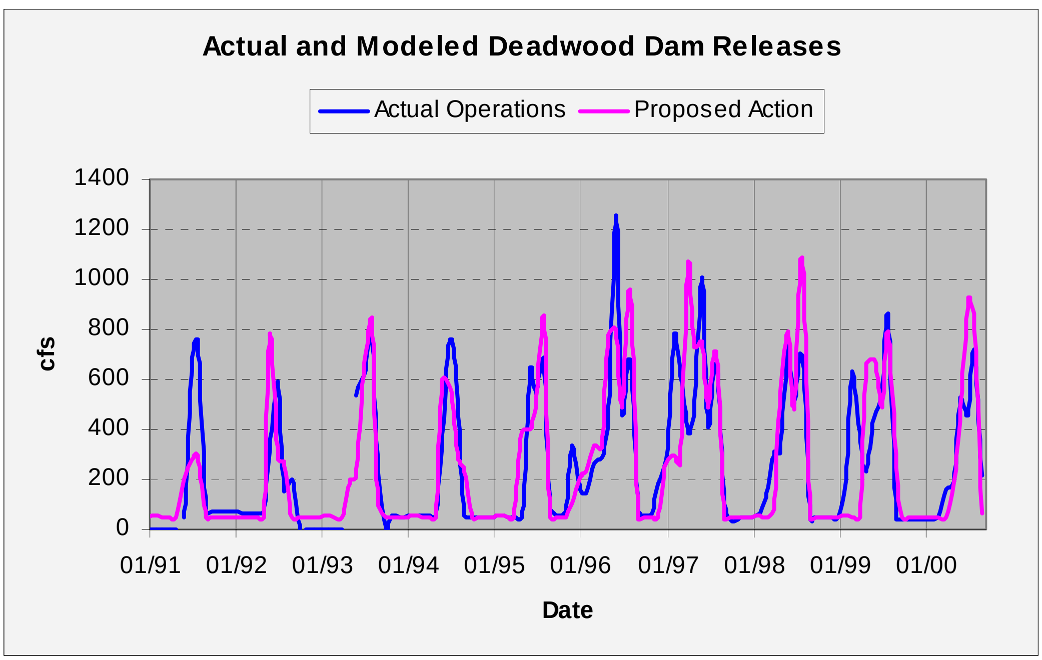

Figure 6-16. Monthly average releases from Deadwood Dam from 1991 to 2000 and the simulated proposed action for similar water conditions.

releases from Deadwood Dam may adversely affect bull trout. Until recently, Deadwood Dam releases were completely stopped during winter months to allow for water storage. Winter flow releases of 50 cfs began in the early 1990s. This rate is less than inflows to Deadwood Reservoir upstream and reduces overall habitat available to bull trout downstream from the dam. Low streamflows promote the formation of frazzle ice, which can plug fish gills (Annear 1987), and limits aquatic insect production in riffle areas. Lower water velocities and streamflows can restrict fish movement and migration and can reduce available habitat, especially for fry and juvenile fish, which survive best in backwater and side channel areas with good cobble cover.

Rapid changes in reservoir discharge velocities may adversely affect bull trout and their prey that occupy the Deadwood River downstream from Deadwood Dam (see USBR 2004b for specific discharge rates). No rates are currently specified for reducing discharge from Deadwood Dam, and under past operations, stranding of fishes and stream habitat dewatering has occurred. The loss of a natural hydrograph and thermal regime has not been studied in the Deadwood River and magnitude of the effect is unknown. The release rates specified remain unchanged from past operations.

Conditions that require use of the spillway for routine maintenance can also adversely affect bull trout and their prey by increasing water temperatures and reducing flow. These projects vary in timing and duration and will be discussed annually with the USFWS to determine necessary measures to reduce harm to bull trout.

Water temperatures in the Deadwood River due to releases from Deadwood Dam may adversely affect fluvial bull trout. The reservoir's very cold water releases probably reduce the ability for adequate metabolic function, including growth and reproduction in most fishes and other aquatic fauna. Densities of fish and other aquatic fauna have been observed to be very low (Allen 1998; Salow unpublished, Deadwood Reservoir). Under the proposed action, the changes between surface and deep releases of water through the dam will continue to cause temperature fluctuations and reduce the overall productivity within the river reach. During dry years, Reclamation will continue to be unable to ameliorate the effects of the cold temperature releases. Overall, the water temperatures in this reach will remain much colder and less variable than comparable watersheds.

Deadwood Reservoir

Two factors have the potential to affect adfluvial bull trout at Deadwood Reservoir: water quality and the subsequent reduction in the prey base, and entrainment at Deadwood Dam. Figure 6-17 shows past reservoir contents for the period from 1990

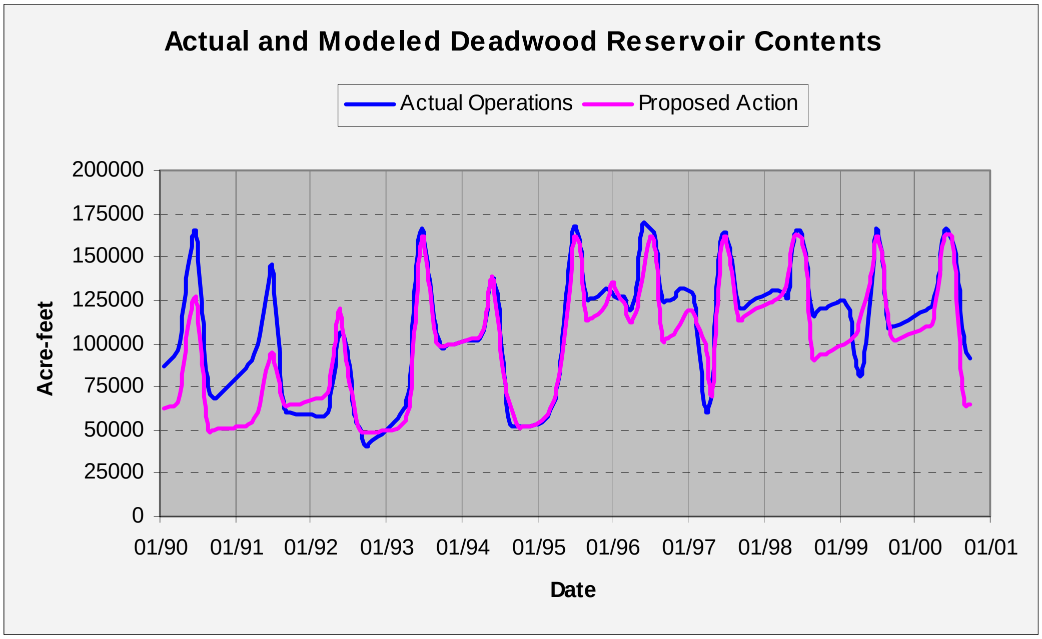

Figure 6-17. Monthly average Deadwood Reservoir contents from 1990 to 2000 and simulated contents for the proposed action for similar water conditions.

to 2000 and simulated contents for the proposed action for a similar series of wet and dry years.

The proposed action may result in low reservoir elevations, which may affect the bull trout prey base and may adversely affect fluvial and adfluvial bull trout in the reservoir during periods of multiple dry years. Reclamation has maintained a 50,000-acre-foot conservation pool since 1993. However, under the proposed action, Reclamation may reduce the conservation pool volume up to 10,000 acre-feet during multiple dry-year events. The model predicts this condition will occur in about 7 percent of years (during the month of September when reservoir elevations are lowest). The minimum reservoir volume would be about 46,000 acre-feet. Historically, Deadwood Reservoir has been less than 50,000 acre-feet during September in about 20 percent of years, and it has been emptied in some years. Minimum reservoir elevations under the proposed action will be significantly improved from past operations.

Densities of adfluvial bull trout are lower than past levels, possibly due to past drought, chemical treatment, and introduced species. The magnitude of the effects to bull trout of reducing the conservation pool cannot be accurately quantified with the data available.

Thermal conditions will usually be suitable for bull trout except in the late summer and early fall period when the reservoir is at or near the 50,000-acre-foot conservation pool, the dissolved oxygen levels become inadequate, and water temperatures begin to exceed bull trout tolerances (USBR 2004c). Removing additional water during this period may adversely affect aquatic fauna, including bull trout and kokanee. Kokanee are an important prey item for bull trout where they are present (Vidergar 2000). An adverse effect to kokanee in these extremely dry years will also likely adversely affect adfluvial bull trout in Deadwood Reservoir.

Entrainment is not likely to adversely affect bull trout at Deadwood Dam. Entrainment of bull trout from Deadwood Reservoir to the Deadwood River has not been documented, though some entrainment may occur. Under the proposed action, water will normally flow over the unregulated spillway in June or July. If patterns of adfluvial bull trout movement in this system parallel those of others, then the bull trout would generally be at the mouths of or have migrated into tributaries to spawn during June and July. However, movement and migration patterns of adfluvial bull trout have not been documented for the Deadwood River system.

In addition, the outlet works for Deadwood Dam are located about 130 feet below the spillway crest. During the fall and winter, Reclamation will operate the reservoir to maintain a minimum pool of 50,000 acre-feet and release 50 cfs to maintain streamflow downstream from the dam. Winter operations do not likely provide a high probability of entrainment for bull trout.

Reclamation has determined that the proposed action may affect and is likely to adversely affect bull trout overwintering in the Deadwood Reservoir when reservoir storage is less than 50,000 acre-feet in about 7 percent of years. Loss of overwintering habitat and poor water quality conditions could create unfavorable conditions for both bull trout and their prey. The effect of the action cannot be accurately estimated given the already low population densities of adfluvial bull trout.

Lake Cascade

Because bull trout have only been incidentally documented in Lake Cascade, and no upstream passage is currently available between spawning and rearing populations, Reclamation has determined there will be no effect on bull trout in Lake Cascade.

6.8.3 Malheur River Basin

The Malheur River basin is in the action area for future O&M in the Malheur River system.

Beulah Reservoir and the North Fork Malheur River

Under the proposed action, conditions in Beulah Reservoir will likely continue to limit reservoir productivity and fish populations. The year-to-year and season-to-season fluctuations in water supply and irrigation demand will continue. Summer drawdown and low fall reservoir levels will continue to limit the reservoir's productivity, discourage growth and reproduction of aquatic invertebrates and plants, and limit development of the fish prey base for adfluvial bull trout. Currently, there are no population estimates for bull trout in Beulah Reservoir and the North Fork Malheur River, and the extent of this effect on the population or habitat conditions is unknown.

Reclamation (2002) found that keeping Beulah Reservoir at full pool during summer months would not provide water quality suitable for adfluvial bull trout. This likely explains why most bull trout leave the reservoir in the spring and return after spawning late in the fall. In years when Beulah Reservoir is emptied, migratory bull trout may briefly return to Beulah Reservoir in the fall and then migrate back upstream where they overwinter in areas with an adequate food supply. Recent Burns Paiute Tribe trapping efforts in Beulah Reservoir may support this concept as very few bull trout have been collected from the reservoir during the 2002-2004 spring sampling period. In average water years, more bull trout were captured during spring sampling periods.

During drought periods, Beulah Reservoir adfluvial bull trout may be exhibiting similar feeding behavior to those Salow and Hostettler (2004) identified with Boise River bull trout that were overwintering in the South Fork Boise River rather than in Arrowrock Reservoir. Schwabe (2003) documented the adequate food supply in these upriver reaches of the North Fork Malheur River based on catch rates from a screw trap. The Burns Paiute Tribe fished a screw trap immediately upstream from Beulah Reservoir in the springs of 2002 and 2003 and caught numerous non-game fish species that would be considered prey base species for bull trout. This supports USGS findings (Petersen et al. 2003) of the fish community in the Beulah Reservoir vicinity being resilient to repeated reservoir drawdowns and that annual recruitment of prey base species from the North Fork Malheur River and Warm Springs Creek have helped ameliorate some of the effects of reservoir fluctuations on the bull trout prey base.

Though water quality conditions may not directly affect bull trout during the summer months, they can adversely affect the bull trout prey base. Loss or reduction in the bull trout prey base could potentially adversely affect bull trout that overwinter in Beulah Reservoir. Based on the historical record from 1970 to 2003, the reservoir would drop to 2,000 acre-feet in 7 percent of the years and would be emptied in 4 percent of the years. During this low volume period, bull trout would have left Beulah Reservoir in the spring to upstream locations to either spawn or over-summer; however, their prey base would still be affected.

Operational changes at Agency Valley Dam since 2000 resulted in less water being passed over the spillway that reduced but did not eliminate entrainment. Entrainment of bull trout from Beulah Reservoir to the North Fork Malheur River will likely remain low as long as all releases 650 cfs or less are made through the valves and not over the spillway. Using the spillway at Agency Valley Dam to pass reservoir inflows prior to 2000 likely resulted in higher levels of entrainment of bull trout. This might explain why 4 of 39 radio-tagged bull trout were entrained during a 1999 telemetry study when spring releases were passed over the spillway. Since 2000, releases over the spillway are likely to occur only when the valves exceed their release 650-cfs capacity. When total releases are less than 1,000 cfs, 650 cfs can be released through the valves and 350 cfs can be passed over the spillway. Releases greater than 1,000 cfs must be passed exclusively over the spillway.

Historical data from 1961 to 2003 showed that releases between February and June exceeded 650 cfs about 5.5 percent of the time and exceeded 1,000 cfs about 1.5 percent of the time. The conditions requiring spillway use depend on both reservoir elevation and magnitude of reservoir inflow. While the above percentages for releasing water over the spillway are small, there is still the opportunity for entrainment to occur. The magnitude of the effect of entrainment cannot be quantified because population estimates of bull trout in Beulah Reservoir have not been made. Entrainment of bull trout through Agency Valley Dam will continue and is likely to adversely affect the bull trout population above the dam through the loss of adult spawning fish. However, efforts to reduce bull trout entrainment from Agency Valley Dam following the change in releases (spillway to valve) identified in current conditions appear to be reducing entrainment based on fewer bull trout angled in the tailrace.

Conditions in the North Fork Malheur River downstream from Agency Valley Dam will likely continue to limit stream productivity and survivability of entrained bull trout. Bull trout that are entrained in the spring and not recaptured by trap and haul operations will likely perish.

Warm Springs Reservoir

Bull trout have not been documented in Warm Springs Reservoir, and Reclamation has determined there will be no effect on bull trout in Warm Springs Reservoir.

6.8.4 Powder River Basin

The Powder River basin is in the action areas for future O&M in the upper and lower Powder River systems. Bull trout have not been documented to occur in this basin, and Reclamation has determined there will be no effect on bull trout in the Powder River.

6.8.5 Snake River from Brownlee Reservoir to the Columbia River and the Columbia River below the Snake River Confluence

The Snake River downstream from Brownlee Reservoir and the Columbia River downstream from its confluence with the Snake River are in the action areas for all 11 proposed actions. This effects discussion considers the combined effects of these 11 actions.

The ability to ascertain or determine the effects of Reclamation's 11 proposed actions on bull trout is complicated by the presence and operation of Idaho Power's Hells Canyon Complex and the effects of Hells Canyon Complex operations on lower Snake River flow, water quality, and other environmental conditions. It is reasonable to expect that any measurable or tangible effect from Reclamation's proposed actions would be most pronounced in the Snake River upstream from Brownlee Dam and diminish with distance downstream from Brownlee Dam due to tributary inflow, the operations of Oxbow and Hells Canyon Reservoirs, and an array of other environmental and anthropogenic factors.

The model predicts that Brownlee Reservoir inflows will decrease in winter and increase in spring and summer. The decrease in average monthly inflow in the winter and early spring will be no more than 448 cfs less than flows under current operations. The model also predicts that during the driest years, Brownlee Reservoir inflows could increase by as much as 1,100 cfs in July (at the 90 percent exceedance level) compared to current operations. This is attributed to salmon flow augmentation.

These operational changes are not likely to have any measurable effect on bull trout and their prey base in the Hells Canyon Complex and downstream areas. The changes in Brownlee Reservoir inflows are relatively minor compared to existing inflows, and Brownlee Reservoir elevations (as well as Oxbow and Hells Canyon) are not likely to be affected at all since flow augmentation is passed through the three reservoirs. Changes in flows below Hells Canyon Dam would also be unlikely to have a measurable effect on bull trout, their prey base, and bull trout accessibility to spawning tributaries since changes would be very minor compared to existing flows.

6.8.6 Cumulative Effects

Bull trout are distributed primarily on Federal land, but private and state activities and management programs may affect bull trout and their habitats.

Private irrigation withdrawals from instream natural flow rights issued by the State of Idaho are not likely to adversely affect bull trout populations in the action area within the Boise and Payette River watersheds. The Deadwood River contains few known diversions with most of the watershed located entirely on Federal land. Most private diversions in the Boise River upstream from Lucky Peak Dam are not closely monitored; however, most are small private diversions (less than 1 cfs) along tributary streams that remove an estimated 50 cfs from the system annually (Sisco 2004). The North Fork Malheur River upstream from Beulah Reservoir has three unscreened diversions that operate during periods when bull trout are migrating through the area (upstream and downstream). Telemetry studies showed that these diversions either delayed the migration of bull trout or likely resulted in bull trout mortality into an unscreened diversion (Schwabe et al. 2000).

Fisheries management actions, such as stocking, angling regulations, and enforcement, may adversely affect prey species and bull trout populations. The States of Idaho and Oregon conduct fisheries management actions, including harvest regulation and stocking, in the Boise, Payette, Powder, and Malheur River watersheds. The demand for recreational opportunities in the Boise, Payette, and Malheur River basins is expected to increase as local population centers in the Treasure Valley continue to increase and expand. Population increases result in additional pressures on reservoir and stream fishing in the action area. Increased angling can affect the habitat of bull trout. Angling can also directly interfere with the species in the form of poaching and the inability of anglers to properly identify and release bull trout (Salow and Hostettler 2004; Haynes 2003).

6.9 Effects Conclusion

6.9.1 Future O&M in the Boise River System

Reclamation has determined that future O&M in the Boise River system may affect and is likely to adversely affect bull trout in Anderson Ranch Reservoir, the South Fork Boise River, and in Arrowrock Reservoir.

Adverse effects to bull trout at Anderson Ranch Dam will occur in 2 percent of years when the 62,000-acre-foot conservation pool is not maintained.

Adverse effects to up to 44 percent of overwintering bull trout will occur in the South Fork Boise River when winter streamflows fall below 300 cfs in 3 percent of years. Adverse effects to bull trout in the South Fork Boise River will also occur from water temperature changes when Anderson Ranch Dam spillway discharges occur during flood control operations and when there are large changes in discharge velocities. Adverse effects to bull trout at Arrowrock Reservoir will occur from mortality and entrainment. Bull trout mortality will occur in 5 percent of years when the reservoir falls below 3,100 feet elevation and causes a loss of cover and an increase in exposure to prey. Entrainment will occur during winter operations in 6 percent of years, during March-through-June flood control operations in 27 percent of years (with an estimated 4 to 16 percent of Arrowrock Reservoir adfluvial bull trout being entrained, and in July and August during 95 percent of years (up to 2 percent of bull trout may become entrained during July and August operations).

6.9.2 Future O&M in the Payette River System

Reclamation has determined that future O&M in the Payette River system may affect and is likely to adversely affect bull trout in Deadwood Reservoir and in the Deadwood River below Deadwood Dam.

Adverse effects to bull trout in Deadwood Reservoir will occur in 7 percent of years when the 50,000-acre-foot conservation pool is not maintained (during late summer and early fall).

Adverse effects to bull trout in the Deadwood River below Deadwood Dam will occur from unfavorably low (very cold) water temperature releases from the dam that cause large variations in water temperatures, from large variations in discharge velocities, and from low winter streamflows. These will occur in all years, and will adversely affect bull trout, its habitat, and its prey.

6.9.3 Future O&M in the Malheur River System

Reclamation has determined that future O&M in the Malheur River system may affect and is likely to adversely affect bull trout in Beulah Reservoir and in the North Fork Malheur River below Agency Valley Dam. Adverse effects to bull trout in Beulah Reservoir will occur through loss of reservoir productivity when the reservoir is annually drawn down and occasionally emptied in 4 percent of years. Adverse effects to bull trout will also occur when the spillway must be used at flows greater than 650 cfs in 5.5 percent of years. Water temperatures from reservoir releases are not conducive for bull trout entrained into the North Fork Malheur River below Agency Valley Dam.

6.9.4 Combined Effects of all Proposed Actions in the Snake River from Brownlee Reservoir to the Columbia River and in the Columbia River below the Snake River Confluence

Reclamation has determined that the 11 proposed actions may affect but are not likely to adversely affect bull trout in the Snake River from Brownlee Reservoir to the Columbia River and in the Columbia River below the Snake River confluence. The operational changes are not likely to have any measurable effect on bull trout, their prey base, or accessibility to their spawning tributaries.

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Chapter 7 GRAY WOLF

7.1 Overview

The gray wolf (*Canis lupus*) is currently listed as threatened in some parts of the State of Idaho, but where it occurs in the action areas, it is listed as experimental/non-essential. Historically, the gray wolf was present throughout much of the region, but it was extirpated from the western states about 1930. An experimental population of gray wolves was introduced into Yellowstone National Park and into central Idaho in 1995 and 1996.

Wolves are now reproducing in the uppermost reaches of the Snake River and central Idaho, the upper Deadwood River drainage, and possibly the upper Boise River watershed in the Sawtooth Mountains. This is within the action areas for future O&M in the Snake River system above Milner Dam, the Boise River system, and the Payette River system. However, future O&M in the Snake River system and the Payette River system have no effect on gray wolves.

7.2 Effects Conclusion

It is unlikely that the future O&M in the Boise River system will have a direct effect on gray wolves. However, the gray wolf preys on deer and elk that occur in the action area, and the wolves may be indirectly affected when deer and elk occasionally fall through the ice during winter at Lucky Peak and Arrowrock Reservoirs. The level of mortality to deer and elk does not significantly affect their populations, and there is still ample prey for wolves. Reclamation has determined that future O&M in the Boise River system may affect, but is not likely to adversely affect, the gray wolf experimental population.

Chapter 8 UTE LADIES'-TRESSES

8.1 Status

Ute ladies'-tresses (*Spiranthes diluvialis*), a perennial orchid, was federally listed as threatened in 1992 (57 FR 2048). In 1995, the known population was approximately 20,500 individuals. Subsequent searches of potential habitat have revealed a greater number of populations and individual plants than was known when listed; the estimated population in 1999 was less than 60,000 individuals (Jordan 1999). The USFWS (1995) prepared a draft recovery plan for the Ute ladies'-tresses, but this plan has not been finalized.

8.2 Distribution

The Ute ladies'-tresses are only known to occur in Colorado, Idaho, Montana, Nebraska, Nevada, Utah, Washington, and Wyoming (Moseley 1996; Jordan 1999). Although the orchid has a large geographic range, most occurrences contain fewer than 100 individuals. The Idaho metapopulation (see Figure 8-1) only contains

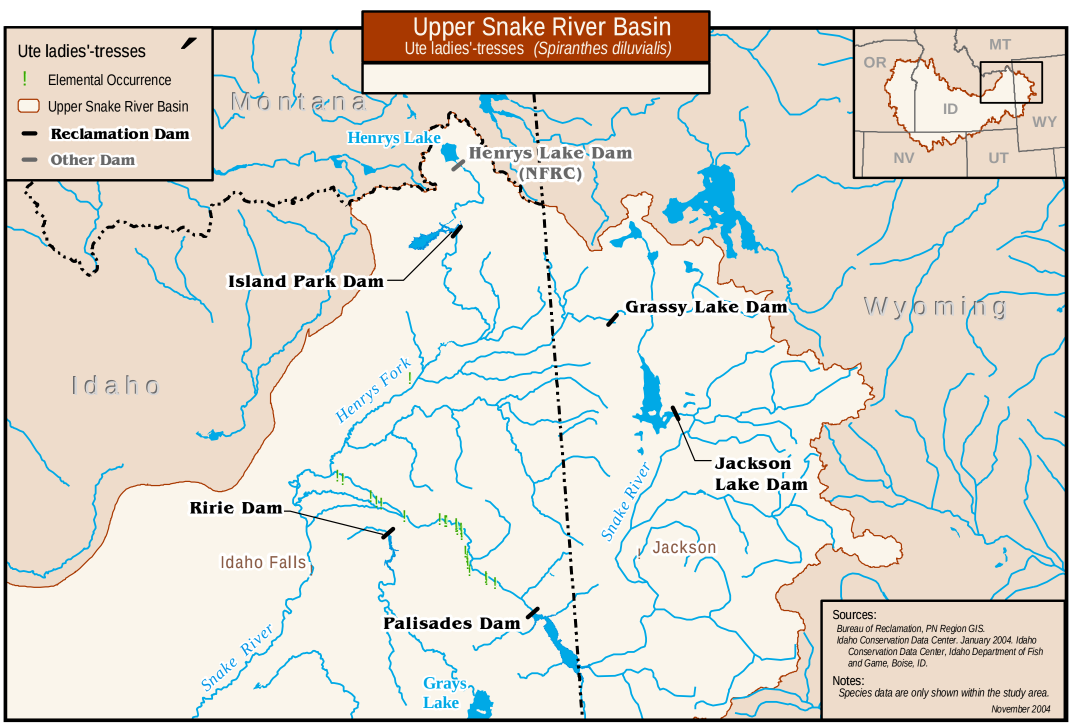

Figure 8-1. Known Ute ladies'-tresses locations in the upper Snake River basin.

populations along the South Fork of the Snake River and the Henrys Fork; these represent about 15 percent of the known population. Figure 8-1 on page 225 shows known locations for 24 elemental occurrences in the Snake River system above Milner Dam action area (22 on the South Fork of the Snake River and 2 on the Henrys Fork) with approximately 4,300 individual flowering plants identified in 2003 (Murphy 2004a, 2004b). BLM lands along the Snake River in Wyoming were surveyed in 1999, but no plants were identified; the species is known to occur only in the southeast portion of Wyoming (Fertig 2000).

8.3 Life History

The Ute ladies'-tresses is a perennial, terrestrial orchid with the stem arising from tuberously thickened roots. Its narrow leaves are about 11 inches long at the base and become reduced in size toward the apex (Jordan 1999). The small white or ivory flowers cluster into a spike arrangement at the top of the stem (see Figure 8-2).

Figure 8-2. Flowering Ute ladies'-tresses.

The species usually flowers from the end of July until early September. Reproductively mature plants do not flower every year. Reproduction appears to be strictly sexual, with bumblebees as the primary pollinators. Each fruit contains thousands of very small seeds. Seeds disseminate primarily through water transport. After seeds reach suitable habitat, they must come in contact with the suitable species of mycorrhizal endophyte. This fungus provides the developing plant with the nutrients necessary for further growth (USFWS 1995; Jordan 1999). The orchid seedlings may remain underground, dependent on mycorrhizal fungi, for up to 8 years (Fertig 2000).

8.4 Habitat Requirements

The Ute ladies'-tresses is a floodplain species that is suspected to require mid-seral riparian habitats created by streams and rivers with actively changing channels (USFWS 1995). The orchid appears to be well adapted to, and perhaps dependent on, regular disturbances from water moving through floodplains. Natural fluvial processes create new habitat. Flooding also maintains the existing habitat by reducing tree and shrub colonization of gravel bars.

The orchid is endemic to moist soils in mesic or wet meadows near springs, lakes, or perennial streams (USFWS 1995). The elevational range of known Ute ladies'-

tresses is 4,300 to 7,000 feet (Stone 1993). In some localities in the eastern Great Basin, Ute ladies'-tresses are found near freshwater lakes or springs (57 FR 2048). The plant seems to require permanent sub-irrigation (Coyner 1989), indicating a close affinity with floodplain areas where the water table is near the surface throughout the growing season. It grows primarily in areas where the vegetation is relatively open and not overly dense or overgrown (Coyner 1989, 1990; Jennings 1989, 1990), although a few populations in eastern Utah and Colorado are found in riparian woodlands. Plants usually occur in small scattered groups and occupy relatively small areas within the riparian system (Stone 1993). These preferred habitat features seem to imply that the plant is most likely to occur in riparian habitats created and maintained by stream activity within their floodplains (USFWS 1995).

This orchid is tolerant of a mix of herbaceous wetland, forb, and grass species but does not compete well with emergent or aggressive species that form dense monocultures, such as Russian olive (*Elaeagnus angustifolia*), reed canary grass (*Phalaris arundinacea*), and other similar non-native invasives (USFWS 1995). Maturing riparian communities with an overstory of trees or shrubs do not provide suitable habitat conditions (USFWS 1995; Moseley 1998). The plants thrive in full sun or partial shade; Moseley (1998) notes that the species is often associated with cottonwood galleries. The plants are not tolerant of long-term standing water throughout the growing season. Beaver dams that raise the water table within 18 inches of the ground surface likely improve habitat conditions in adjacent areas (USFWS 1999).

Within the floodplain of the Snake River, Moseley (2000) identified the five distinct cover types the Ute ladies'-tresses occupies: wandering spike-rush (*Eleocharis rostellata*), silverberry/redtop (*Elaeagnus commutate*), wooly sedge (*Carex lanuginose*), sandbar willow/mesic graminoid (*Salix exigua/mesic graminoid*), and varied scouring rush (*Equisetum variegatum*). The wandering spike-rush and silverberry/redtop tend to occur as larger-scale patches on the Snake River, while the sandbar willow/mesic graminoid and varied scouring rush are rarer and occur as small-scale patches within the cottonwood forests. The Ute ladies'-tresses occurs in connection with the wandering spike-rush and wooly sedge communities only on Kellys Island (Moseley 2000).

8.5 Factors Contributing to Species Decline

Several long-term threats may affect the species and its habitat, including urban development; stream channelization; stream alterations that reduce the natural dynamics of stream systems; increased demands for agricultural, municipal, and industrial water; recreation; and invasion by non-native plant species (USFWS 1995). These threats are expected to intensify as the population of western states grows.

Murphy (2000, 2001, 2003, 2004a) and Moseley (2000) describe short-term effects on the Ute ladies'-tresses from a variety of adverse human actions, including hydrologic and floodplain alterations, livestock grazing/trespass grazing, off-highway vehicle use, recreation, and non-native weed invasions.

Agricultural development has several components that could continue to threaten the species as a whole. Water diversion, channelization, groundwater withdrawal, and increased sedimentation from upland land-clearing and development activities have likely affected some populations. Alterations in hydrology of natural stream and river systems has been reported as both beneficial and detrimental to the orchid, depending on the availability of water throughout the growing season (Jordan 1999).

Heavy livestock grazing is believed to be detrimental to the species. Mild to moderate grazing and mowing early during the growing season may promote flowering by opening the canopy of competing vegetation, permitting the orchid to grow in full sun. However, grazing and mowing later in the growing season may impede fruit set by removing flowering stalks and enhancing harvest of the fruits by small mammals. Livestock trampling may also be detrimental.

Many orchid populations occur on public rangelands where domestic livestock and grasshoppers are commonly viewed as competitors for forage. Insecticides registered for control of grasshoppers on rangelands include acephate, carbaryl, Dimilin, and Malathion (EPA 1985). These pesticides also affect bumblebees, which are the preferred pollinators of the Ute ladies'-tresses (Fertig 2000).

Most recently, Murphy (2004a) identifies threats specific to the Idaho meta-population as alteration of hydrologic regime on the South Fork of the Snake River due to the operation of Palisades Dam since the 1950s, cattle grazing, off-highway vehicle use, non-native plant species invasion, and recreation, such as camping, boating, fishing, etc. The threat from alternation of the flow regime is the result of reduced peak flows that may reduce the ability of the river to maintain existing orchid habitat and create new orchid habitat through erosion and avulsion.

8.6 Recovery Efforts

The managing agencies along the Snake River corridor have instituted several management activities to restrict grazing, prevent recreation damage, and control non-native weeds for the protection of the species. Studies indicate that long-term health of the population of this species is dependent not only in controlling these impacts, but more importantly, in providing flows that maintain a dynamic floodplain.

The BLM, the USFS, and the IDFG Conservation Data Center survey the Snake River below Palisades Dam each growing/flowering season to determine the status of known species locales and to locate new occurrences of the species.

8.7 Current Conditions in the Action Area

Several recent Idaho surveys illustrate fluctuations in species population (Moseley 1998, 2000; Murphy 2000, 2001, 2003, 2004a). Table 8-1 displays the survey results for recent years. Poor understanding of the species and poor survey timing may explain some variations. The number of plants observed in any specific population may also vary considerably from year to year and may lead to false estimates of the population size and vigor. Apparent fluctuations in populations are the result of dormancy periods likely brought on by variation in environmental conditions. During dormancy periods, there may either be no above-ground growth or limited above-ground growth with no floral development.

The 2001 count of 4,133 individuals represents a significant expansion at one location on the Snake River below Palisades Dam (Murphy 2001). The 2002 survey showed a significant decrease in counted individual plants, down 2,380 to 1,753 individuals. Trespass cattle grazing at Annis Island reduced the number of flowering plants counted from 2,557 to 306 individuals (Murphy 2003). When this reduction in observed individuals is removed from the tabulations, the number of flowering individuals fell by 129. In 2003, 2,006 individuals were counted in the Annis Island population. New populations were discovered in 2002 at the Chester Wetlands on the Henrys Fork and in 2003 near Texas Slough between the Snake River below Palisades Dam and Henrys Fork (Murphy 2003, 2004b).

Specific trend data has not been developed for the Idaho occurrences of this species. The species is often difficult to observe for a variety of reasons, including the plant's small size among its grassy habitats, the natural variability in year-to-year flowering

Table 8-1. Recent Snake River basin Ute ladies'-tresses survey results.

Survey Year	Source	Number of Plants	Number of Occurrences
1996	Murphy 2004a	201	4
1997	Moseley 1998	1,171	20
1998	Moseley 1998	2,604	19
1999	Moseley 2000	3,410	20
2000	Murphy 2000	2,600	20
2001	Murphy 2001	4,133	20
2002	Murphy 2003	1,753	20
2003	Murphy 2004a, 2004b	4,341	22

plants, alternations in phenology due to annual climate fluctuations, and mistimed surveys that miss peak flowering (Murphy 2004a). Additionally, counting flowering plants may not determine the long-term health of the population because it does not take into account the general condition of the habitat.

8.7.1 Snake River below Palisades Dam

Extensive surveys in 1996 covered a wide area of eastern Idaho to assess the distribution of potential habitat (Moseley 1996). These surveys documented the existence of four separate occurrences of the plant in the floodplain along the mainstem of the Snake River between Heise and Swan Valley. One population consisted of 12 individuals scattered over about 1 acre while another population consisted of 15 individuals within about 1 acre. The largest population was 173 plants within 1 acre, while the smallest population was one plant at another site (Moseley 1996).

The BLM, the USFS, the IDFG Conservation Data Center, and the USFWS conducted more intensive surveys in 1997. Preliminary analysis of data indicates the existence of 20 occurrences along the Snake River between Swan Valley and the confluence with the Henrys Fork (Moseley 1997). A total of 1,171 individuals (mostly flowering/fruiting plants) were counted. Non-flowering plants were not counted due to the difficulty of species identification (Moseley 1998).

Cattle grazing poses a short-term impact to the species from the loss of flowering plants and a long-term threat from the loss of production (Murphy 2004a). Impacts from recreation activities, such as camping, boating, and fishing, continue to increase in this reach of the Snake River. Murphy (2004a) reports that effects to 11 occurrences are associated with recreation. Off-highway vehicle use causes a minor threat. Non-native weeds may be responsible for nearly extirpating the orchid from two sites and are in competition with the orchid at nearly all sites (Murphy 2004a).

Grazing and recreational use appear to be the most likely activities affecting the plant along the Snake River below Palisades Dam. Recent surveys along the Snake River below Palisades Dam reflect this. It is generally believed that any activity that degrades floodplain riparian or wetland habitats also affects Ute ladies'-tresses (USFWS 1995).

The hydrologic alteration of the Snake River below Palisades Dam presents the greatest threat to the long-term viability of the Ute ladies'-tresses on the South Fork of the Snake River (Murphy 2004a); this alteration is most evident in the suppression of the ecological processes inherent in fluvial systems. Several sources have indicated that reduction in peak flows have reduced geomorphologic processes downstream from Palisades Dam (Murphy 2004a; Moseley 1998; Hauer et al. 2004; Merigliano 1995). In general, floodplains are modified by erosional deposition and channel avulsion, which lead to destruction and development of habitats, both temporally and spatially; this is described as a "shifting habitat mosaic" within the floodplain (Hauer et al. 2004). The constant creation and destruction of habitats is the basis for the biological diversity within riparian habitats.

The BLM contributed funding for a study by Merigliano (1995) to investigate the effects of natural and managed river flows on maintenance of cottonwood stands below Palisades Dam. This study analyzed pre-dam river flows to identify flows to maintain the cottonwood forest on the South Fork. The study also presents information showing that post-dam flow regulation has reduced large flood flows, sediment transport, and channel migration, causing a reduction in the amount of suitable areas for cottonwood establishment and long-term survival of the existing cottonwood forest and in turn the riparian habitat of the river.

Reclamation has funded two efforts to determine river operation schemes that mimic more natural streamflows to support the IDFG cutthroat trout management program. If implemented, these should also benefit Ute ladies'-tresses. In 2000, Reclamation initiated a project to analyze operations from an ecological perspective. The Ecologically Based System Management (EBSM) project identified annual and inter-annual operations to support long-term ecological functions in the Snake River below Palisades Dam (Hauer et al. 2004). Burnett and Van Kirk (2004b) provided a statistical analysis of a long-term regulated hydrograph and a long-term unregulated hydrograph for the Snake River below Palisades Dam as they relate to the ratio between the high and low flows and the effects of the alteration ratio on cutthroat trout. These two studies looked at post-dam operations that influenced the physical and biological character of the river.

These studies suggest that species that evolved under flow conditions in high-energy Rocky Mountain streams benefit from regulated flow regimes that mimic naturally occurring hydrographs. Flows great enough to cause sediment mobilization that scour rainbow trout redds and give Yellowstone cutthroat trout a competitive edge also provide the mechanism for channel erosion and avulsion processes that benefit Ute ladies'-tresses (Burnett and Van Kirk 2004b; Hauer et al. 2004).

Hauer et al. (2004) and Merigliano (1995) report that in order to maintain the existing habitat mosaic, including cottonwood and Ute ladies'-tresses' habitats on the Snake River below Palisades Dam, flows in excess of 30,000 cfs are needed to cause erosion and avulsion of the floodplain (orthofluvial flows). Hauer et al. (2004) determined that a flow of 17,000 to 19,000 cfs is the average threshold flow needed to begin mobilizing sediment within the active river channel (parafluvial flow). The erosion and avulsion process that creates or destroys habitat begins at this flow. Hauer et al. (2004) also noted that the ramping rate down from these higher flows is important to this process, with a 5 percent ramp-down likely most effective. Hauer et al. (2004) suggest a minimum of around 28,000 cfs in wet years to initiate orthofluvial flow with sustained flows of 30,000 cfs for as long as possible, with flows over 25,000 cfs for 12 to 15 days in the very wettest of years (4 years out of 45). Merigliano (1995) suggests that flows of 38,000 cfs are necessary every 10 to 15 years for the establishment of new cottonwood stands.

Murphy (2004a) and Moller and Van Kirk (2004) identify that past project operations below Palisades Dam on the Snake River, as measured at the Snake River near Irwin and Heise gages, have decreased winter flows during the storage season, reduced June peak flows, and increased summer flows during the irrigation season. Project operations have significantly reduced the high, annual scouring flows associated with uncontrolled spring runoff. Over the last 87 years, the average unregulated (theoretical operation without the project) peak flow for the Snake River at Heise gage would have been 32,081 cfs as opposed to actual average regulated peak flow of 21,000 cfs since Palisades Dam was completed in 1956.

This reduction in peak flows reduces the mobilization of sediment, which in turn may alter seral development of some plant communities and reduce the amount or development of new mid-seral riparian habitat. Murphy (2004a) notes that over time, the affected mid-seral communities could become drier and allow progressive encroachment of shrub and woody vegetation.

Flows above flood stage still occasionally occur in the river reach below Palisades Dam as measured at the Irwin gage. Flood stage in this reach, 24,500 cfs, has been exceeded in four years since 1956. In June 1997, flows exceeded 38,000 cfs for over a week, peaking at 40,300 cfs on June 20, 1997.

Most of the known populations of Ute ladies'-tresses are inundated for a period of time ranging from several days to several weeks under flow conditions that range from 18,000 cfs to 20,000 cfs (Moseley 1998). Spring inundation is considered a normal occurrence within the habitat of this orchid and is likely necessary for the continued existence of the plant (Moseley 1998) and its habitat. Once the higher flows associated with spring runoff recede, the orchids again become exposed and can begin the normal growth cycle. Actual average daily flows in June at the Snake River near Heise gage exceeded 18,000 cfs for at least one day in 27 years since 1956 (57 percent). The actual monthly average flow during June has exceeded 18,000 cfs in 12 of those years (25.5 percent).

Low summer flows that occur due to extreme drought can cause moisture stress at some orchid sites during July and August, which Murphy (2004a) reports as the prime growing period. Murphy (2004a) reports that inadequate soil moisture is not likely a limiting factor at any site when flows are higher than 6,900 cfs. In 2001, August streamflow on the Snake River dropped to 6,879 cfs and was sufficiently low enough to cause moisture stress (Murphy 2003). As Table 8-1 on page 229 shows, the population occurrences from 2001 to 2002 did fall significantly, but this reduction is nearly entirely attributable to the loss of 2,251 individuals at Annis Island from trespass cattle grazing (Murphy 2003). Thus, the soil moisture stress from the 6,879 cfs flow did not appear to significantly affect the orchid populations in the Snake River.

Murphy (2003) goes on to report that flows of 8,400 cfs maintain adequate soil moisture at all but one occurrence, and flows of 7,300 cfs or higher are high enough to maintain soil moisture "at most occurrences." Winter flows are not reported as causing adverse growth conditions, most likely because the plants are dormant.

Lower flows during the orchid's growing period occurred regularly in the past. Analysis of pre-Palisades Dam flow at the Snake River near Heise gage shows that flows regularly fell below 7,300 cfs during late summer (it is important to note that upstream from this location, Jackson Lake Dam was in place and operating). For example, in the period between 1910 and 1940, August daily flows dropped below 7,300 cfs for at least one day in August in 24 of 31 years, and they dropped below 7,300 cfs for every day in August in 4 of 31 years. In the 44 water years from 1960 to 2003, August daily flows dropped below 7,300 cfs for at least one day in 13 of 44 years, and they never dropped below 7,300 cfs for every day of the month.

Average July monthly flows at the Snake River near Irwin have been above 8,400 cfs 100 percent of the time. Average August monthly flows have been above 8,400 cfs 66 percent of the time, above 7,300 cfs 92 percent of the time, and above 6,900 cfs 96 percent of the time.

The BLM, the USFS, and the IDFG Conservation Data Center surveyed numerous sites on BLM lands on the Snake River from the Henrys Fork confluence to American Falls Reservoir. They found no Ute ladies'-tresses (Moseley 1998; Murphy 2004a).

8.7.2 Henrys Fork

A new population was discovered at IDFG's Chester Wetlands Wildlife Management Area on the Henrys Fork below the Cross Cut Diversion Dam above St. Anthony, Idaho. This was the first documented occurrence outside the Snake River corridor below Palisades Dam (Murphy 2003). Approximately 300 individuals at 6 to 7 separate sites were found in surveys conducted in 2003 (Aslett 2004).

Island Park Dam partially controls Henrys Fork flows, but irrigation diversions below the Fall River confluence with the Henrys Fork have a greater influence on Henrys Fork flows. These result in low late summer flows but not in a substantial alteration of peak flow (Burnett and Van Kirk 2004b). Burnett and Van Kirk (2004a) further note that Reclamation's operational control of the Henrys Fork only minimally alters the natural hydrograph. Operations at Island Park Dam or the Cross Cut Diversion

Dam immediately downstream from the Fall River confluence with the Henrys Fork most likely have not significantly affected this orchid population.

This population is associated with subsurface flows from nearby canals and a naturally high water table (Murphy 2003). One sub-population is located about 20 meters from the Henrys Fork and may be inundated during peak flow events. This site is also influenced by sub-irrigation from a leaky canal upslope of the site. The rest of the sub-populations are approximately 0.75 mile from the river and are located in a wetland that is sub-irrigated by a high water table and small canals and ditches. Storage and release of water at Island Park Reservoir and its subsequent diversion later in the irrigation season has likely indirectly benefited the orchid by supporting subsurface flows during the orchid's growing season.

A second occurrence was found in the historical floodplain of the Snake River near the Henrys Fork confluence and near Texas Slough in a drainage that flows towards the Henrys Fork. This is a small population with three individuals occurring in two groups (Murphy 2004b). The occurrence is on a piece of private land that apparently is being managed as a private wildlife refuge and residential area and is not influenced by Reclamation operations.

8.8 Effects Analysis

The area of analysis for the Ute ladies'-tresses is in the Snake River corridor below Palisades Dam to the Henrys Fork confluence and in Henrys Fork just above the Snake River confluence. This area is within the action area for future O&M in the Snake River system above Milner Dam. Since implementation of the proposed action will not affect the extent, management, or location of floodplain development, grazing, recreation, off-highway vehicle use, or non-native plant species invasion, these factors will not be analyzed.

8.8.1 Snake River below Palisades Dam

Under the proposed action, Reclamation's future operations at Palisades Dam are likely to slightly reduce the present frequency of Ute ladies'-tresses inundation, the degree of soil moisture, and the erosion and avulsion process on the Snake River from Palisades Dam to its confluence with the Henrys Fork.

Habitat Inundation

Section 8.7.1 describes spring inundation of the orchid's known habitat along the Snake River below Palisades Dam as a normal occurrence that is most likely needed for the plant's continued existence (Moseley 1997) and the maintenance of appropriate habitat conditions. Flows above the 18,000-to-20,000-cfs range inundate all but one occurrence of Ute ladies'-tresses for a period of time ranging from several days to several weeks (Moseley 1998; Murphy 2004a). For this analysis, Reclamation uses an 18,000-cfs benchmark flow to help determine how the proposed action may cause inundation of known Ute ladies'-tresses occurrences.

Under the proposed action, the model predicts that average monthly flows at the Snake River near Heise gage in June will exceed 18,000 cfs in about 23 percent of years. This is only a 2 percent reduction from the frequency of flows above 18,000 cfs in the historical record since 1956 and is almost identical to the Current Operations scenario (see Figure 8-3). The model's monthly time step does not fully capture how often daily flow will exceed 18,000 cfs in a month when the month's average flow does not exceed 18,000 cfs. With only a 2 percent reduction in frequency for the average monthly flows to exceed 18,000 cfs, it is likely that the 57 percent of years daily flows have exceeded 18,000 cfs will likely not drop below 50 percent; thus, the Ute ladies'-tresses habitat will still likely be inundated for at least one day in at least 50 percent of years.

The proposed action differs slightly from current operations because it includes a provision for Palisades Reservoir powerhead to serve as a source for salmon flow augmentation in dry years. Because Reclamation may vacate this space in some years, this would increase the volume of space Reclamation would need to fill before beginning flood control releases during the subsequent spring. As a result, Palisades

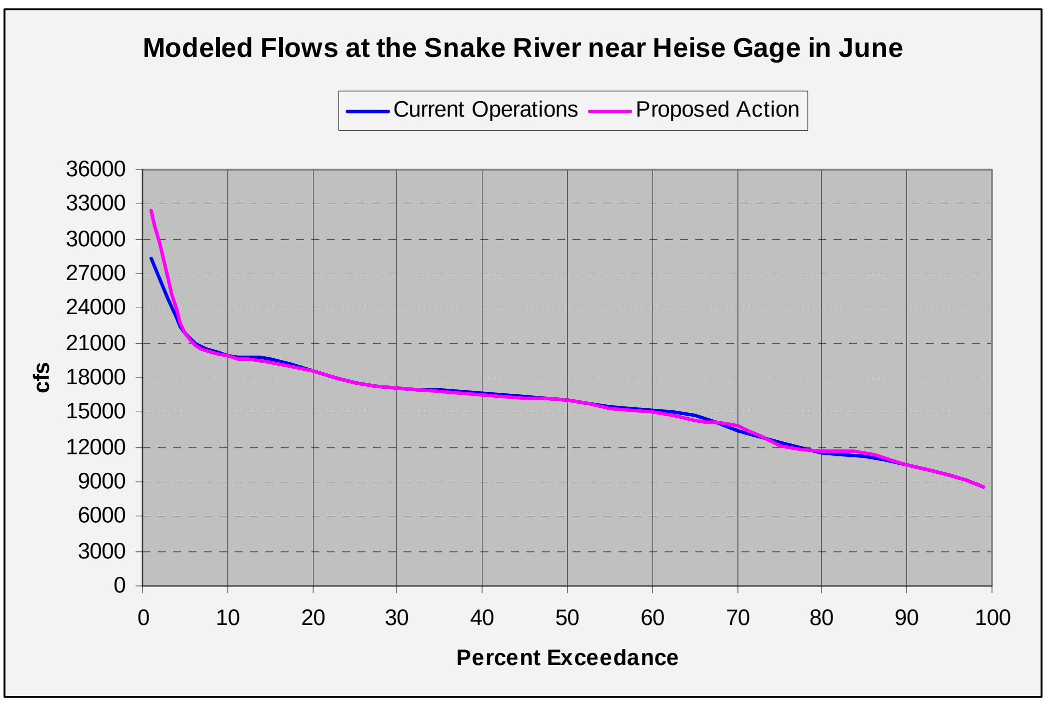

Figure 8-3. Comparison of modeled average monthly flows for current operations and the proposed action for the month of June at the Snake River near Heise gage.

Reservoir would fill slightly slower, and Reclamation would need to release less water than it would otherwise have released. Flows in the Snake River below Palisades Dam above 18,000 cfs will still occur with sufficient frequency to inundate the Ute ladies'-tresses habitat, and flood flows exceeding 24,500 cfs, the official flood stage, will continue with near the same frequency as they have in the past.

Soil Moisture

The model predicts that flows during the prime growing season (July and August) will be sufficient to maintain soil moisture for most orchid occurrences. Murphy (2003) notes that 8,400 cfs maintains moisture at all but one occurrence, and that 7,300 cfs maintains moisture at 16 of 22 occurrences. Murphy (2004a) reports that inadequate soil moisture is not likely a limiting factor at any site when flows are above 6,900 cfs.

The model predicts that average monthly flows for the proposed action at the Snake River near Irwin in July will be above 8,400 cfs 100 percent of the time. The model also predicts that average monthly flows for the proposed action in August will be above 8,400 cfs 58 percent of the time (down from 66 percent under actual operations), above 7,300 cfs 88 percent of the time (down from 92 percent under actual operations), and above 6,900 cfs 96 percent of the time (identical to actual operations). As Figure 8-4 shows, the proposed action will slightly increase soil moisture from current operations. In the 4 percent of years that flows will fall to 6,900 cfs, stress may occur (Murphy 2003), but as described in Section 8.7.1 on low flows in 2001, this stress will not likely be significant.

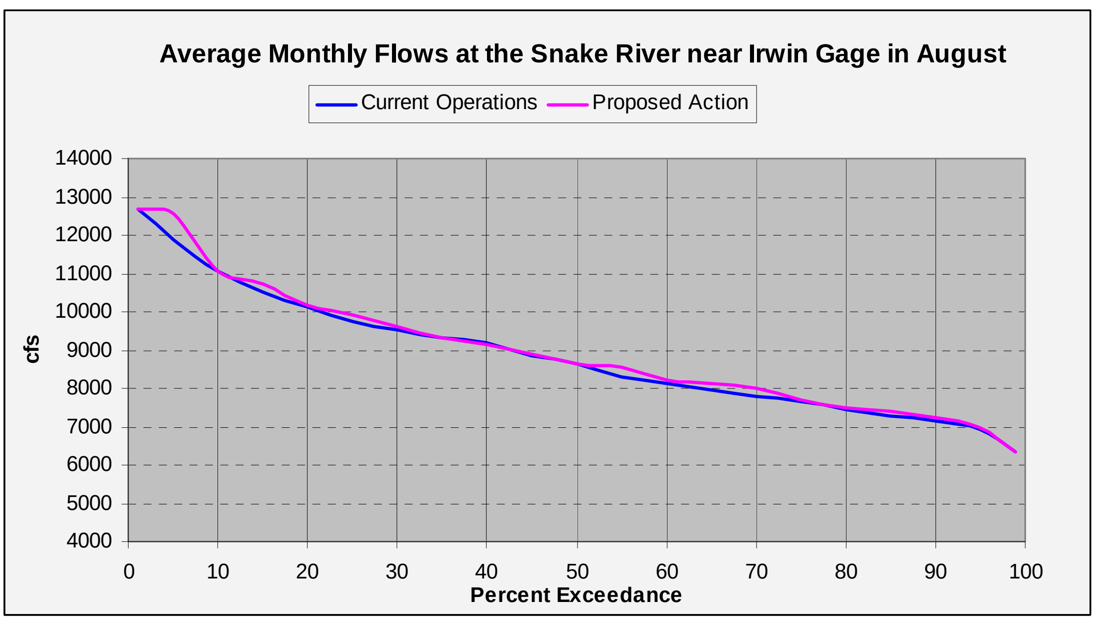

Figure 8-4. Comparison of modeled average monthly flows for current operations and the proposed action for the month of August at the Snake River near Irwin gage.

Erosion and Avulsion Processes

As described in Section 8.7.1, construction and subsequent past and current operations of Palisades and Jackson Lake Dams have altered the geomorphologic processes in the Snake River below Palisades Dam. Hauer et al. (2004) determined that a flow of 17,000 to 19,000 cfs is the average threshold flow needed to begin mobilizing sediment within the active river channel, and flows from 25,000 to 38,000 cfs maintain a shifting habitat mosaic, including cottonwood and Ute ladies'-tresses' habitats.

The model predicts that the proposed action, when compared to actual historical operations (see Figure 8-5), will slightly reduce flows in wetter and drier water years while slightly increasing flows in average water years. The model predicts that in the wettest 5 percent of years (flows near or above 25,000 cfs), the proposed action will reduce flows by an average of 2,600 cfs from what has occurred in the past, or about 10 percent of the Snake River flow.

The model predicts the maximum average monthly flows at the Snake River near Irwin gage in June will be 30,284 cfs for the proposed action (see Figure 8-5). This may correlate to an average daily flow peak of near 40,000 cfs (the June 1997 peak daily flow was 40,300 cfs on June 20, 1997, but the average monthly flow for that month was 29,300 cfs). Peak flooding under the proposed action will likely be of the same magnitude as peak flooding in the past.

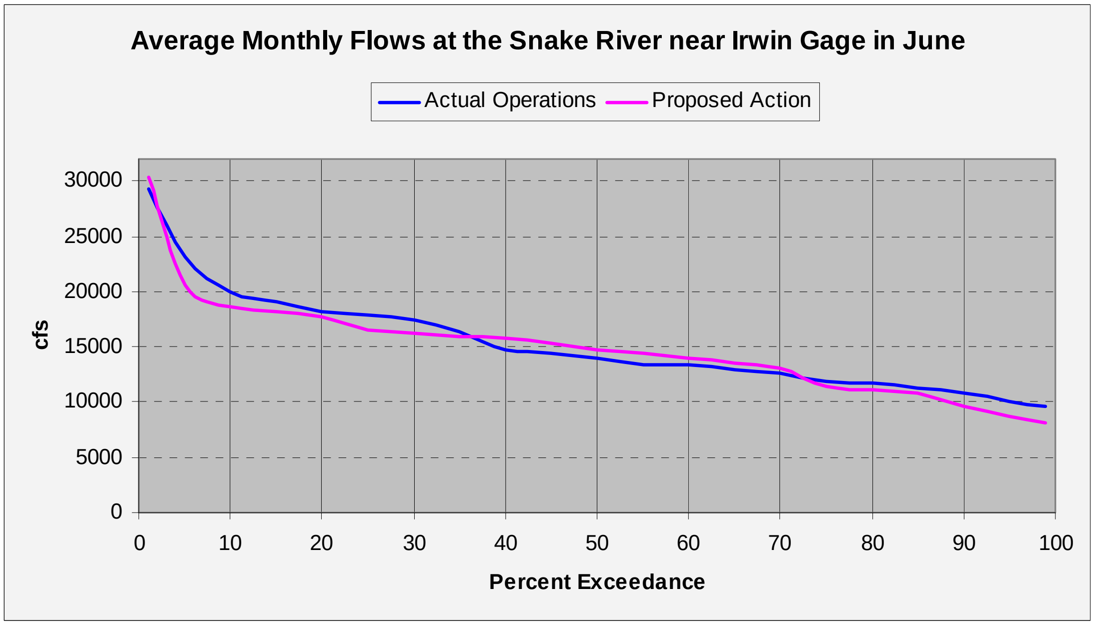

Figure 8-5. Comparison of actual operations and modeled proposed action average monthly flows for the month of June at the Snake River near Irwin gage.

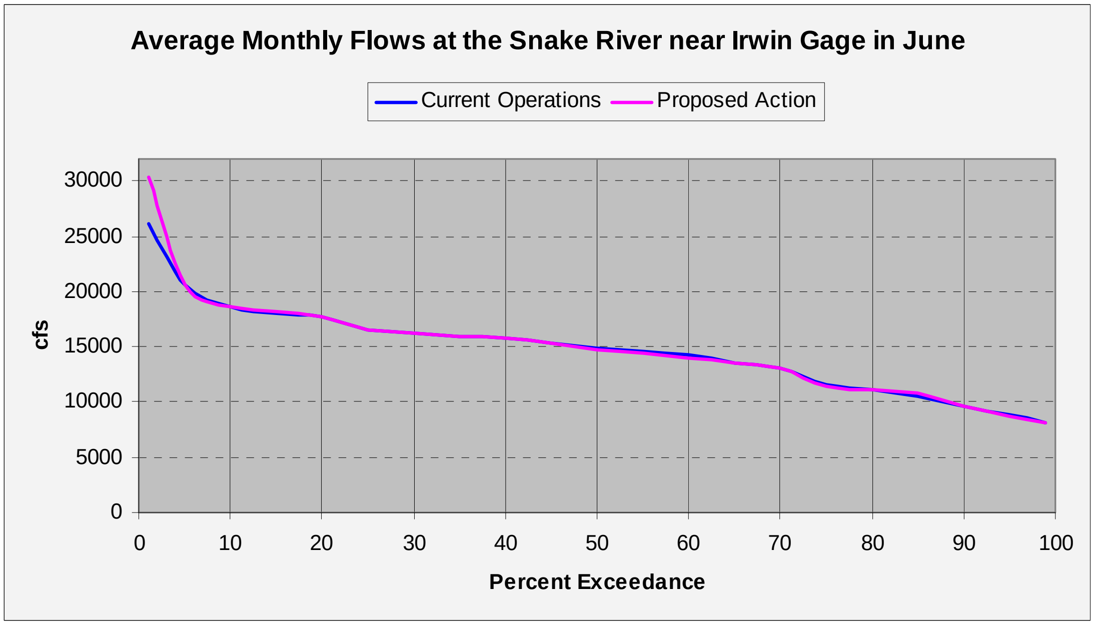

Figure 8-6. Comparison of modeled average monthly flows for current operations and the proposed action for the month of June at the Snake River near Irwin gage.

Though the model predicts peak flows will be slightly less than they have historically been in the Snake River below Palisades Dam, the model also predicts that peak flows under the proposed action will be slightly improved over those flows modeled under current operations (see Figure 8-6).

8.8.2 Henrys Fork

The Henrys Fork population at the Chester Wetlands Wildlife Management Area does not directly depend on the Henrys Fork flows. Diversions into canals benefit the species indirectly by contributing to the subsurface flows and the high water table. The Texas Slough population is not affected by the proposed action.

8.8.3 Cumulative Effects

The Ute ladies'-tresses is distributed primarily on Federal land (only 4 of the 22 known orchid sites below Palisades Dam are on private land or non-Federal land; two of these are partially on Federal land), but private and state activities and management programs may affect Ute ladies'-tresses and its habitat. Future activities that are reasonably certain to occur in the action area are livestock grazing and increased residential development.

Livestock grazing in the area has been an ongoing activity for many years, and future practices may not differ significantly from past practices. Residential development will also continue in and near the Snake River; future development will likely further alter the floodplain dynamics.

8.9 Effects Conclusion

The proposed action of future O&M in the Snake River system above Milner Dam may affect and is likely to adversely affect the Ute ladies'-tresses. In the wettest 10 percent of years, the model predicts the proposed action may reduce peak flows by up to 10 percent. This modeled reduction in flows may slightly adversely affect the orchid in these years as the erosion and avulsion processes are slightly suppressed.

8.10 Literature Cited

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PART III

CHAPTERS FOR NOAA FISHERIES

Chapter 9 SALMON AND STEELHEAD

This chapter addresses the potential combined effects of Reclamation's proposed actions on listed Snake and Columbia River salmon and steelhead Evolutionarily Significant Units (ESUs) in the action areas. An ESU is a distinct group of Pacific salmon or steelhead distinguished by genetics, meristics, life history characteristics, behavior, and geographical area occupied that can be considered a species for purposes of the ESA. The chapter provides a broad overview of the listing status of relevant salmon and steelhead ESUs and water quality concerns within the action areas. The chapter then considers separately each salmon and steelhead ESU, with background and current conditions, discussing the Snake River ESUs first, followed by the upper Columbia River ESUs, and then ESUs downstream to the lower Columbia River. The effects analyses and conclusions for all listed ESUs in the action areas are discussed in a separate section at the end of this chapter.

9.1 Background

9.1.1 Listed Salmon and Steelhead in the Action Areas

The 2001 biological opinion on operation of Reclamation's Snake River projects (NOAA Fisheries 2001) considered the action area for anadromous salmonids as the farthest upstream point at which smolts enter (or adults exit) the Snake River and Columbia River (at and below its confluence with the Snake River) to the farthest downstream point at which smolts exit (or adults enter) the migration corridor. The action areas for all 11 proposed actions share the area in the Snake River immediately downstream from Hells Canyon Dam, or wherever an occupied tributary stream meets the Snake River below Hells Canyon Dam, to the confluence of the Snake and Columbia Rivers, and in the Columbia River, or wherever a tributary stream meets the Columbia River, downstream to its mouth.

Although the actual upstream extents of each ESU's occupied geographic area varies, in all cases the occupied geographic areas extend downstream to the Columbia River estuary and plume portion of the nearshore ocean (this is the farthest point at which the proposed actions may influence listed salmonids).

9.1.2 Listed Species in the Action Areas

This assessment considers 13 listed and proposed Pacific salmon and steelhead ESUs. Table 9-1 lists the species and ESUs by common and scientific names, and includes the species status and critical habitat designation.

Section 4 of the NOAA Fisheries 2000 biological opinion on operation of the Federal Columbia River Power System (FCRPS) describes in detail the life histories, factors for decline, and range-wide status of these listed ESUs to that point in time. This assessment provides additional and updated information regarding these ESUs, including recent changes in population abundance.

Table 9-1. Listed anadromous salmonid species and ESUs considered.

ESU (Evolutionarily Significant Unit)	Status	Critical Habitat Designation
Snake River spring/summer Chinook salmon *(Oncorhynchus tshawytscha)*	Threatened; April 22, 1992 (57 FR 14653)	December 28, 1993 (58 FR 68543) October 25, 1999 (64 FR 57399)
Snake River fall Chinook salmon *(O. tshawytscha)*	Threatened; April 22, 1992 (57 FR 14653)	December 28, 1993 (58 FR 68543)
Snake River sockeye salmon (*O. nerka)*	Endangered; November 20, 1991 (56 FR 58619)	
Columbia River chum salmon (*O. keta)*	Threatened; March 25, 1999 (64 FR 14508)	Critical habitat designation vacated April 30, 2002
Snake River Basin steelhead (*O. mykiss*)	Threatened; August 18, 1997 (62 FR 43937)	
Middle Columbia River steelhead (*O. mykiss*)	Threatened; March 25, 1999 (64 FR 14517)	
Lower Columbia River steelhead *(O. mykiss)*	Threatened; March 19, 1998 (63 FR 13347)	
Lower Columbia River Chinook salmon (*O. tshawytscha)*	Threatened; March 24, 1999 (64 FR 14308)	
Upper Columbia River spring Chinook salmon (*O. tshawytscha)*	Endangered; March 24, 1999 (64 FR 14308)	
Upper Columbia River steelhead (*O. mykiss)*	Endangered; [1] August 18, 1997 (62 FR 43937)	
Upper Willamette River Chinook salmon (*O. tshawytscha)*	Threatened; March 24, 1999 (64 FR 14308)	
Upper Willamette River steelhead (*O. mykiss)*	Threatened; March 25, 1999 (64 FR 14517)	
Lower Columbia River coho salmon (*O. kisutch*)	Proposed; June 14, 2004 (69 FR 33101)	None

1 The Upper Columbia River steelhead ESU was proposed for relisting as threatened on June 14, 2004 (69 FR 33101).

Critical habitat was designated for Snake River spring/summer Chinook salmon, Snake River fall Chinook salmon, and Snake River sockeye salmon in December 1993 (58 FR 68543) and revised for Snake River spring/summer Chinook salmon in October 1999 (64 FR 57399). Critical habitat designations for all other listed upper Columbia River, middle Columbia River, lower Columbia River, and Willamette River anadromous salmonid ESUs, and for Snake River Basin steelhead, was vacated on April 30, 2002, when the U.S. District Court for the District of Columbia adopted a consent decree resolving the claims in *National Association of Homebuilders, et al. v. Evans.*

Habitat essential for Snake River salmon consists of four components: spawning and juvenile rearing areas; juvenile migration corridors; areas for growth and development to adulthood; and adult migration corridors (58 FR 68543). The ESU discussions below address three of these components. Areas for growth and development to adulthood are not addressed because Pacific Ocean areas used by listed salmon for growth and development to adulthood have not been identified.

Washington Department of Fish and Wildlife (WDFW) personnel count adult salmon and steelhead passing each of the lower Columbia River and lower Snake River dams from March 15 to December 15. At some dams, videotapes capture additional passage information when personnel are unavailable or off-duty. Table 9-2 shows the time periods at the several projects during which the various runs are considered spring, summer, and fall Chinook salmon for fisheries management purposes.

9.1.3 Present Hydrologic Condition

As discussed in Section 3.3.1, the construction and subsequent operations of Reclamation project facilities have contributed to hydrologic changes and the present hydrologic conditions in the Snake and Columbia Rivers. Reclamation's operations generally

Table 9-2. Traditional adult return reporting dates and dates used to classify Chinook salmon.

Dam and Traditional Adult Return Reporting Dates	Spring Chinook Salmon	Summer Chinook Salmon	Fall Chinook Salmon
Bonneville Dam (03/15 to 11/15)	03/15 to 05/31	06/01 to 07/31	08/01 to 11/15
The Dalles Dam (04/01 to 10/31)	04/01 to 06/03	06/04 to 08/03	08/04 to 10/31
John Day Dam (04/01 to 10/31)	04/01 to 06/05	06/06 to 08/05	08/06 to 10/31
McNary Dam (04/01 to 10/31)	04/01 to 06/08	06/09 to 08/08	08/09 to 10/31
Ice Harbor Dam (04/01 to 10/31)	04/01 to 06/11	06/12 to 08/11	08/12 to 12/15
Lower Monumental Dam (04/01 to 10/31)	04/01 to 06/13	06/14 to 08/13	08/14 to 10/31
Little Goose Dam (04/01 to 10/31)	04/01 to 06/15	06/16 to 08/15	08/16 to 10/31
Lower Granite Dam (03/01 to 12/15)	03/01 to 06/17	06/18 to 08/17	08/18 to 12/15
Priest Rapids Dam (04/15 to 11/15)	04/15 to 06/13	06/14 to 08/13	08/14 to 11/15

Source: FPC 2004.

decrease flows from November to June and increase flows from July through September (see Table 3-7). Average annual depletions at Brownlee Reservoir attributed to Reclamation's operation is 2.01 million acre-feet (see Section 3.3.1). Appendix C provides historical inflow data to Brownlee Reservoir for the 1971-to-2003 period.

9.1.4 Water Quality Conditions in the Action Areas

Water quality conditions in the Snake River downstream from Hells Canyon Dam are especially relevant to the Snake River fall Chinook salmon, Snake River spring/ summer Chinook salmon, Snake River sockeye salmon, and Snake River Basin steelhead ESUs. The IDEQ and ODEQ (2003) jointly developed the TMDL for the Snake River from the Idaho-Oregon border to the confluence with the Salmon River. The TMDL process is initiated when beneficial uses are not being supported, which is generally identified through exceedance of criteria. Primary water quality problems identified in the Snake River between the Idaho-Oregon border and the confluence with the Salmon River include water temperature, sediment, nutrients, total dissolved gas, and mercury (IDEQ and ODEQ 2003).

Plans for achieving state water quality standards in the area encompassing the Reclamation upper Snake River projects are being formulated through the TMDL process specified under Section 303(d) of the Clean Water Act (CWA). The Federal Court mandated the schedule for the States of Idaho and Oregon to develop TMDLs for water quality-limited stream reaches. Table 9-3 summarizes the TMDL development on those stream reaches.

Table 9-3. 303(d) Listings and TMDL schedule for upper Snake River basin reaches and major tributaries within areas affected by Reclamation project operations.

State and Subbasin	Listed Pollutants [1]	Target Completion
Idaho		
Willow subbasin		
Willow Creek, Ririe Dam to Hydrologic Unit boundary	S	2003
Ririe Lake	S	2003
American Falls subbasin		
Snake River, Bonneville County line to American Falls Reservoir (2 segments)	DO, N, S	2003 (being written)
American Falls Reservoir	DO, N, S	2003 (being written)
Lake Walcott subbasin		
Snake River, American Falls Dam to Lake Walcott (3 segments)	DO, N, O/G, S	Approved 2000
Upper Snake, Rock subbasin		
Snake River, Milner Dam to King Hill (10 segments)	N, S, B, A, P, O/G	Approved 2000
Middle Snake, Succor subbasin		
Snake River, Swan Falls to Idaho/Oregon border	N, S, B, DO, pH	2002
Succor Creek, Oregon Line to Snake River	S, T	2002

State and Subbasin	Listed Pollutants [1]	Target Completion
South Fork Boise subbasin		
South Fork Boise River, Anderson Ranch Dam to Arrowrock Reservoir	S	SBA completed in 2001
Lower Boise subbasin		
Boise River, Barber Diversion to Snake River	S, N, B, T	Approved 2000
Lake Lowell	DO, N	2006
Middle Snake, Payette subbasin		
Snake River, Boise River to Weiser	B, N, pH, S	2001
North Fork Payette subbasin		
Cascade Reservoir (2 phases)	N, DO, pH	Approved 1996, 1999
North Fork Payette River, Clear Creek to Smiths Ferry	N, S, T	2004
(Lower) Payette subbasin		
Payette River, Black Canyon Dam to Snake River	N, B, T	Approved 2000
Weiser subbasin		
Mann Creek, Mann Creek Reservoir to Weiser River	S	2003
Weiser River, Galloway Dam to Snake River	S, N, B, DO, T	2003
Oregon		
Owyhee Basin		
Owyhee River, mouth to Owyhee Reservoir	B, C, Tx, DO	2006
Malheur Basin		
Malheur River, mouth to Hog Creek	B, C, Tx	2007
North Fork Malheur River, mouth to Beulah Reservoir	B	2007
Bully Creek, mouth to Bully Creek Reservoir	B, C	2007
Willow Creek, mouth to Pole Creek	B, C	2007
Powder Basin		
Burnt River, mouth to Unity Reservoir	T, C	2008
Powder River, mouth to Thief Valley Reservoir	B, DO, T	2008
Idaho–Oregon Joint		
Snake River, Hells Canyon		
Snake River, Idaho-Oregon border to upstream of the Salmon River	S, B, DO, N, pH, Hg, P, T	2001
Washington		
Lower Snake River	TDG T	Submitted 2003 2004 (being written)
Oregon–Washington Joint		
Columbia River, middle reaches	TDG	Approved 2004
Columbia River, lower reaches	TDG	Approved 2002
Columbia River	B, Hg, P, pH, Tx T	2004 and 2006 2004 (being written)

Sources: Wyoming 2000 303(d) list (none); Idaho 1998 303(d) list; Oregon 2002 303(d) list; and Washington 1998 303(d) list.

A - Ammonia; B - Bacteria; C - Chlorophyll a; DO - Dissolved oxygen; Hg - Mercury; N - Nutrients; O/G - Oil and Grease; P - Pesticides; pH - pH; S - Sediment; T - Temperature; Tx - Toxics

Water Temperature

Water quality criteria for temperature primarily focus on time of year and consider maximum temperature thresholds (either instantaneous or averaged) above which the water body is considered “impaired.” Alterations to the thermal regime of a water body, such as seasonally delayed warming or cooling, may influence, in either a positive or negative manner, incubation time and growth rates of anadromous fish and other aquatic organisms. The Hells Canyon Complex impoundments themselves do not act as heat sources, but rather they act to delay temperature changes within the mainstem Snake River downstream (IDEQ and ODEQ 2003). This conclusion is also true for other impoundments in the upper Snake River basin.

Several TMDLs and independent studies completed in the Pacific Northwest have evaluated the temperature regimes and influences on water temperatures in natural and highly controlled river environments. The Lower Boise River TMDL and the City of Boise have evaluated temperature sources affecting the Boise River. The Lower Boise River TMDL (CH2M Hill 2003) concluded that:

- Cold water aquatic life and salmonid spawning criteria are exceeded frequently.
- Point sources and tributaries are modest sources of heat.
- Natural atmospheric conditions cause exceedances and preclude compliance.
- A temperature TMDL is not recommended for the lower Boise River.

The Snake River – Hells Canyon TMDL noted that natural heat exchange through elevated air temperature and direct solar radiation on the water surface plays a major role in summer water temperatures (IDEQ and ODEQ 2003). This TMDL also concluded that:

- Because of the length of the Snake River, temperature changes in the headwaters of the Snake River cause little if any detectable change in water temperature downstream.
- Although flow alteration in the mainstem Snake River above the Hells Canyon Complex occurs, the increase in summer flows potentially acts to decrease naturally induced heating due to meteorological effects.
- Water temperatures between 22 and 25 °C are commonly observed in the Snake River approximately ten miles upstream from the headwaters of Brownlee Reservoir, and these water temperatures are not much different from those currently found in the Salmon River near its mouth.

Armstrong (unpublished) explains many of the natural processes that occur in a highly regulated river environment. Most notable is the discussion of water and air temperature relationships. The heating and cooling of water is related to the heat being transferred back and forth between the water and the air. Sources of heat to water include short wave radiation, long wave atmospheric radiation, conduction of heat from the atmosphere to water, and direct heat inputs from municipal and industrial activities or other sources. Armstrong (unpublished) also notes sinks, or losses, of heat. An important note is that as the temperature of a waterbody (such as the Snake River) is changed, the water temperature will change exponentially until the heat content is dissipated and reaches equilibrium with its surroundings. This process relates directly to temperatures of the outflow of impoundments. While the downstream waters are seasonally either warmer or cooler than ambient air temperature, the water temperature will rise or fall to reach equilibrium, and this process occurs at an exponential rate downstream.

Sediment

Although Reclamation operations have most likely altered the size and quantity of sediment transported in the Snake River upstream from the Hells Canyon Complex (IDEQ and ODEQ 2001), the effect of these operations on the sediment transport regime in the action areas downstream from the Hells Canyon Complex likely has been small, since Brownlee Reservoir and other Idaho Power dams and reservoirs on the Snake River trap sediment and process nutrients.

Nutrients

Irrigated agriculture and other sources contribute nutrients, particularly phosphorus, to the mainstem Snake River upstream from the Hells Canyon Complex. Although nutrient and sediment levels may not support all beneficial uses upstream from Oxbow Dam, biological processing and physical settling within Brownlee and Oxbow Reservoirs result in attainment of the nutrient and sediment standards of both Idaho and Oregon in Hells Canyon Reservoir and the Snake River downstream to the Salmon River confluence.

Total Dissolved Gas

Levels of total dissolved gas (TDG) become elevated as a result of the involuntary spill of flows that exceed powerhouse capacity or available loads at the Hells Canyon Complex dams. Immediately downstream from Hells Canyon Dam, recorded TDG levels have exceeded 130 percent saturation. While TDG levels equilibrate in a downstream direction, in some cases the water quality standard of 110 percent TDG saturation is exceeded for 67 miles (to below the Snake River's confluence with the Salmon River) downstream from Hells Canyon Dam (Myers et al. 1998). TDG problems occur primarily in years with higher than normal runoff.

Dissolved Oxygen

The effects of low dissolved oxygen levels (3 to 6 mg/L) on pre-spawning migrating adult salmon are not well understood (ODEQ 1995) but may include, depending upon the exposure to these conditions, negative impacts such as avoidance, delayed migration, reduced swimming speeds, reduced spawning success, and death. The effects of low dissolved oxygen levels on early life history stages of salmonids are well known (Bjornn and Reiser 1991). At levels below 8 mg/L, the size of fish at emergence is reduced, and the survival of juveniles declines (Shumway et al. 1964 cited in Bjornn and Reiser 1991). Similarly, below 5 to 6 mg/L dissolved oxygen, survival of embryos is often low (ODEQ 1995). Chapman (1988) concluded that any reduction in dissolved oxygen below saturation during incubation may cause salmonids to be smaller than normal at emergence, which would put them at a competitive disadvantage. Bjornn and Reiser (1991) recommended that dissolved oxygen concentrations should be at or near saturation for successful egg incubation.

Preliminary non-peer-reviewed data indicate low dissolved oxygen levels in the Snake River downstream from Hells Canyon Dam. An Idaho Power (2000) study suggests the problems may be less extensive than originally reported. The TMDL process underway for the Snake River between the Idaho-Oregon border and the Salmon River may provide information to help determine the causes of low dissolved oxygen levels downstream from the Hells Canyon Complex.

Mercury

Elevated mercury levels in the Snake River are believed to be a result of historical gold mining and milling operations, particularly in the Jordan Creek area of the Owyhee River basin upstream from Owyhee Reservoir. Storage of water and sediment in Owyhee Reservoir may inhibit downstream transport of mercury from past mining operations, and thereby reduce mercury loads available for bioaccumulation in the river system downstream from the Hells Canyon Complex (USBR 2001; IDEQ and ODEQ 2003).

9.1.5 Climate and Ocean Conditions

Recent observations indicate that salmon and steelhead cohort survival is enhanced under certain ocean regimes and reduced under others (Francis and Mantua 2003). Bottom (1999) noted that nearshore environmental conditions during the first few weeks of ocean life may be critical to salmon survival. Recent analysis of longer-term datasets and observations of ocean environmental conditions has provided a better understanding of ocean conditions and the linkage between these conditions and salmon and steelhead survival.

Large-scale atmospheric circulation patterns affect ocean circulation patterns and currents. For example, decades-long cycles have been documented; one cycle is the recently described Pacific Decadal Oscillation (PDO) (Mantua et al. 1997). It is characterized by changes in sea-surface temperature (SST), sea level pressure, and wind patterns. The warm phase of the PDO corresponds to a positive index, while the cool phase corresponds to a negative index. In the cool phase (negative PDO index), ocean SSTs are comparatively cooler; wind-driven ocean circulation patterns with strong Ekman transport offshore promote upwelling of nutrient-rich water from depth and mixing of the upper ocean, which replenishes nutrients to the near-surface waters to promote biological production (Francis and Mantua 2003). The increased production and cooler ocean temperatures improve survival of juvenile salmon entering the ocean. Under a warm phase (positive PDO index), SSTs are warmer, upwelling of nutrient-rich water from depth is weaker, and productivity is reduced, thereby decreasing survival of juvenile salmon and steelhead entering the ocean and the eventual returns of adults.

Large spatial and temporal scale oceanic and atmospheric conditions drive the PDO. The PDO is correlated roughly with changes in ocean conditions but also with inland terrestrial conditions, such as precipitation. Mantua et al. (1997) show Pacific salmon catch records from Alaska sockeye and pink salmon and Washington-Oregon-California (WOC) coho salmon and Columbia River spring Chinook salmon from about 1925 to the mid-1990s compared to the PDO signature for this period from early 1900s to the mid-1990s. The negative PDO signature or cool PDO from 1947 to 1977 generally resulted in greater biological productivity and increased salmon survival that is reflected in catch of WOC coho salmon and Columbia River spring Chinook salmon that were greater than the long-term median. During the negative or cool PDO that ended about 1977, catch of WOC coho salmon and Columbia River spring Chinook salmon were greater than the long-term median, while catch of western and central Alaska sockeye salmon and central and southeast Alaska pink salmon were less than the long-term median. Conversely, with a positive or warm PDO that started about 1977, catch of WOC coho salmon and Columbia River spring Chinook salmon were generally less than the long-term median, while catch of western and central Alaska sockeye salmon and central and southeast Alaska pink salmon were greater than the long-term median. Though this is the general pattern, it is not absolute; there are some years when catch is greater than the long-term median in a positive PDO, and other years when catch is less than the long-term median in a negative PDO.

Superimposed on the decades-long PDO are the more frequent El Niño-Southern Oscillation (ENSO) events that have their own unique influence on regional climate. When warm or cool phases of PDO and an ENSO event are in synchrony, climatic conditions are enhanced. Since the time scale of PDO events are long, data are limited and exist to describe only a few cycles, and their long-term stability and predictability are still being investigated.

Another large-scale atmospheric phenomenon is the Aleutian Low Pressure Index (ALPI), which is a measure of the intensity of winter winds in the Subarctic Pacific (Beamish 1999); the Pacific Circulation Index (PCI) is an index of the general Pacific atmospheric circulation in the winter (December-March) (King et al. 1998, cited in Beamish 1999). A weak Aleutian Low results in more westerly winds in the northern Pacific Ocean and a stronger California Current, with greater coastal upwelling (Taylor 1999).

Large scale climatic change, whether occurring naturally or from anthropogenic activities, will affect both ocean conditions, due to the atmospheric-oceanic linkage, and the inland or freshwater habitat of anadromous salmonids. Climate change that affects air and consequently water temperature, seasonal changes in rain and snowfall, and annual runoff will affect the freshwater component of salmonid habitat. However, because of the complexity of atmospheric, terrestrial, and oceanic interactions, it is a complex process and is not straightforward; it is not the intent of this biological assessment to assess the effects of climate change on salmon in other than general terms.

9.1.6 Components of Viable Salmonid Populations

In recent determinations for proposed listings for 27 West Coast salmonid ESUs, NOAA Fisheries (69 FR 33101) used in part the four components of the Viable Salmonid Populations (VSP) concept (McElhany et al. 2000) in their assessment of ESU status and condition, and those conclusions for the 12 listed salmon and steelhead ESUs and one proposed ESU downstream from Hells Canyon can be considered in assessing effects of the proposed actions on these ESUs. The four components of VSP are abundance, productivity/population growth rate, spatial distribution, and diversity, which includes genetic diversity. McElhany et al. (2000) provide detailed explanations of the components of VSP. The conclusions of the Biological Review Team (BRT) relative to the four components of VSP for the various salmon and steelhead ESUs discussed below will be presented.

9.2 Snake River Spring/summer Chinook Salmon

9.2.1 Background

NOAA Fisheries listed the Snake River spring/summer Chinook salmon ESU as threatened on April 22, 1992 (see Table 9-1 on page 246). These fish spawn and rear in numerous tributaries of the Snake River downstream from Hells Canyon Dam, and smolts migrate in the spring as yearlings through the lower Snake River and Columbia River to the estuary and ocean. This ESU includes all natural spring/ summer-run Chinook salmon populations in the mainstem Snake River and in the Tucannon, Grande Ronde, Imnaha, and Salmon River subbasins (NOAA Fisheries 2000). Figure 9-1 shows the geographic range of this ESU. The Interior Columbia Basin Technical Recovery Team (ICBTRT) (2003) used genetic and geographic considerations to establish five major groupings in this ESU:

- the lower Snake River tributaries
- the Grande Ronde and Imnaha Rivers
- the South Fork Salmon River
- the Middle Fork Salmon River
- the upper Salmon River

They also identified two unallied areas: the Little Salmon River and Chamberlain Creek. These groupings were further subdivided into a total of 31 extant demographically independent populations (ICBTRT 2003). The Clearwater, Grande Ronde, and Salmon Rivers are the three major subbasins of the Snake River that produce spring/summer Chinook salmon; two smaller subbasins are the Tucannon and the Imnaha. Fifteen artificial propagation programs are considered to be part of this ESU (69 FR 33101). The BRT found moderately high risk for the abundance and

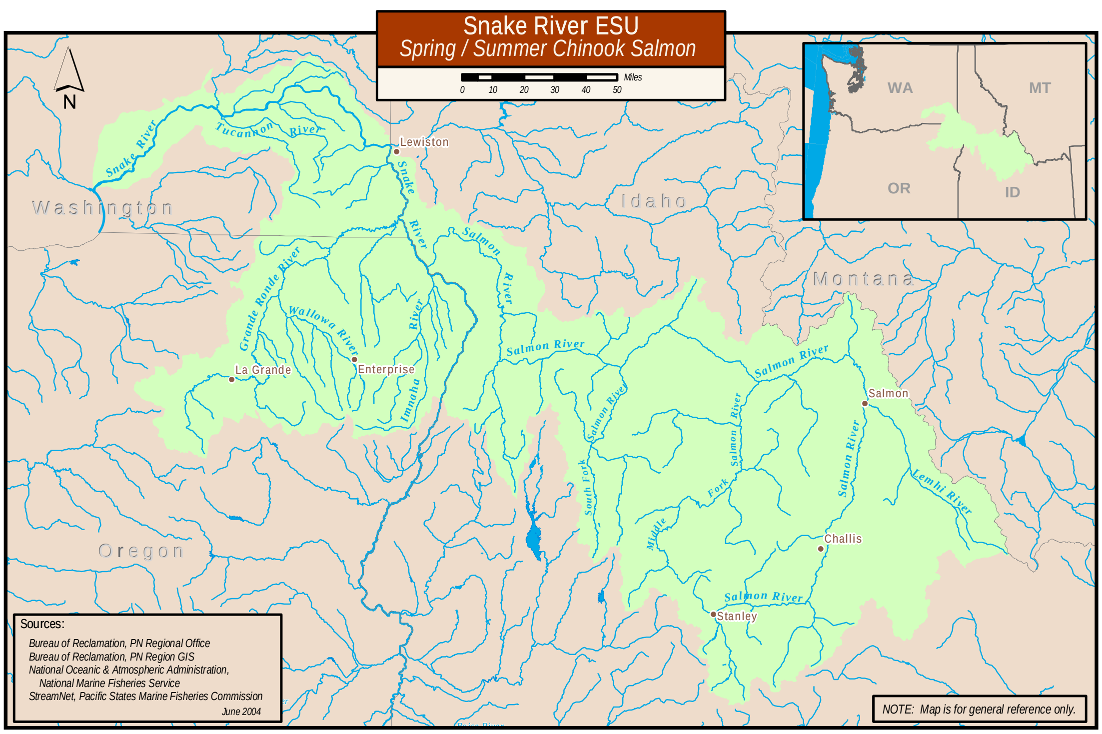

Figure 9-1. Geographic range of the Snake River spring/summer Chinook salmon ESU.

productivity components of VSP, and comparatively lower risk for the spatial structure and diversity components (69 FR 33101).

Fish from this ESU no longer occur in the upper Snake River basin above Hells Canyon Dam, although historically they ascended the Snake River up to and including Rock Creek, a tributary of the Snake River just downstream from Auger Falls, near Twin Falls, Idaho, more than 930 miles (1,497 kilometers) from the sea, as well as the Powder River, Burnt River, Weiser River, Payette River, parts of the Malheur River, Boise River, Owyhee River, Bruneau River, Big Wood River, and Salmon Falls Creek (ICBTRT 2003). The Big Wood River is not included in this historical distribution in the 1995 proposed recovery plan for Snake River salmon (USDOC 1995). The major river basins containing spawning and rearing habitat for this ESU comprise about 22,390 square miles in Idaho, Oregon, and Washington (NOAA Fisheries 2004).

Adult spring/summer Chinook salmon migrate up the Snake River from spring to about mid-August. Genetics and other life history information indicate the Snake River spring/summer Chinook salmon are one ESU. However, fisheries managers separate the spring and summer runs for management purposes according to the dates they pass the several Columbia and Snake River dams (see Table 9-2 on page 247). Spring/summer Chinook salmon exhibit a "stream-type" life history strategy, wherein the juvenile fish spend one year rearing in freshwater and outmigrate as one-year-old smolts, also called yearlings. Adults are migrating upstream and juveniles are migrating downstream while Reclamation is storing, releasing, and diverting water. Myers et al. (1998) contains additional information on Snake River spring/summer Chinook salmon.

Lohn (2002) lists a total of 41,900 returning wild adults as the interim abundance target for 14 spawning aggregations of this ESU, and notes that, "[f]or delisting to be considered, the 8-year (approximately two generations) geometric mean cohort replacement rate of a listed species must exceed 1.0 during the eight years immediately prior to the delisting. For spring/summer chinook (sic) salmon, this goal must be met for 80 percent of the index areas available for natural cohort replacement rate estimation." The interim abundance targets are 8-year geometric means of annual natural spawners.

9.2.2 Critical Habitat

NOAA Fisheries designated critical habitat for Snake River spring/summer Chinook salmon on December 28, 1993 (see Table 9-1 on page 246). Critical habitat includes river reaches of the Columbia, Snake, and Salmon Rivers, and all tributaries of the Snake and Salmon Rivers (except the Clearwater River) presently or historically accessible to Snake River spring/summer Chinook salmon (except reaches above impassable natural falls and Hells Canyon Dam) (58 FR 68543). This designation was revised October 25, 1999 (64 FR 57399) to exclude areas above Napias Creek Falls. Essential features of Snake River spring/summer Chinook salmon spawning and rearing areas include adequate spawning gravel, water quality, water quantity, water temperature, cover/shelter, food, riparian vegetation, and space. Essential features of juvenile and adult migration corridors include adequate substrate, water quality, water quantity, water temperature, water velocity, cover/shelter, food (except for adults), riparian vegetation, space, and safe passage conditions.

9.2.3 Current Conditions in the Action Areas

The BRT (2003) noted that this ESU saw a large increase in escapement in 2001 in many populations, but that the recent increase was still short of the levels that the proposed recovery plan for Snake River salmon indicated should be met over at least an 8-year period. About 79 percent of the 2001 return of spring-run Snake River Chinook salmon was of hatchery origin. In addition, the numbers declined in 2002 and 2003, but they still substantially exceeded the 10-year average up to 2003. The BRT (2003) considered the 2001 increase a positive sign. Table 9-4 on page 258 shows the counts for Snake River spring and summer Chinook salmon at Ice Harbor Dam and Lower Granite Dam for the period 1977 to 2003. Preliminary data for spring Chinook salmon for 2004 are included. The table includes Columbia River basin counts at Bonneville Dam for reference and convenience.

Adult spring Chinook salmon at Ice Harbor Dam increased 341 percent from 38,807 fish in 2000 to 171,173 fish in 2001. The count declined 50.2 percent from 171,173 fish in 2001 to 85,207 fish in 2002, and declined about 8 percent further to 78,302 fish in 2003. Preliminary data indicate that about 800 fewer adult spring Chinook salmon returned in 2004.

Adult summer Chinook salmon at Ice Harbor Dam increased 260 percent from 4,241 fish in 2000 to 15,270 fish in 2001. The count increased 74.0 percent from 15,270 fish in 2001 to 26,607 fish in 2002 but declined 22.0 percent to 20,742 fish in 2003 (FPC 2004). The 4,678 adult summer Chinook salmon counted at Lower Monumental Dam in 2000 increased to 19,287 fish counted in 2001. More upstream migrating summer Chinook salmon were counted at Lower Monumental Dam than at Ice Harbor Dam in 2000; thus, that number was used to more accurately represent the number of adult summer Chinook salmon returning to the Snake River basin.

At Lower Granite Dam, adult spring Chinook salmon increased 408 percent from 33,822 fish in 2000 to 171,958 fish in 2001. The count declined 56.3 percent from 171,958 fish in 2001 to 75,025 fish in 2002, and declined 5.9 percent further to 70,609 fish in 2003. Preliminary data indicate that about 169 more adult spring Chinook salmon returned in 2004.

Table 9-4. Spring and summer Chinook salmon counts at Bonneville, Ice Harbor, and Lower Granite Dams from 1977 to 2003 (FPC 2004).

Year	Bonneville Dam				Ice Harbor Dam				Lower Granite Dam			
	Spring Chinook		Summer Chinook		Spring Chinook		Summer Chinook		Spring Chinook		Summer Chinook	
	Adult	Jack	Adult	Jack	Adult	Jack	Adult	Jack	Adult	Jack	Adult	Jack
1977	115,551	3,957	34,083	6,940	42,431	1,990	9,467	870	36,203	2,567	7,710	719
1978	147,680	2,183	39,730	4,593	49,044	259	10,209	231	40,713	289	11,649	106
1979	48,638	2,824	27,742	6,475	8,547	700	1,712	896	6,753	786	2714	858
1980	53,100	7,887	26,952	4,113	8,301	1,367	2,327	978	5,461	1,298	2,688	759
1981	62,827	2,182	22,363	4,566	15,592	575	3,316	498	13,115	527	3,326	479
1982	70,011	6,033	20,129	6,485	14,302	298	4,204	323	12,367	379	4,210	318
1983	54,898	1,940	18,046	5,412	12,189	413	4,321	601	9,517	509	3,895	767
1984	46,870	4,272	22,321	6,127	8,137	933	5,487	966	6,511	1,410	5,429	1,815
1985	83,113	7,851	23,898	5,455	31,306	2,233	4,054	1,191	25,207	2,530	4,938	1,568
1986	118,371	4,963	26,300	4,,820	38,040	1,012	6,981	764	31,576	1,307	6,154	1,255
1987	98,573	3,234	33,033	4,674	31,276	807	6,559	376	28,835	946	5,891	660
1988	90,532	4,214	31,315	5,209	33,336	1,058	7,442	416	29,495	924	6,145	362
1989	81,267	5,992	28,786	4,185	15,376	1,653	3,453	762	12,955	1,549	3,169	902
1990	94,014	2,090	24,983	3,038	20,512	218	5,630	164	17,315	244	5,093	128
1991	57,346	3,889	18,897	3,056	10,171	1,110	4,703	1,158	6,623	980	3,809	1,179
1992	88,425	2,157	15,063	4,182	25,460	654	3,993	384	21,391	533	3,014	298
1993	110,820	1,352	22,045	1,571	24,693	242	6,820	99	21,035	183	7,889	130
1994	20,169	397	17,631	1,900	3,416	56	922	81	3,120	43	795	73
1995	10,192	2,371	15,030	2,043	1,507	366	736	179	1,105	373	692	157
1996	51,493	4,687	16,034	1,960	5,973	1,698	3,277	809	4,207	1,639	2,607	944
1997	114,000	963	27,939	1,926	41,398	75	9,196	122	33,855	81	10,709	127
1998	38,342	775	21,433	2,678	12,434	130	5,473	304	9,854	109	4,355	328
1999	38,669	8,691	26,169	4,022	5,351	2,657	3,900	1,311	3,296	2,507	3,260	1,584
2000	178,302	21,259	30,616	13,554	38,807	9,489	4,241	3,179	33,822	10,318	3,939	3,756
2001	391,367	14,172	76,156	14,723	171,173	3,026	15,270	2,397	171,958	3,135	13,735	3,804
2002	268,813	6,477	127,436	7,952	85,207	1,826	26,607	2,437	75,025	2,089	22,159	1,953
2003	192,010	14,258	114,808	13,358	78,302	8,020	20,742	4,602	70,609	8,295	16,422	4,137
2004[1]	170,188	8,885			77,106	4,658			70,778	4,482		

1 Data are preliminary counts from July 9, 2004, and are subject to review.

Adult summer Chinook salmon at Lower Granite Dam increased 249 percent from 3,939 fish in 2000 to 13,735 fish in 2001. The count increased 61.3 percent from 13,735 fish in 2001 to 22,159 fish in 2002 and declined 25.9 percent to 16,422 fish in 2003. Many of these fish were of hatchery origin. The BRT (2003) stated that an estimated 98.4 percent of the 2001 return of adult spring Chinook salmon were of hatchery origin; however, an estimate calculated from the BRT's (2003) figure A.2.2.1 shows about 89.9 percent hatchery fish, or about 10 percent natural-origin fish. The 2001 spring Chinook salmon counts at Lower Monumental Dam and Little Goose Dam were 180,787 fish and 174,823 fish, respectively. The lower count of adult spring Chinook salmon at Ice Harbor Dam is not explained.

Recent fish counts at Bonneville Dam parallel the recent changes in numbers seen in the abundance of Snake River populations. At Bonneville Dam, adult spring Chinook salmon increased 119 percent from 178,302 fish in 2000 to 391,367 fish 2001. The count declined 31.3 percent from 391,367 fish in 2001 to 268,813 fish in 2002, and declined 28.6 percent further in 2003 to 192,010 fish. Preliminary data indicate that about 21,822 less adult spring Chinook salmon returned in 2004.

Adult summer Chinook salmon at Bonneville Dam increased 149 percent from 30,616 fish in 2000 to an estimated 76,156 fish in 2001. The count increased 67.3 percent from 76,156 fish in 2001 to 127,436 fish in 2002 but declined 9.9 percent to 114,808 fish in 2003.

Spring Chinook salmon jack counts were highest at all three dams in 2000, decreasing in 2001 and 2002 but increasing substantially in 2003. Summer Chinook salmon jack counts were greater in 2001 at Bonneville Dam, the year prior to the record return of 127,436 adults. This also occurred at Lower Granite Dam, but at Ice Harbor Dam the highest jack count occurred in 2000, two years before the recent record high return of 26,607 adults. Jacks are precocious males that return from the ocean within a year of their outmigration; jack counts provide a reasonably good indicator of the early ocean survival rate of the cohort and are used in part to estimate future adult returns.

For the period from 1977 to 2003, spring Chinook salmon counts at Ice Harbor Dam reached 49,044 fish in 1978 and then fluctuated substantially to the present, with a low return of 1,507 fish in 1995 to a record high of 171,173 fish in 2001 (see Table 9-4). The summer Chinook salmon return followed nearly the same pattern, with a high of 10,209 fish in 1978, a low of 736 fish in 1995, and a recent peak return of 26,607 fish in 2002. The same pattern prevailed at Lower Granite Dam.

Table 9-5 on page 260 shows the estimated adult wild Snake River spring and summer Chinook salmon counts at Lower Granite Dam from 1979 to 2003. The wild spring Chinook salmon count peaked in 1992, and the wild summer Chinook salmon count peaked in 1997. Counts for wild spring Chinook salmon decreased substantially through the 1990s but increased dramatically in 2000. The count of wild summer Chinook salmon at Lower Granite Dam has decreased substantially from the 1997 peak.

Redds are counted in seven index streams in Idaho and Oregon and are used to estimate trends in abundance of spring/summer Chinook salmon (see Table 9-6 on page 261). Bear Valley, Marsh, Sulphur, and Minam Creeks are spring Chinook salmon index streams; Poverty Flats and Johnson Creeks are summer Chinook salmon index streams; and the Imnaha stock is considered to be intermediate in run timing and is considered separately. Data on redd counts are only available up to 2000.

Table 9-5. Estimated adult wild spring/summer Chinook salmon escapement to Lower Granite Dam (includes total counts at Bonneville and Lower Granite Dams for comparison).

Year	Bonneville Dam (Total Fish Count)		Lower Granite Dam (Total Fish Count)		Wild Snake River Fish Count		
	Spring Chinook	Summer Chinook	Spring Chinook	Summer Chinook	Spring Chinook	Summer Chinook	Total
1979	48,600	27,742	6,839	2,714	2,573	2,714	5,287
1980	53,100	26,952	5,460	2,688	3,478	2,404	5,882
1981	62,827	22,363	13,115	3,306	7,941	2,739	10,680
1982	70,011	20,129	12,367	4,210	7,117	3,531	10,648
1983	54,898	18,046	9,517	3,895	6,181	3,219	9,400
1984	46,866	22,421	6,511	5,429	3,199	4,229	7,428
1985	83,182	24,236	25,207	5,062	5,245	2,696	7,941
1986	118,082	26,221	31,722	6,154	6,895	2,684	9,579
1987	98,573	33,033	28,835	5,891	7,883	1,855	9,738
1988	90,532	31,315	29,495	6,145	8,581	1,807	10,388
1989	81,267	28,789	12,955	3,169	3,029	2,299	5,328
1990	94,158	24,983	17,315	5,093	3,216	3,342	6,558
1991	57,339	18,897	6,623	3,809	2,206	2,967	5,173
1992	88,425	15,063	21,391	3,014	11,134	441	11,575
1993	110,820	22,045	21,035	7,889	5,871	4,082	9,953
1994	20,169	17,631	3,120	795	1,416	183	1,599
1995	10,194	15,030	1,105	692	745	343	1,088
1996	51,493	16,034	4,215	2,607	1,358	1,916	3,274
1997	114,071	27,939	33,855	10,709	2,126	5,137	7,263
1998	38,342	21,433	9,854	4,355	5,089	2,913	8,002
1999	38,669	26,169	3,296	3,260	1,335	1,584	2,919
2000	178,302	30,616	33,822	3,933	8,049	846	8,895
2001	391,367	76,156	171,958	13,735	na	na	16,477
2002	268,813	127,436	75,025	22,159	na	na	33,784
2003	195,770	114,808	70,609	16,422	na	na	38,636

Sources: Yuen 2001; FPC 2004.

Minam and Sulphur Creeks are in wilderness areas. The spring redd index peaked in the mid- to late 1980s; Minam Creek peaked in 1985, while the remaining spring Chinook salmon redd indices peaked in 1988. The spring redd index fluctuated through the 1990s, reaching zero in some cases. Redd index counts increased slightly in 2000 but at substantially lower numbers than the 1985 or 1988 years. Bear Valley was the only redd index stream that met the Biological Requirements Work Group (BRWG) threshold level, and no stocks met the recovery level.

Table 9-6. Number of redds counted in several Snake River spring/summer Chinook salmon index streams (Yuen 2001, 2004).

Brood Year	Spring Chinook Index Streams				Summer Chinook Index Streams		Intermediate Timing
	Bear Valley (Idaho)	Marsh (Idaho)	Sulphur (Idaho)	Minam (Oregon)	Imnaha (Oregon)	Poverty Flats (Idaho)	Johnson (Idaho)
1979	215	83	90	40	238	76	66
1980	42	16	12	43	183	163	55
1981	151	115	43	50	453	187	102
1982	83	71	17	104	590	192	93
1983	171	60	49	103	435	337	152
1984	137	100	0	101	557	220	36
1985	295	196	62	625	641	341	178
1986	224	171	385	357	449	233	129
1987	456	268	67	569	401	554	175
1988	1,109	395	607	493	504	844	332
1989	91	80	43	197	134	261	103
1990	185	101	170	331	84	572	141
1991	181	72	213	189	70	538	151
1992	173	114	21	102	73	578	180
1993	709	216	263	267	362	866	357
1994	33	9	0	22	52	209	50
1995	16	0	4	45	54	81	20
1996	56	18	23	233	143	135	49
1997	225	110	43	140	153	363	236
1998	372	164	140	122	90	396	119
1999	72	0	0	96	56	153	49
2000	313	65	13	na	na	350	63
Recovery Level	900	450	300	450	850	850	300
BRWG Threshold	300	150	150	150	300	300	150

Of the two summer Chinook salmon redd index streams, Poverty Flats Creek peaked in 1988, and Johnson Creek peaked in 1993. Redd counts in both summer index streams fluctuated prior to 2000 but were still substantially lower than the peaks in 1988 and 1993. The Imnaha stock peaked in 1985 and showed a similar pattern of fluctuating counts through 1999. Data from Minam Creek and the Imnaha River are not available for 2000.

Information more recent than 2000 is not available, and the most recent table of redd counts in index streams for Snake River spring/summer Chinook salmon from the USFWS (Yuen 2004) does not include data for the Imnaha River.

The 1996 to 2003 8-year geometric mean for wild adult spring/summer Chinook salmon at Lower Granite Dam is 9,255, far below the 41,900 combined interim abundance target.

9.3 Snake River Fall Chinook Salmon

9.3.1 Background

NOAA Fisheries listed the Snake River fall Chinook salmon ESU as threatened on April 22, 1992 (see Table 9-1 on page 246). This ESU includes all natural fall-run Chinook salmon populations in the mainstem Snake River and the Tucannon, Grande Ronde, Imnaha, Salmon, and Clearwater River subbasins. Figure 9-2 shows the geographic range of this ESU. The ICBTRT (2003) identified only one population in this ESU, the Snake River Mainstem and Lower Tributaries population. Four artificial propagation programs are considered to be part of this ESU (69 FR 33101). The BRT found moderately high risk for all VSP categories (69 FR 33101).

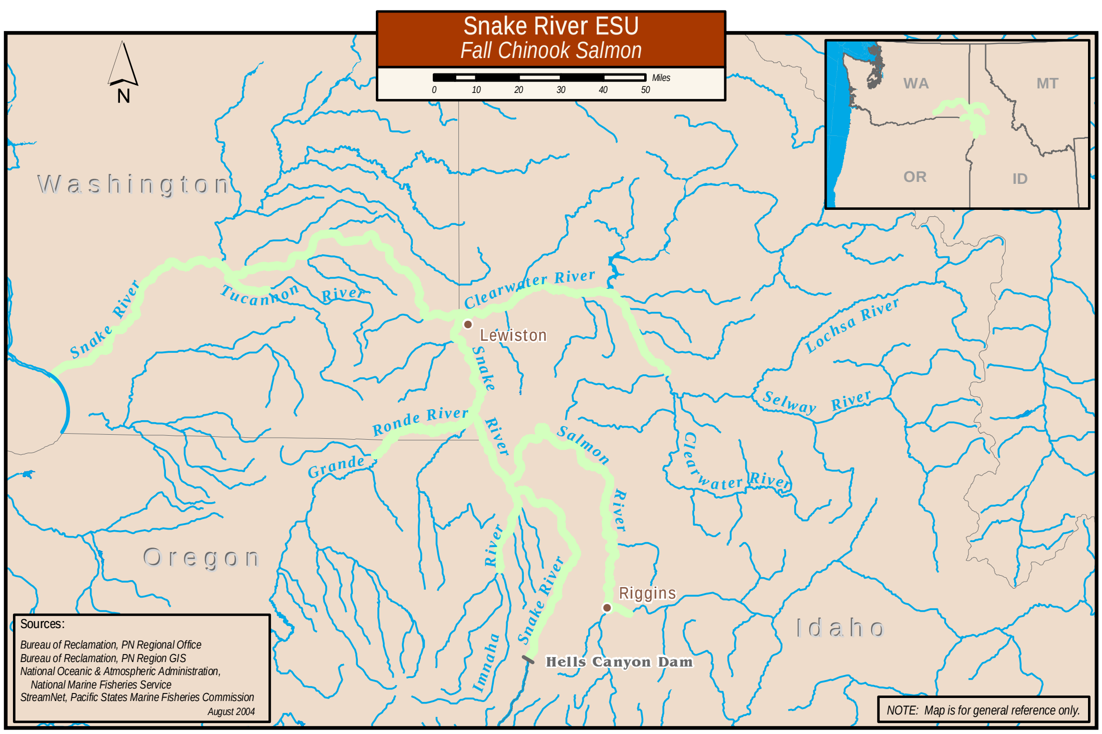

Figure 9-2. Geographic range of the Snake River fall Chinook salmon ESU.

Adult Snake River fall Chinook salmon migrate up the Snake River from about mid-August to October. A majority of this population spawns in the mainstem Snake River between the upstream extent of Lower Granite Reservoir and Hells Canyon Dam, although some spawning occurs in the lower reaches of major tributaries. The Lyons Ferry Hatchery fall Chinook salmon stock was derived from returns to the lower Snake River and consequently was included in the ESU (ICBTRT 2003). The major river basins containing spawning and rearing habitat for this ESU comprise approximately 13,679 square miles in Idaho, Oregon, and Washington (NOAA Fisheries 2004).

Snake River fall Chinook salmon do not occur in the upper Snake River basin above Hells Canyon Dam, although historically they migrated up the Snake River to Shoshone Falls and some of the larger tributaries. About 595.5 km of mainstem habitat has been lost between Hells Canyon Dam and Shoshone Falls. Construction of Swan Falls Dam denied fall Chinook salmon access to upstream spawning areas downstream from Upper Salmon Falls; these fish then reportedly used an area of the Snake River near Marsing, Idaho (Evermann 1896 cited in ICBTRT 2003). Construction of Idaho Power's Hells Canyon Complex further reduced Snake River spawning and rearing habitat available for fall Chinook salmon. Additional life history information for fall Chinook salmon can be found in Waples et al. (1991b), Myers et al. (1998), Healey (1991), and Bjornn and Reiser (1991).

Fall Chinook salmon generally exhibit an "ocean-type" life history strategy, wherein the adults spawn in larger rivers than spring/summer Chinook salmon, and the juvenile fish begin their downriver rearing migration through the lower Snake River and Columbia River to the estuary and ocean the year they hatch, as subyearlings. Recent research by Conner et al. (in press) has documented the existence of an alternative life history strategy for Snake River fall Chinook salmon that may enhance juvenile survival and therefore increase adult returns. Conner et al. (in press) reported the existence of a "reservoir-type" life history in which the juveniles spend their first winter in a reservoir and resume their seaward migration the following spring as yearlings at age 1. The reservoir-type juveniles enter the ocean at a size that is potentially twice that of the ocean-type juveniles that migrate as subyearlings at age 0 and spend their first winter in the ocean. Size at ocean-entry is thought to be a major factor in marine survival and adult return rate. Based on scale pattern analyses on fall Chinook salmon collected between 1998 and 2003, 41 percent of the wild fish and 51 percent of the hatchery fish at Lower Granite Dam were of the reservoir type (Conner et al. in press). This recently identified life history strategy may have significant management implications.

Idaho Power conducted extensive research on fall Chinook salmon in the Snake River downstream from Hells Canyon Dam to Asotin, Washington (Groves and Chandler 2001). They developed criteria for parameters for migration, rearing, and spawning. They reported optimal water temperature for migrating adult fall Chinook salmon as between 8 and 15 °C (range: 1 to 8 °C and 15 to 21 °C); optimum water temperature for spawning fall Chinook salmon as between 10 and 15 °C (range: 5 to 10 °C and 15 to 16 °C); optimal water temperature for rearing fall Chinook salmon as between 10 and 15 °C (range: 1 to 10 °C and 15 to 21 °C); optimal water temperature for migrating juvenile fall Chinook salmon as between 8 and 15 °C (range: 1 to 8 °C and 15 to 21 °C); optimal dissolved oxygen levels need to be greater than 76 percent saturation at water temperatures of 16 °C or lower; requirements for spawning fall Chinook salmon include water depths between 0.2 and 6.5 m; mean water column velocities between 0.6 and 1.7 m/s, and substrate size between a 2.6- and 15.0-cm-long axis length. Requirements for rearing fall Chinook salmon include areas within littoral zone to depths of 1.5 m, with substrates of less than a 22.5-cm-long axis length, mean water column velocities less than 0.4 m/s, and lateral shoreline slopes less than 40 percent (Groves and Chandler 2001). Some adults and most juveniles are in the action areas while Reclamation is storing, releasing, or diverting water.

In the Snake River downstream from the Hells Canyon Complex to Asotin (RM 247.0 to about RM 148.4), fall Chinook salmon generally initiate spawning as water temperatures drop below 16 °C and terminate spawning as temperatures drop to 7 °C (Groves 2001). However, this varies annually and initiation of spawning has been delayed until water temperatures were as low as 12 °C and infrequently began when temperatures were as high as 17 °C (Groves 2001).

Lohn (2002) lists 2,500 returning wild adult fall Chinook salmon as the interim abundance target, noting that this should be an 8-year, or approximately two-generation, geometric mean of annual natural spawners in the mainstem Snake River.

9.3.2 Critical Habitat

NOAA Fisheries designated critical habitat for Snake River fall Chinook salmon on December 28, 1993 (see Table 9-1 on page 246). Critical habitat extends from the mouth of the Columbia River to Hells Canyon Dam on the Snake River. It includes the Palouse River from its confluence with the Snake River upstream to Palouse Falls; the Clearwater River from its confluence with the Snake River upstream to its confluence with Lolo Creek; and the North Fork Clearwater River from its confluence with the Clearwater River upstream to Dworshak Dam. Essential features of Snake River fall Chinook salmon spawning and rearing areas are the same as for Snake River spring/summer Chinook salmon. Essential features of juvenile migration corridors include adequate substrate, water quality, water quantity, water temperature, water velocity, cover/shelter, food, riparian vegetation, space, and safe passage conditions. Essential features of adult migration corridors include those of the juvenile migration corridors, excluding adequate food.

9.3.3 Current Conditions in the Action Areas

Table 9-2 on page 247 shows when fall Chinook salmon are counted at lower Columbia River and Snake River dams. Table 9-7 shows adult and jack fall Chinook salmon counts from 1977 to 2003 at Bonneville, Ice Harbor, and Lower Granite Dams.

Adult returns of fall Chinook salmon to Ice Harbor and Lower Granite dams fluctuated substantially from 1977 to the present (see Table 9-7). The lowest returns of fall Chinook salmon at both dams occurred in 1981. Adult returns increased

Table 9-7. Fall Chinook salmon counts at Bonneville, Ice Harbor, and Lower Granite Dams from 1977 to 2003 (FPC 2004).

Year	Bonneville Dam		Ice Harbor Dam		Lower Granite Dam	
	Adult	Jack	Adult	Jack	Adult	Jack
1977	132,025	74,101	1,220	536	609	1,284
1978	144,913	55,491	1,089	504	641	843
1979	143,955	46,658	1,243	813	497	941
1980	127,718	25,748	1,140	579	453	328
1981	147,109	46,603	770	1,332	337	1,414
1982	157,771	62,380	1,627	1,892	724	1,478
1983	113,270	50,910	1,771	964	536	977
1984	147,278	96,478	1,650	795	637	731
1985	186,792	151,497	1,784	7,421	668	1,446
1986	226,404	190,331	3,119	2,679	782	1,802
1987	336,950	70,977	6,755	1,620	944	390
1988	290,050	72,708	3,847	2,035	629	327
1989	263,149	32,701	4,638	1,352	707	276
1990	177,392	39,281	3,470	1,847	383	189
1991	150,190	41,266	4,489	1,560	633	399
1992	116,200	30,272	4,636	894	855	102
1993	126,472	15,397	2,805	332	1,170	39
1994	170,397	32,956	2,073	1,033	791	255
1995	164,197	46,217	2,750	2,452	1,067	308
1996	205,358	17,103	3,851	811	1,308	424
1997	218,734	23,526	2,767	1,854	1,451	504
1998	189,085	28,631	4,220	3,491	1,909	2,002
1999	242,143	23,482	6,532	3,489	3,384	1,863
2000	192,815	55,382	6,485	9,864	3,696	7,131
2001	400,410	74,503	13,516	10,170	8,915	8,834
2002	474,554	40,220	15,248	6,079	12,351	5,727
2003	610,336	47,728	20,998	10,666	11,732	8,481

substantially in 2001, following a substantial increase in jack counts in 2000. At Ice Harbor Dam, adult returns continued to increase through 2003, when 20,998 adults and 10,666 jacks were counted. At Lower Granite Dam, adult returns increased almost 39 percent in 2002 but declined 5 percent in 2003 to 11,732 fish. Fall Chinook salmon jack counts were the highest for the period of record for Ice Harbor Dam in 2003 and second highest at Lower Granite Dam. Wild fall Chinook salmon returns and hatchery returns from increased production in the Lyons Ferry Snake River egg bank stock have provided the bulk of the increase in returns (BRT 2003).

Table 9-8 shows adult fall Chinook salmon escapement and estimated wild and hatchery numbers at Lower Granite Dam from 1975 to 2003. Since 1983, hatchery fish were recorded at Lower Granite Dam, and since 1990, some marked fish have been transported to Lyons Ferry Hatchery for propagation. The remaining marked fish are allowed to remain in-river and continue their upstream migration. From 1975 to 1982, there was apparently only a wild component to the adult fall Chinook salmon returns at Lower Granite Dam. The Lyons Ferry Hatchery has been the primary artificial propagation facility for fall-run Chinook salmon in the Snake River since 1984 (Myers et al. 1998).

The wild component of the fall Chinook salmon run has also increased since 1990, when the number of wild fish reached its lowest point at 78 fish. The estimated number of wild fish reached a peak of 6,630 fish in 2001, and decreased to 4,285 fish in 2002. The estimate for the wild component of the 2003 run is not yet available.

Fall Chinook salmon spawning has been documented to occur in the Snake River from mid-October to about mid-December, with peaks occurring from November 5 to 13, 2001, and November 10 and 16, 2002 (Groves 2003).

Redd counts have increased steadily since 1991 (Groves 2001; USFWS et al. 2003). Idaho Power surveyed three reaches of the Snake River from Hells Canyon Dam to Asotin for redds. Underwater video methods began in 1991 to supplement existing aerial surveys. The number has increased substantially from a low of 46 redds in 1991 to an estimated total for the Snake River of 1,374 redds in 2003 (see Table 9-9 on page 268) concomitant with an increase in the number of returning adults, especially since 1999 (see Table 9-7 and Table 9-8). Redds have been observed as deep as 10.0 m, with redds deeper than 3.0 m commonly comprising 30 percent of the total number (Groves 2001). The USFWS et al. (2003) reported an increase in redd counts in the mainstem Snake River between Asotin, Washington, and Hells Canyon Dam; the 2003 count of 1,374 redds exceeded the recovery goal of sufficient habitat upstream from Lower Granite Reservoir to support 1,250 redds (Groves and Chandler 2003). However, this one-year exceedance of the redd recovery goal should not be viewed as recovery of Snake River fall Chinook salmon; since it is only one year, it may include some hatchery-origin fish spawning in the wild, and abundance of returning adults has varied in the past and may continue to do so in the future.

Table 9-8. Fall Chinook salmon escapement and stock composition at Lower Granite Dam from 1975 to 2003 (CRITFC 2000; NOAA Fisheries 2003)

Year	Lower Granite Dam Count	Marked Fish to Lyons Ferry Hatchery	Lower Granite Dam Escapement	Wild	Hatchery Origin	
					Snake River	Non-Snake
1975	1,000		1,000	1,000		
1976	470		470	470		
1977	600		600	600		
1978	640		640	640		
1979	500		500	500		
1980	450		450	450		
1981	340		340	340		
1982	720		720	720		
1983	540		540	428	112	
1984	640		640	324	310	6
1985	691		691	438	241	12
1986	784		784	449	325	10
1987	951		951	253	644	54
1988	627		627	368	201	58
1989	706		706	295	206	205
1990	385	50	335	78	174	83
1991	630	40	590	318	202	70
1992	855	187	668	549	100	19
1993	1,170	218	952	742	43	167
1994	791	185	606	406	20	180
1995	1,067	430	637	350	1	286
1996	1,308	389	919	639	74	206
1997	1,451	444	1,007	797	20	190
1998	1,909	947	962	306	479	177
1999	3,381	1,519	1,862	905	882	75
2000	3,830	1,372	2,458	857	1,278	323
2001	14,763	2,918	12,477	6,630	5,281	566
2002	12,466	2,406	10,284	4,285	5,572	427
2003			11,732			
8-year geometric mean				1,023		

Table 9-9. Number of fall Chinook salmon redds counted in the Snake River and some tributaries between Lower Granite Reservoir and Hells Canyon Dam from 1986 to 2003 (USFWS et al. 2003) [1].

River	Year																	
	1986	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003 [2]**
Snake (helicopter)	7	66	64	58	37	41	47	60	53	41	71	49	135	273	255	535	878	1,111
Snake (underwater video)						5	0	67	14	30	42	9	50	100	91	174	235	263
Total						46	47	127	67	71	113	58	185	373	346	709	1,113	1,374
Lower Clearwater (RM 0-41)			21	10	4	4	25	36	30	20	66	58	78	179	164	290	520	
Potlatch															7	24	3	
Mid Clearwater (RM 42-74)							1	0	0	0	0	0	0	2	8	16	4	
M.F. Clearwater (RM 75-98)									0	0	0	0	0	0	0	0	0	
Selway									0	0	0	0	0	0	0	0	0	
N.F. Clearwater			0	0	0	0	0	0	7	0	2	14	0	1	0	1	0	
S.F. Clearwater							0	0	0	0	1	0	0	2	1	5	0	
Grande Ronde	0	7	1	0	1	0	5	49	15	18	20	55	24	13	8	197	111	91
Imnaha		0	1	1	3	4	3	4	0	4	3	3	13	9	9	38	72	41
Salmon							1	3	1	2	1	1	3	0	0	22	31	
Basin Totals	7	73	87	69	45	54	82	219	120	115	206	189	303	579	543	1,302	1,854	1,506

1 Data collected and reported by the WDFW, Nez Perce Tribe, Idaho Power, and the USFWS. An empty cell means that no searches were conducted in that year or at that location. Some of the data are broken down by sampling method or river reach.

2 2003 data are preliminary and incomplete.

In the early 1990s, more fall Chinook salmon redds were observed in the lower reach, while by the late 1990s, more redds were observed in the upper reach below Hells Canyon Dam (Groves 2001). The lower Clearwater River and the Grande Ronde and Imnaha Rivers also support substantial populations of fall Chinook salmon, as seen by the increase in redds counted in those rivers (see Table 9-9). About 60 percent of the fall Chinook salmon redds were counted in the Snake River, and the remaining 40 percent were distributed among the several tributaries in year 2002 (USFWS et al. 2003). Based on preliminary data, about 91 percent of the redds were observed in the mainstem Snake River in 2003 (see Table 9-9). The number of adults counted at Lower Granite Dam to redds counted upstream in all locations averaged 5.4 in 2002 (USFWS et al. 2003).

Connor et al. (2002) reported that for the three current spawning areas of Snake River fall Chinook salmon, there are significant differences in early life history mediated by water temperature. Connor et al. (2002) found progressively lower average winter-spring (December 21 to June 20) and spring (March 20 to June 20) temperatures that differed significantly progressing downstream in the Snake River from Hells Canyon Dam to the mouth of the Salmon River (upper reach), in the Snake River from the mouth of the Salmon River to the upper end of Lower Granite Reservoir (lower reach), and in the lower Clearwater River. Warmer temperatures in the upper reach resulted in earlier fry emergence, more rapid growth to parr size, and earlier emigration and seaward movement, with later emergence and slower growth at downstream spawning reaches. Connor et al. (2003c) reported that about 1,066 degree-days are required from fertilization to median date of fall Chinook salmon fry emergence; thus, eggs incubating in cooler water required additional time to accumulate the required number of degree-days to hatch and for the fry to emerge. Average number of degree-days to emergence accumulates more quickly in the upper reach Snake River than it does in the lower reach Snake and Clearwater Rivers. The Clearwater River population that hatches and emerges later grows more slowly, has a protracted outmigration, and arrives later at Lower Granite Dam.

Downstream migration of Snake River fall Chinook salmon proceeds mostly from early June through August, with a peak in the passage index at Lower Granite Dam about June 9 (FPC 2004). Connor et al. (2003b) indicated that subyearling Chinook salmon in the Snake River migrate rapidly in the free-flowing river and may spend a considerably longer amount of time in Lower Granite Reservoir. Connor (2004) indicated that in 2004 most Snake River juvenile fall Chinook salmon were out of the mainstem Snake River by the end of June, and 72 percent of the Snake River fall Chinook salmon outmigrants passed Lower Granite Dam by July 1. However, the outmigration was uncharacteristically early in 2004 (see Figure 9-3 on page 270). Connor (2004) also indicated that increasing water temperatures in the Snake River downstream from Hells Canyon Dam in the summer motivates downstream migration

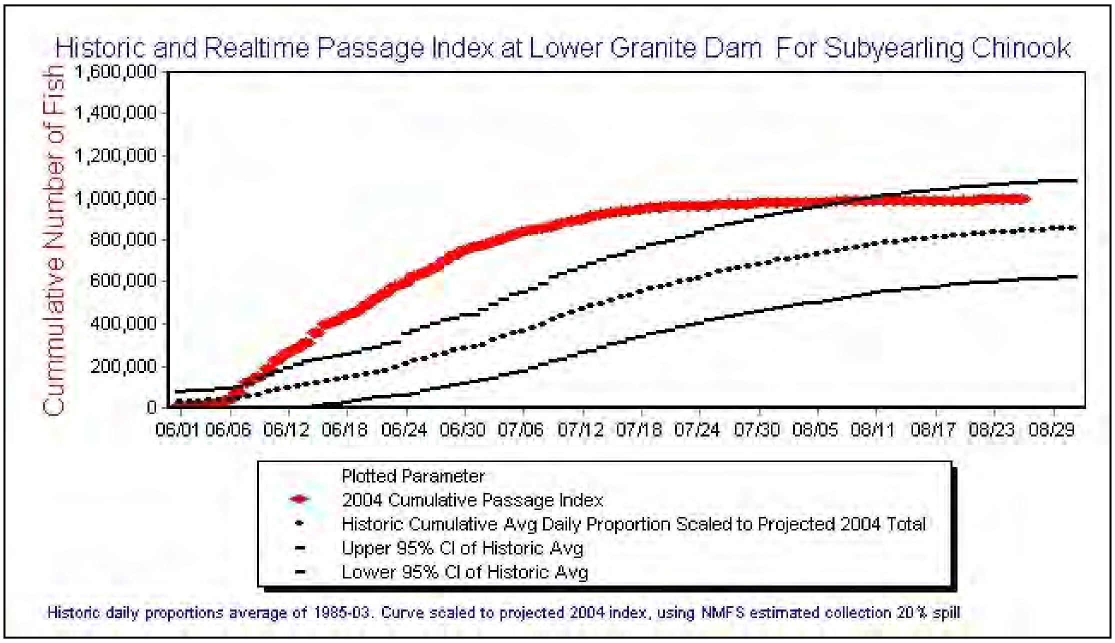

Figure 9-3. Historic and 2004 real time passage index for Snake River fall Chinook salmon subyearlings at Lower Granite Dam.

of juvenile fall Chinook salmon. Increasing water temperature up to a point increases metabolism, growth, and smoltification, but temperatures above a threshold but not lethal may reduce growth, retard smoltification, disrupt downstream movement, and decrease survival (Banks et al. 1971 and Marine 1971, both cited in Connor et al. 2003c). Those juvenile fall Chinook salmon from the lower Clearwater River, where fry emergence is later and growth is slower compared to those in the upper reach of the Snake River downstream from Hells Canyon Dam, also outmigrate later.

Connor et al. (2003c) reported that temperature influences the distribution of fall Chinook salmon spawning areas in the Snake River basin. Spawning areas in the mainstem Snake River that are warmer are preferred to those that are cooler overall, such as those in the Clearwater River. Fry, therefore, emerge earlier in the Snake River and begin feeding and generally migrating earlier. Downstream migrant fall Chinook salmon from the Snake River move down the river and into Lower Granite Reservoir earlier than those from the Clearwater River.

In 2004, with warmer water temperatures, juvenile Snake River fall Chinook salmon began migrating earlier than the average; they exited the free-flowing Snake River by the end of June and passed Lower Granite Dam by the end of July (Connor 2004).

The 2004 outmigration, as documented by detection of PIT-tagged subyearling fish at Lower Granite Dam, was earlier than normal but a little later than the forecast (Connor 2004). Most of the migrating juvenile fall Chinook salmon were out of the mainstem Snake River below Hells Canyon Dam by the end of June, and about

72 percent had passed Lower Granite Dam (Connor unpublished). Figure 9-3 (FPC 2004, www.fpc.org/Passgraphs/passgraph.asp) shows the historical and 2004 real time passage index for subyearling fall Chinook salmon at Lower Granite Dam. The 2004 outmigration is substantially earlier than the historical outmigration timing. Connor (unpublished) noted that beach seining for subyearling fish was discontinued July 1 when the water temperature was about 18 °C. Water temperature may have motivated the juvenile fish to move downstream earlier in 2004.

Figure 9-4 shows the fall Chinook salmon juvenile passage index for 2004 at Lower Granite Dam (FPC 2004, www.fpc.org/smoltqueries/CurrentDailyGraph.asp). The first three peaks from about June 8 to June 16 most likely represents hatchery releases, the second series of peaks from about June 20 to June 28 most likely represents wild subyearling fall Chinook salmon PIT-tagged by Connor, and the third and lower series of peaks from about July 4 to July 14 most likely represents later migrating fish from the Clearwater River (Connor 2004). Outmigration timing varies annually.

Idaho Power voluntarily adopted a flow program designed to provide stable conditions and habitat for spawning fall Chinook salmon in the Snake River downstream from Hells Canyon Dam. The program consisted of maintaining steady flows of about 9,500 cfs from Hells Canyon Dam throughout the spawning period and ensuring that flows do not drop below this threshold during the incubation period, until fry emergence in the spring is essentially completed (Groves 2001).

The BRT (2003) noted that both short-term and long-term trends in returns of natural-origin fish are positive. The BRT (2003) stated that it is difficult to assess the productivity of the natural population when there is a large fraction of naturally

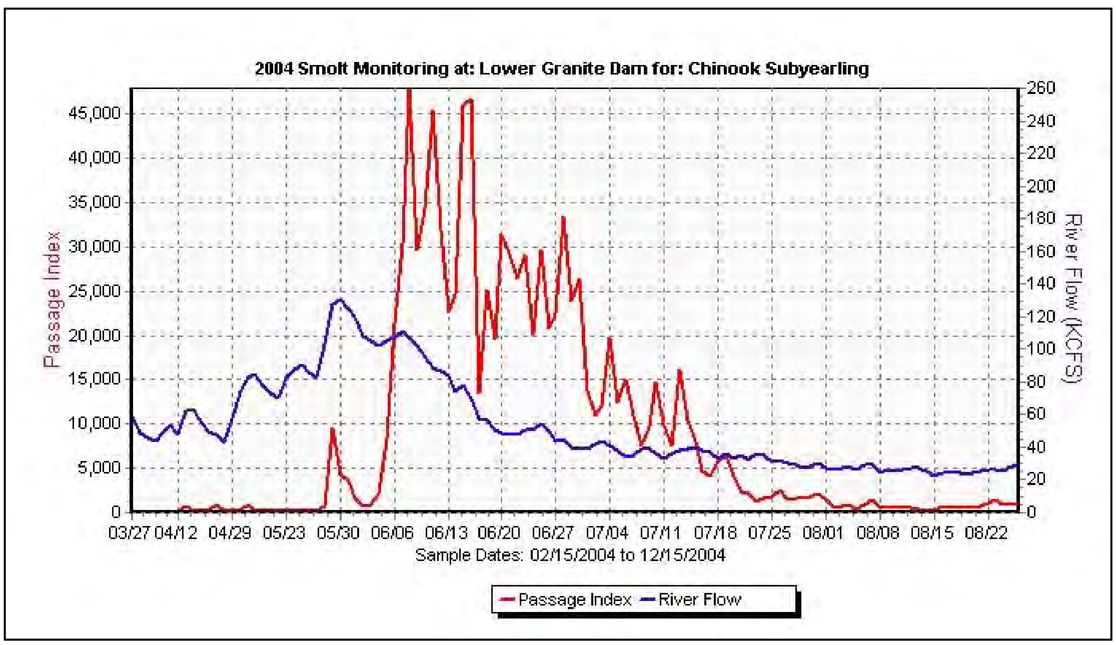

Figure 9-4. Passage index for Snake River fall Chinook salmon at Lower Granite Dam.

spawning hatchery fish and when the effectiveness of hatchery-origin fish spawning in the wild is poorly understood. The BRT was also concerned about straying of out-of-ESU hatchery fish and the potential influence on Snake River fall Chinook salmon.

As Table 9-8 shows on page 267, non-Snake River hatchery-origin fish constitute a wide-ranging component of hatchery-origin fish, with a substantial proportion occurring from 1993 to 1997. In 1998, the proportion of non-Snake River hatchery-origin fall Chinook salmon decreased 27 percent and since then has declined to about 7 percent in 2002.

The 1995 to 2002 8-year geometric mean for wild fall Chinook salmon is 1,023 fish, below Lohn' (2002) 2,500 interim abundance target.

9.4 Snake River Sockeye Salmon

9.4.1 Background

NOAA Fisheries listed the Snake River sockeye salmon as endangered on November 20, 1991 (see Table 9-1 on page 246). This ESU includes anadromous sockeye salmon populations from the Snake River basin in Idaho, notably the Redfish Lake sockeye salmon (ICBTRT 2003), residual sockeye salmon in Redfish Lake, and one captive propagation hatchery program (69 FR 33101). Figure 9-5 shows the geographic range of this ESU. Snake River sockeye salmon do not occur above Hells Canyon Dam;

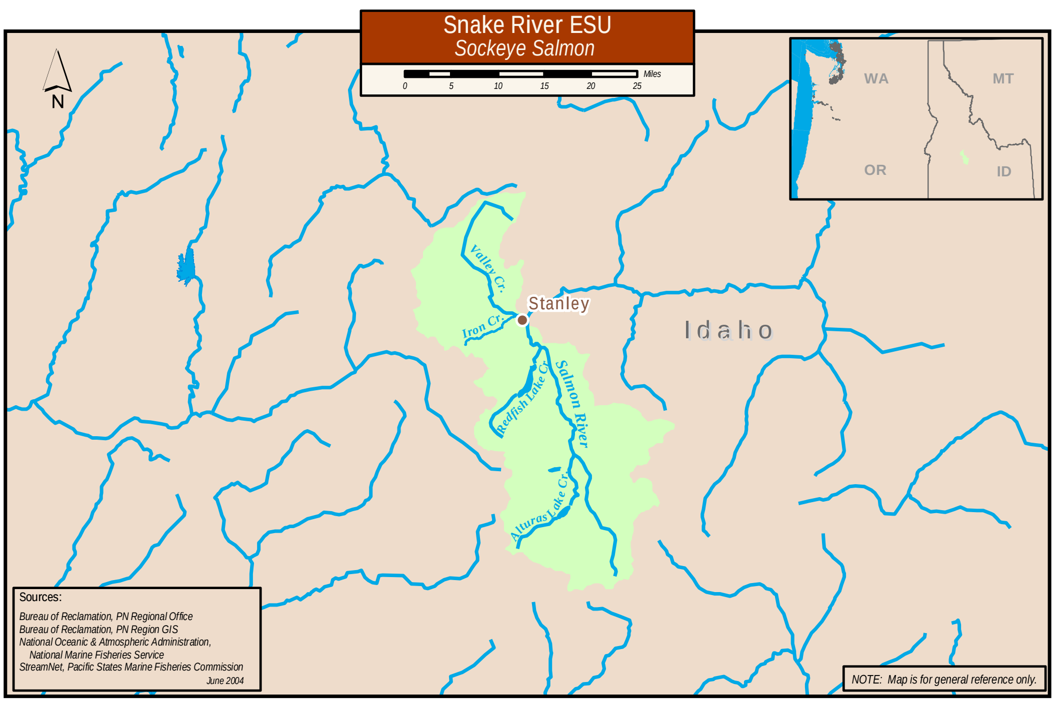

Figure 9-5. Geographic range of the Snake River sockeye salmon ESU.

historically they occurred in Payette Lake on the North Fork Payette River near McCall, Idaho. Between 1870 and 1880, up to 75,000 sockeye salmon per year were harvested commercially at Payette Lake (Evermann 1896 cited in BPA 2003).

Snake River sockeye salmon spawn in Redfish Lake in the upper Salmon River basin upstream from Stanley, Idaho. Reintroductions using progeny from captive broodstock have been attempted in Alturas Lake and Pettit Lake. Watersheds containing spawning and rearing habitat for this ESU comprise approximately 510 square miles within Blaine and Custer Counties, Idaho (NOAA Fisheries 2004). After rearing in the lake for a year, the juvenile fish outmigrate through the Salmon, Snake, and Columbia Rivers to the Columbia River estuary and ocean during the spring and early summer. The juvenile fish enter the action areas at the mouth of the Salmon River; likewise, returning adults leave the action areas when they turn off into the Salmon River on their upstream migration. Returning adults migrate upstream in mid-summer to spawn in Redfish Lake in the fall. Adults and juveniles are migrating in the action areas while Reclamation is storing, releasing, and diverting water. Waples et al. (1991a) and Burgner (1991) contain additional life history information. The BRT found extremely high risks for each of the four VSP categories (69 FR 33101).

Lohn (2002) lists 1,000 spawners per year in one lake and 500 spawners in a second lake as the interim abundance target for Snake River sockeye salmon. The interim target is an 8-year geometric mean.

9.4.2 Critical Habitat

NOAA Fisheries designated critical habitat for Snake River sockeye salmon on December 28, 1993 (see Table 9-1 on page 246). Critical habitat includes river reaches in the Columbia, Snake, and Salmon Rivers, Alturas Lake Creek, Valley Creek, and Stanley, Redfish, Yellow Belly, Pettit, and Alturas Lakes (including their inlet and outlet creeks). Essential features of Snake River sockeye salmon spawning and rearing areas include adequate spawning gravel, water quality, water quantity, water temperature, food, riparian vegetation, and access. Essential features of juvenile migration corridors include adequate substrate, water quality, water quantity, water temperature, water velocity, cover/shelter, food, riparian vegetation, space, and safe passage conditions. Essential features of adult migration corridors include those of the juvenile migration corridors, excluding adequate food.

9.4.3 Current Conditions in the Action Areas

Table 9-10 on page 274 shows adult sockeye salmon counts at Bonneville and Lower Granite Dams from 1975 through 2003, along with Redfish Lake weir counts. Adult sockeye salmon returns are severely depressed, with only 11 fish counted at Lower Granite Dam in 2003. Up to August 3, 2004, 110 adult sockeye salmon were counted at

Lower Granite Dam (Columbia River DART 2004). In 2003, only 3 adults returned to the Sawtooth Hatchery and Redfish Lake weir. The 2000 high return of 299 adults counted at Lower Granite Dam that yielded 257 adults to the Redfish Lake weir appears to be the result of an experimental but successful modification of the captive broodstock program in 1998, wherein a large number of juveniles were reared at the Bonneville Hatchery and later transported back to Redfish Lake for release (Kline 2004).

Table 9-10. Adult Snake River sockeye salmon escapement counts.

Year	Bonneville Dam	Lower Granite Dam [1]	Redfish Lake Weir
1975		209	NC
1976		531	NC
1977	99,829	458	NC
1978	18,436	123	NC
1979	52,627	25	NC
1980	58,882	96	NC
1981	56,037	218	NC
1982	50,219	211	NC
1983	100,542	122	NC
1984	152,540	47	NC
1985	165,933	34	11 wild
1986	58,099	15	29
1987	116,956	29	14
1988	79,721	23	NC
1989	41,884	2	NC
1990	49,581	0	0
1991	76,482	8	4
1992	84,992	15	1
1993	80,178	12	8
1994	12,678	5	1
1995	8,774	3	0
1996	30,252	3	1
1997	47,008	11	0
1998 [2]	13,218	2	1
1999 [2]	17,875	14	7 hatchery
2000 [2]	93,398	299	257 [3]
2001 [2]	115,022 [4]	36 (50 [4])	26 [5]
2002	49,610	55	22 [6]
2003	39,291	11	3 [6]
2004 [7]	123,252	110	na

1 Source: FPC 2004.
2 Sources: Kline 2001; Malaise 2001.
3 Some of these adults returned to the Sawtooth Hatchery; others were counted at the Redfish Lake weir.
4 Includes video counts.
5 As of October 9, 2001.
6 Sum of fish counted at the Sawtooth Hatchery and the Redfish Lake Weir (Baker 2004).
7 Adult returns as of November 3, 2004 (Columbia River DART 2004).

Table 9-10 also shows that the adult sockeye salmon counts fluctuated substantially at Bonneville Dam for the recent period of record, with a high of 165,933 fish in 1985, and a recent peak count of 123,252 fish in 2004. The majority of the sockeye salmon counted at Bonneville Dam are destined for upper Columbia River spawning areas such as the Wenatchee and Okanogan Rivers.

Once adult Snake River sockeye salmon move into the Salmon River from the Snake River, they are outside the action areas. Redfish Lake sockeye salmon have been propagated in a NOAA Fisheries and IDFG-managed captive broodstock program. The program began in 1991 with four adults. Progeny from these adults are reared at an IDFG facility near Eagle, Idaho, and a NOAA Fisheries facility on Puget Sound near Manchester, Washington. Multiple rearing facilities were selected to ensure survival of at least some of the progeny if a catastrophic event such as a disease outbreak occurred at one of the facilities. The captive broodstock program continues to rear juveniles for release into Redfish Lake.

The number of returning adult sockeye salmon is well below the interim abundance target.

9.5 Snake River Basin Steelhead

9.5.1 Background

NOAA Fisheries listed the Snake River Basin steelhead ESU as threatened on August 18, 1997 (see Table 9-1 on page 246). This ESU includes all naturally spawned steelhead populations (and their progeny) in Snake River basin streams in southeast Washington, northeast Oregon, and Idaho. Figure 9-6 on page 276 shows the geographic range of this ESU.

Resident populations of *O. mykiss* below impassible barriers (natural and manmade) that co-occur with anadromous *O. mykiss* are included in this ESU (69 FR 33101). Six artificial propagation programs are considered part of this ESU. These are all summer steelhead. The ICBTRT (2003) identified 24 demographically independent populations in six major groupings in this ESU: the lower Snake River, Clearwater River, Grande Ronde River, Salmon River, Imnaha River, and Hells Canyon. Some small tributaries to the Snake River in Hells Canyon support steelhead spawning; rearing but not spawning apparently occurs in the Snake River in Hells Canyon (ICBTRT 2003). Life history, habitat requirements, factors contributing to decline, and other information are described in Busby et al. (1996), in Section 4.1.6 of the NOAA Fisheries 2000 biological opinion on the FCRPS, and the BRT (2003). The BRT (2003) found moderate risks for the abundance, productivity, and diversity VSP categories, and comparatively lower risks in the spatial structure category (69 FR 33101).

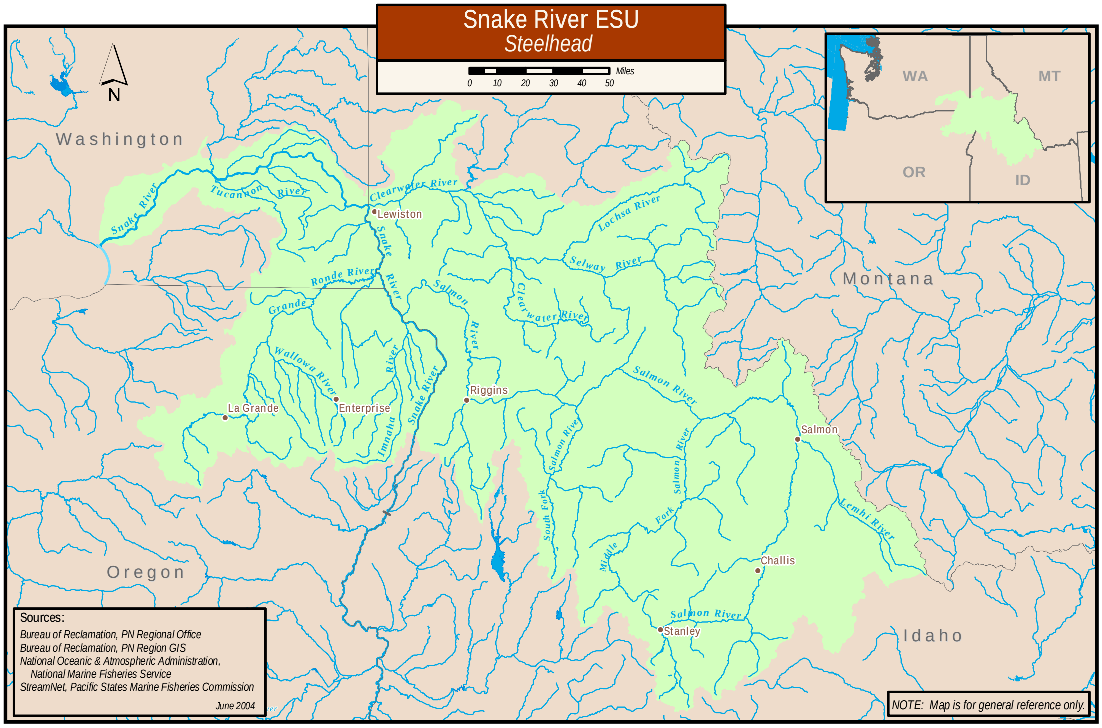

Figure 9-6. Geographic range of the Snake River Basin steelhead ESU.

Lohn (2002) lists 53,700 annual natural spawners as the 8-year, or approximately two-generation, geometric mean as the interim abundance target for 19 spawning aggregations of this ESU. The 1996-2003 8-year geometric mean of 19,913 wild adults at Lower Granite Dam is well below Lohn's (2002) combined interim abundance target of annual natural spawners for this ESU of 53,700 fish.

9.5.2 Life History

This steelhead ESU exhibits a wide range of life history strategies such as varying times of freshwater rearing or ocean residence. 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 (Busby et al. 1996).

All inland steelhead upstream from The Dalles Dam are summer-run fish. They are further classified as either A-run or B-run fish based on two prominent life history strategies. The A-run fish have a shorter freshwater rearing and ocean residence time and are smaller, while B-run fish spend more time rearing in freshwater and the ocean and are larger when they return as adults. B-run summer steelhead are predominately found in the Lochsa and Selway subbasins of the Clearwater River and in the Middle Fork and South Fork Salmon River basins of Idaho. Some may also occur in parts of the mainstem Clearwater River and its major tributaries (NOAA Fisheries 2003). A-run adult summer steelhead pass Bonneville Dam up to August 25, are predominantly age-1-ocean, and are less than 77.5 cm in length (Schriever 2001). B-run summer steelhead pass Bonneville Dam after August 25, are predominantly age-2-ocean, and are larger than 77.5 cm. The B-run steelhead that have a limited distribution in some Snake River tributaries are differentiated by size but not by date of passage at Lower Granite Dam.

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. 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. Unlike salmon, adult steelhead do not necessarily die after spawning but may return to the ocean to grow for another year and return to freshwater to spawn again. Busby et al. (1996) reported that the frequency of iteroparity (multiple spawnings) is variable within and among populations, and that repeat spawning is relatively uncommon north of Oregon. Spawned-out adult steelhead, called kelts, are primarily females and survive at relatively low rates to spawn again. Meehan and Bjornn (1991) report that in small coastal streams, up to 30 percent of adults may survive to spawn a second or third time, but where fish migrate long distances, the proportion of fish that spawn more than once is much lower. Rates of repeat spawning for Columbia River *O. mykiss* range from 1.6 percent for the Yakima River subbasin and the mid/upper Columbia River to 17 percent in tributaries of the lower Columbia River, and from 2 to 9 percent for the South Fork Walla Walla River (Evans et al. 2001). Because of the potential additional production that could be realized from repeat spawners, an experimental program has been implemented to recondition kelts (Evans et al. 2001; CBFWA 2004).

Steelhead eggs hatch in 35 to 50 days, depending on water temperature (about 50 days at 10 °C). Following hatching, alevins remain in the gravel 2 to 3 weeks until the yolk sac is absorbed. About 65 to 85 percent of the fertilized eggs survive to emerge from redds in the middle to late summer as fry; egg to smolt survival is estimated to be 0.75 percent.

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 to 8 inches.

9.5.3 Habitat Requirements

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.

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.

Steelhead diet 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 (mayfly and stonefly nymphs and caddisfly, dipteran, and beetle larvae), amphipods, snails, aquatic worms, fish eggs, and occasionally small fish.

Juvenile diet 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.

9.5.4 Current Conditions in the Action Areas

Table 9-11 shows adult steelhead calendar year counts at Bonneville, Ice Harbor, and Lower Granite Dams from 1977 through December 2003. In some cases adult steelhead will overwinter downstream from a project, for example, in the lower Snake River downstream from Lower Granite Dam, and resume their upstream migration early the next calendar year. Those fish are counted as crossing the project the subsequent year. The proportion of wild to total adult steelhead was determined from scale analysis of a sample of adults.

Adult Snake River Basin steelhead returning to Ice Harbor Dam peaked in 2001 at 255,720 fish, declined 20.9 percent to 202,173 fish in 2002, and further declined 5.2 percent to 191,675 fish in 2003. Wild steelhead peaked in 2002 at 51,308 fish, an increase of 10.9 percent from the 46,257 fish counted at Ice Harbor Dam in 2001. However, wild steelhead declined 7.8 percent to 47,329 fish in 2003.

At Lower Granite Dam, adult steelhead peaked at 262,568 fish in 2001, declined 16.6 percent to 218,879 fish in 2002, and further declined 17.5 percent to

180,672 fish in 2003. Adult wild steelhead also peaked in 2002 with 57,315 fish counted at Lower Granite Dam, up 20.1 percent from the 47,716 fish counted in 2001. Adult wild steelhead declined 20.8 percent in 2003 to 45,391 fish (see Table 9-11).

Table 9-12 on page 280 shows the total steelhead run at Lower Granite Dam for 1986 to 2003 brood years, along with the numbers of wild and hatchery A- and B-run steelhead. These fish counted at Lower Granite Dam migrate to various tributaries of the Snake, Salmon, and Clearwater Rivers. These data are for a run year from June 1 to May 31 and differ from that provided by the Fish Passage Center that is based on

Table 9-11. Total and wild steelhead counts at Bonneville, Ice Harbor, and Lower Granite Dams from 1977 to 2003 (FPC 2004, www.fpc.org/adult_history/adultsites.html).

Year	Bonneville Dam		Ice Harbor Dam		Lower Granite Dam	
	Steelhead	Wild Steelhead	Steelhead	Wild Steelhead	Steelhead	Wild Steelhead
1977	193,437		54,820		51,076	
1978	104,431		26,440		29,960	
1979	114,010		20,792		25,046	
1980	129,254		47,942		40,454	
1981	159,270		39,441		40,234	
1982	157,640		73,405		72,840	
1983	218,419		88,720		86,753	
1984	315,795		93,891		98,930	
1985	330,170		116,878		114,477	
1986	376,752		144,278		134,321	
1987	300,351		74,365		69,334	
1988	279,277		100,519		87,047	
1989	287,802		151,101		132,575	
1990	183,011		54,758		56,939	
1991	274,535		123,765		100,367	
1992	314,974		160,614		121,456	
1993	188,386		73,107		66,700	
1994	161,978	29,174	51,704	8,265	47,550	9,436
1995	202,448		92,026		80,853	
1996	205,213	17,375	100,702	10,551	86,072	9,583
1997	258,385	33,580	103,830	10,324	85,917	8,991
1998	185,094	35,701	77,644	11,050	72,017	9,559
1999	206,488	55,064	80,267	13,215	74,440	11,740
2000	275,273	76,220	120,254	22,996	113,021	20,580
2001	633,464	149,582	255,720	46,257	262,568	47,716
2002	481,203	143,045	202,173	51,308	218,718	57,291
2003	361,412	112,347	186,474	46,001	180,672	45,391
8-year geometric mean						19,913

calendar year. The total number of returns fluctuated substantially over the time period. As noted for other ESUs in the Columbia River basin, total and A-run Snake River Basin steelhead returns peaked in 2001. Both wild and hatchery B-run adult steelhead peaked in 2002. The lowest overall total returns of 47,302 fish occurred in 1994, with the overall lowest return of wild fish occurring the previous year. Hatchery fish peaked in 2001, while wild fish peaked in 2002. Wild and hatchery A-run fish peaked in 2001, while the wild and hatchery B-run fish peaked in 2002. For the recent years 2000 to 2003, the A-run fish averaged 80.49 percent of the run, while the B-run fish averaged 19.50 percent of the run (see Table 9-13).

Table 9-12. Total and A- and B-run wild and hatchery summer steelhead at Lower Granite Dam, brood years 1986 to 2003 (Kiefer 2004).

Year	Run Total			A-run Index			B-run Index		
	Wild	Hatchery	Total	Wild	Hatchery	Total	Wild	Hatchery	Total
1986	21,991	107,992	129,983	16,727	72,095	88,822	5,264	35,897	41,161
1987	25,470	45,810	71,280	20,093	32,133	52,226	5,377	13,677	19,054
1988	21,085	66,052	87,137	16,327	44,132	60,459	4,758	21,920	26,678
1989	24,968	106,452	131,420	16,952	66,553	83,505	8,016	39,899	47,915
1990	9,286	47,579	56,865	4,803	25,561	30,364	4,483	22,018	26,501
1991	17,321	81,731	99,052	14,141	69,850	83,991	3,180	11,881	15,061
1992	19,346	108,919	128,265	13,574	83,353	96,927	5,772	25,566	31,338
1993	7,354	52,414	59,768	5,914	35,510	41,424	1,440	16,904	18,344
1994	7,516	39,786	47,302	5,071	32,411	37,483	2,444	7,375	9,819
1995	7,991	71,135	79,126	6,701	63,562	70,263	1,290	7,573	8,863
1996	7,623	79,275	86,898	5,979	67,066	73,045	1,644	12,209	13,853
1997	8,738	77,879	86,617	7,411	66,981	74,392	1,327	10,898	12,225
1998	9,386	61,335	70,721	7,086	43,888	50,974	2,300	17,446	19,747
1999	11,038	62,772	73,810	10,129	53,945	64,074	909	8,827	9,736
2000	19,978	95,183	115,161	17,129	78,140	95,269	2,849	17,044	19,893
2001	38,842	220,303	259,145	35,792	190,157	225,950	3,050	30,145	33,195
2002	42,155	174,663	216,818	28,132	122,386	150,518	14,023	52,277	66,300
2003	29,080	145,350	174,430	21,833	122,319	144,152	7,247	23,031	30,278
	16,871	8-year geometric mean							

Table 9-13. Percent of wild and hatchery A- and B-run steelhead at Lower Granite Dam from 2000 to 2003.

Year	Wild A-run	Hatchery A-run	Wild B-run	Hatchery B-run
2000	14.87	67.85	2.47	14.80
2001	13.81	73.38	1.17	11.63
2002	12.97	56.45	6.46	24.11
2003	12.52	70.12	4.15	13.20
Average	13.54	66.95	3.56	15.94

The 8-year geometric mean for wild Snake River steelhead at Lower Granite Dam based on FPC calendar year data is 19,913 fish, which is below the 53,700 interim abundance target of annual natural spawners, and 16,871 fish, based on brood year data from the IDFG.

9.6 Upper Columbia River Spring Chinook Salmon

9.6.1 Background

NOAA Fisheries listed the Upper Columbia River Chinook salmon ESU as endangered on March 24, 1999 (see Table 9-1 on page 246). This ESU includes all naturally spawned Chinook salmon populations in all river reaches accessible to Chinook salmon in Columbia River tributaries upstream from Rock Island Dam and downstream from Chief Joseph Dam in Washington, excluding the Okanogan River. Figure 9-7 shows the geographic range of this ESU. The ICBTRT (2003) identified three independent populations in this ESU: the Wenatchee River, the Entiat River, and the Methow River. Six artificial propagation programs are considered to be part of this ESU (69 FR 33101): Twisp River (spring run); Chewuch River (spring run); Methow Composite (spring run); Winthrop National Fish Hatchery; Chiwawa River (spring run); and White River (spring run). The BRT had strong concerns about the

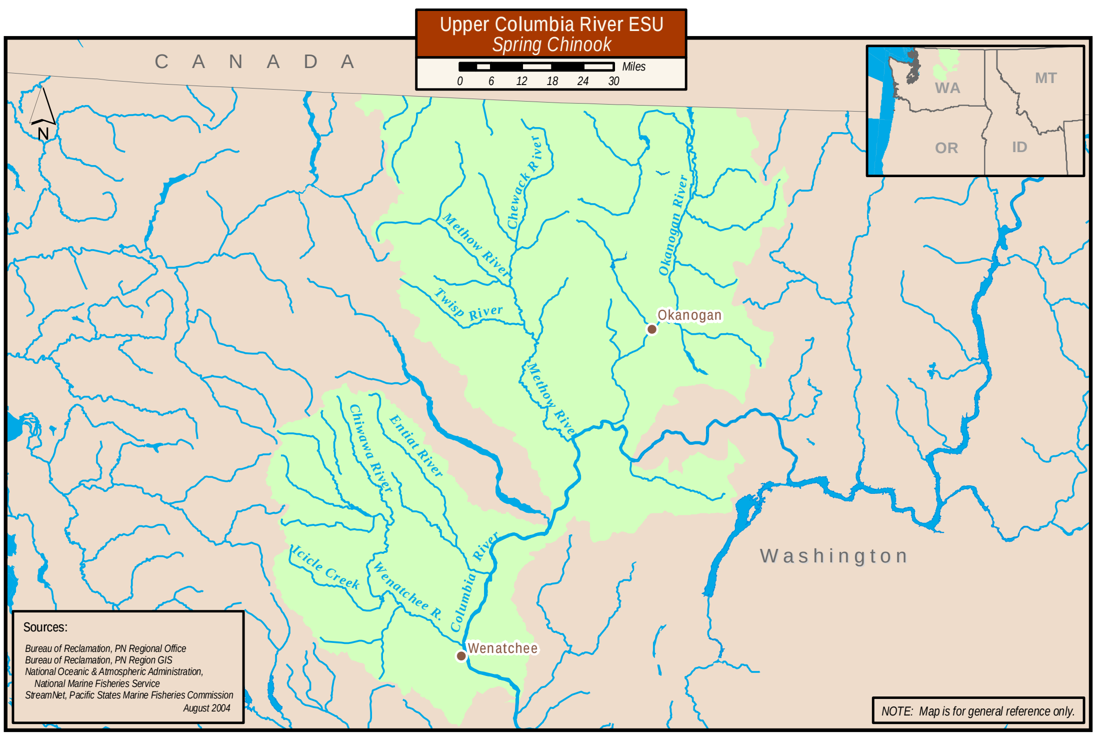

Figure 9-7. Geographic range of the Upper Columbia River spring Chinook salmon.

abundance and productivity categories of the VSP, and comparatively less concern for spatial structure and diversity (69 FR 33101).

This ESU's geographical range for spawning, incubation, and rearing is outside the action areas; juveniles enter the action areas in the Columbia River downstream from the mouth of the Snake River, and adults leave the action areas when they pass the mouth of the Snake River. This ESU has had substantial hatchery influence since hatchery programs were established as mitigation programs, notably Leavenworth National Fish Hatchery and its satellite facilities at Entiat and Winthrop. The Leavenworth hatchery has released Chinook salmon since 1940. Production at this hatchery had been augmented with eggs transferred into the program from outside the ESU, but recently broodstocking for each hatchery program has been switched to emphasize locally adapted broodstocks (BRT 2003). Section 4.1.3 of the NOAA Fisheries 2000 biological opinion contains additional information on life history, habitat requirements, and factors for decline.

The Upper Columbia Biological Requirements Workgroup (Ford et al. 2001) recommended interim delisting levels of 3,750, 500, and 2,200 spawners for populations returning to the Wenatchee, Entiat, and Methow drainages, respectively (BRT 2003). Recent spawning escapements are much below this. Lohn (2002) lists 2,000 spawners for the Methow, 500 spawners for the Entiat, and 3,750 spawners for the Wenatchee for a total of 6,250 spawners as interim abundance targets. These are 8-year, or approximately two-generation, geometric means of annual natural spawners.

9.6.2 Current Conditions in the Action Areas

Table 9-14 shows Upper Columbia River spring Chinook salmon counts at Rock Island Dam from 1977 to 2003. As seen in other salmon and steelhead ESUs, the highest returns occurred in 2001. Many of these are hatchery fish produced by the Leavenworth National Fish Hatchery. Myers et al. (1998) note that the natural abundance of this ESU is quite low, that some populations have become extinct, and that almost all remaining naturally spawning populations have fewer than 100 spawners. The Washington Department of Fish and Wildlife considered eight of the nine stocks within this ESU of native origin with natural production, although they considered the status of all nine stocks to be depressed.

The BRT (2003) noted that long-term population trends for this ESU were generally downward; they only considered return data up to 2001. Dam counts for Upper Columbia River spring Chinook salmon have declined about 57 percent in 2003 from the high return of 39,785 fish in 2001, and declined 72.5 percent to 10,917 fish in 2004 from 2001; the 2004 spring Chinook salmon count at Bonneville Dam was also substantially below expectations. In the Methow River spawning area, about

Table 9-14. Spring Chinook salmon counts at Rock Island Dam from 1977 to 2003 (FPC 2004).

Year	Adult	Jack	Year	Adult	Jack
1977	17,192	1,390	1991	5,450	331
1978	19,030	198	1992	15,380	254
1979	6,215	333	1993	19,910	32
1980	6,591	542	1994	2,004	34
1981	7,610	166	1995	792	131
1982	7,568	324	1996	1,887	263
1983	9,499	385	1997	6,153	52
1984	11,528	657	1998	3,187	54
1985	25,153	695	1999	3,309	915
1986	20,537	464	2000	14,850	1,558
1987	18,442	441	2001	39,785	1,761
1988	15,868	344	2002	24,017	827
1989	10,350	340	2003	16,881 17,481 [1]	753
1990	7,603	117	2004	10,917	958

1 Columbia River DART 2004.

80 percent of the 2001 return was estimated to be from supplementation adults. The combined hatchery and wild adult returns were used to calculate the 1997-to-2004 8-year geometric mean, which was then reduced by 80 percent based on the observation that about 80 percent of the 2001 return to the Methow River was estimated to be from supplementation adults. This resulted in a geometric mean of 2,137 adults, far below the 6,250 adults listed as Lohn's (2002) interim abundance target.

9.7 Lower Columbia River Chinook Salmon

9.7.1 Background

NOAA Fisheries listed the lower Columbia River Chinook salmon ESU as threatened on March 24, 1999 (see Table 9-1 on page 246). This is a complicated ESU that has both spring and fall runs and includes all naturally spawned Chinook salmon populations from the Columbia River and its tributaries from its mouth upstream to a transitional point between Washington and Oregon east of Hood River and the White Salmon River; it also includes the Willamette River to Willamette Falls but not spring-run Chinook salmon in the Clackamas River. Figure 9-8 on page 284 shows the geographic range of this ESU. Seventeen artificial propagation programs are considered to be part of this ESU (69 FR 33101). The Willamette Lower Columbia

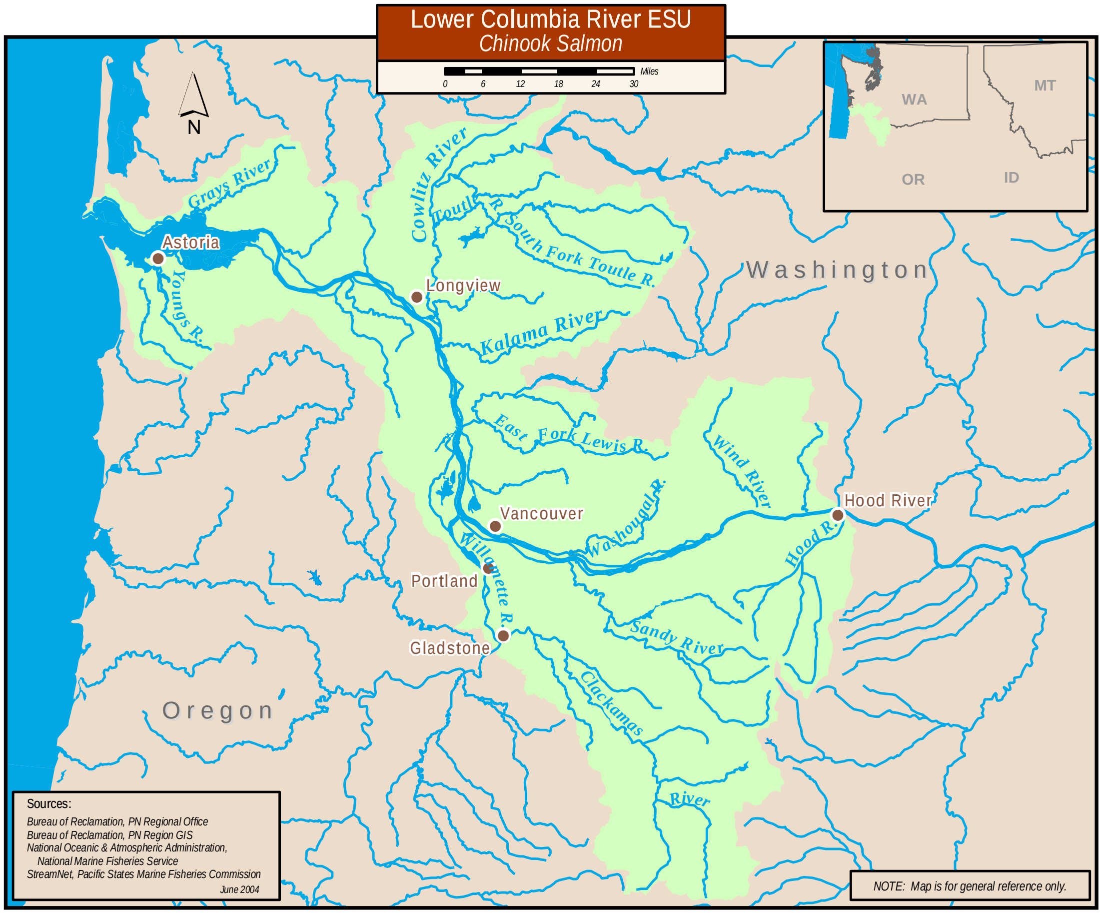

Figure 9-8. Geographic range of the Lower Columbia River Chinook salmon.

Technical Review Team (WLCTRT 2003) hypothesized that this ESU contained 31 populations with 20 fall-run populations (tules), 2 late fall-run populations (brights), and 9 spring-run populations. These were grouped by life history and ecological zone (Coastal, Western Cascade, and Gorge). Some spawning occurs downstream from Bonneville Dam in the Ives Island area. The fall Chinook salmon populations are dominated by large-scale hatchery production (BRT 2003). Major river basins containing spawning and rearing habitat for this ESU comprise approximately 6,338 square miles in Oregon and Washington. Section 4.1.5 of the NOAA Fisheries 2000 biological opinion on the FCRPS and the BRT (2003) report contain additional information on life history, habitat requirements, and factors for decline. In addition, the BRT found moderately high risk for all VSP categories, and the majority of these fish appear to be hatchery produced (69 FR 33101).

9.7.2 Current Conditions in the Action Areas

Myers et al. (1998) note that the numbers of naturally-spawning spring runs of this ESU are very low, and long-term and short-term abundance trends are mostly negative. The BRT (2003) reported a recent abundance of natural spawners for this ESU as 11,720 adult fish, and noted that recent trend indicators for almost all populations remain negative. Long-term trends in productivity are below replacement for the majority of the population in the ESU (69 FR 33101). Literally millions of hatchery produced lower Columbia River Chinook salmon smolts have been released into the river.

9.8 Upper Willamette River Chinook Salmon

9.8.1 Background

NOAA Fisheries listed the Upper Willamette River Chinook salmon ESU as threatened on March 24, 1999 (see Table 9-1 on page 246). This ESU includes all naturally spawned spring-run Chinook salmon populations in the Clackamas River and in the Willamette River and its tributaries above Willamette Falls, Oregon. Figure 9-9 shows the geographic range of this ESU. Seven artificial propagation programs are considered to be part of this ESU (69 FR 33101). Major river basins

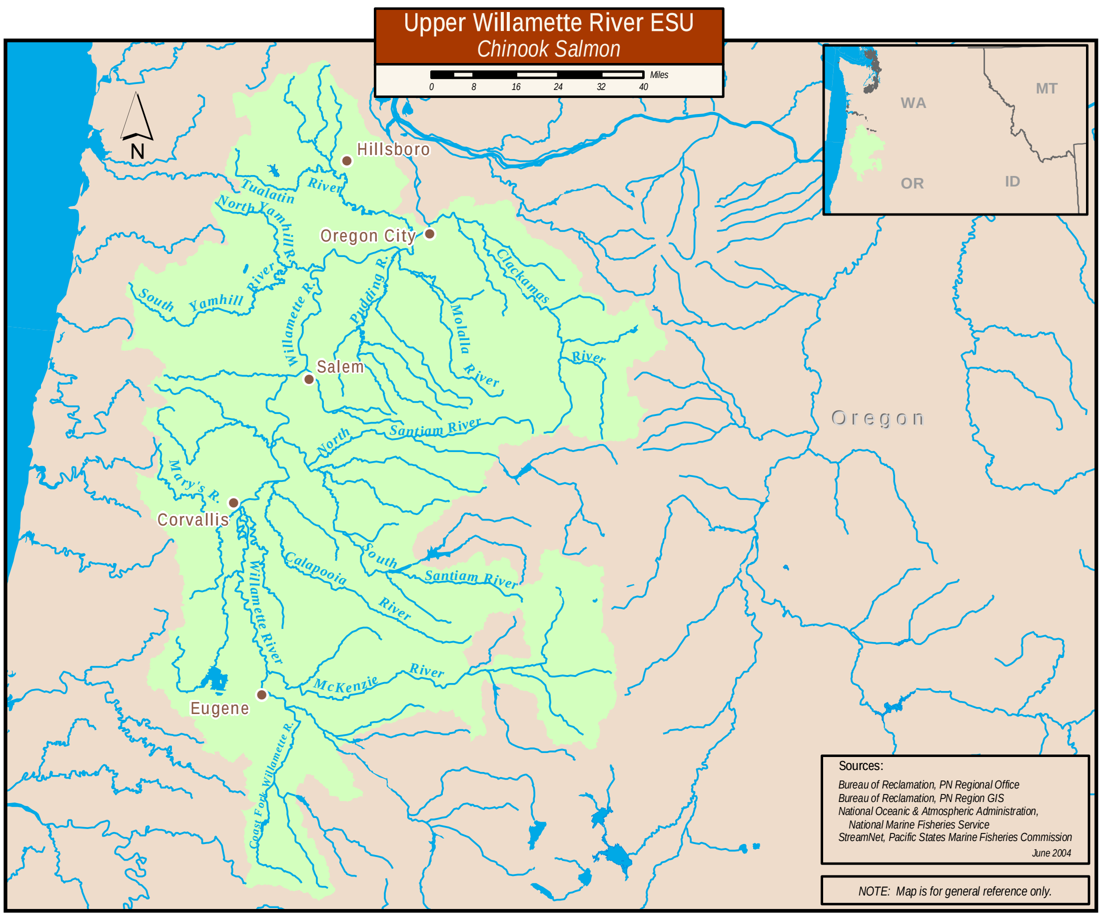

Figure 9-9. Geographic range of the Upper Willamette River Chinook salmon ESU.

containing spawning and rearing habitat for this ESU comprise approximately 8,575 square miles. The WLCTRT (2003) identified seven populations in this ESU: the Clackamas River, the Molalla River, the North Santiam River, the South Santiam River, the Calapooia River, the McKenzie River, and the Middle Fork Willamette River. Section 4.1.4 of the NOAA Fisheries 2000 biological opinion on the FCRPS contains additional information on life history, habitat requirements, and factors for decline. This ESU's geographical range for spawning, incubation, and rearing is outside the action areas; juveniles enter the action areas in the Columbia River when they exit the Willamette River, and adults leave the action areas when they enter the Willamette River. The BRT found moderately high risk for all four VSP categories (69 FR 33101).

9.8.2 Current Conditions in the Action Areas

Myers et al. (1998) note that the total abundance of this ESU has been relatively stable at about 20,000 to 30,000 fish, although recent escapement has been declining. The BRT (2003) estimated an abundance of 1,787 natural spawners for this ESU, concluding that many of the returning adults are of hatchery origin. Figure A.2.6.2 of the BRT (2003) shows some higher returns in the late 1980s and early 1990s. Table 9-15 shows recent counts at Willamette Falls Fishway. Risks to this ESU include habitat blockage and habitat degradation.

Table 9-15. Willamette Falls spring Chinook salmon counts (ODFW 2004).

Year	Adults	Jacks
2001	52,685	1,288
2002	82,111	1,025
2003	117,600	na
2004	109,400 (projected)	

9.9 Upper Columbia River Steelhead

9.9.1 Background

NOAA Fisheries listed the Upper Columbia River steelhead ESU as endangered on August 18, 1997 (see Table 9-1 on page 246). In a recent status review, this ESU was proposed for relisting as threatened (69 FR 33101). This ESU includes all naturally spawned steelhead populations (and their progeny) in streams in the Columbia River basin upstream from (but not including) the Yakima River to the Canadian border; essentially, this ESU includes those steelhead that pass Priest Rapids Dam.

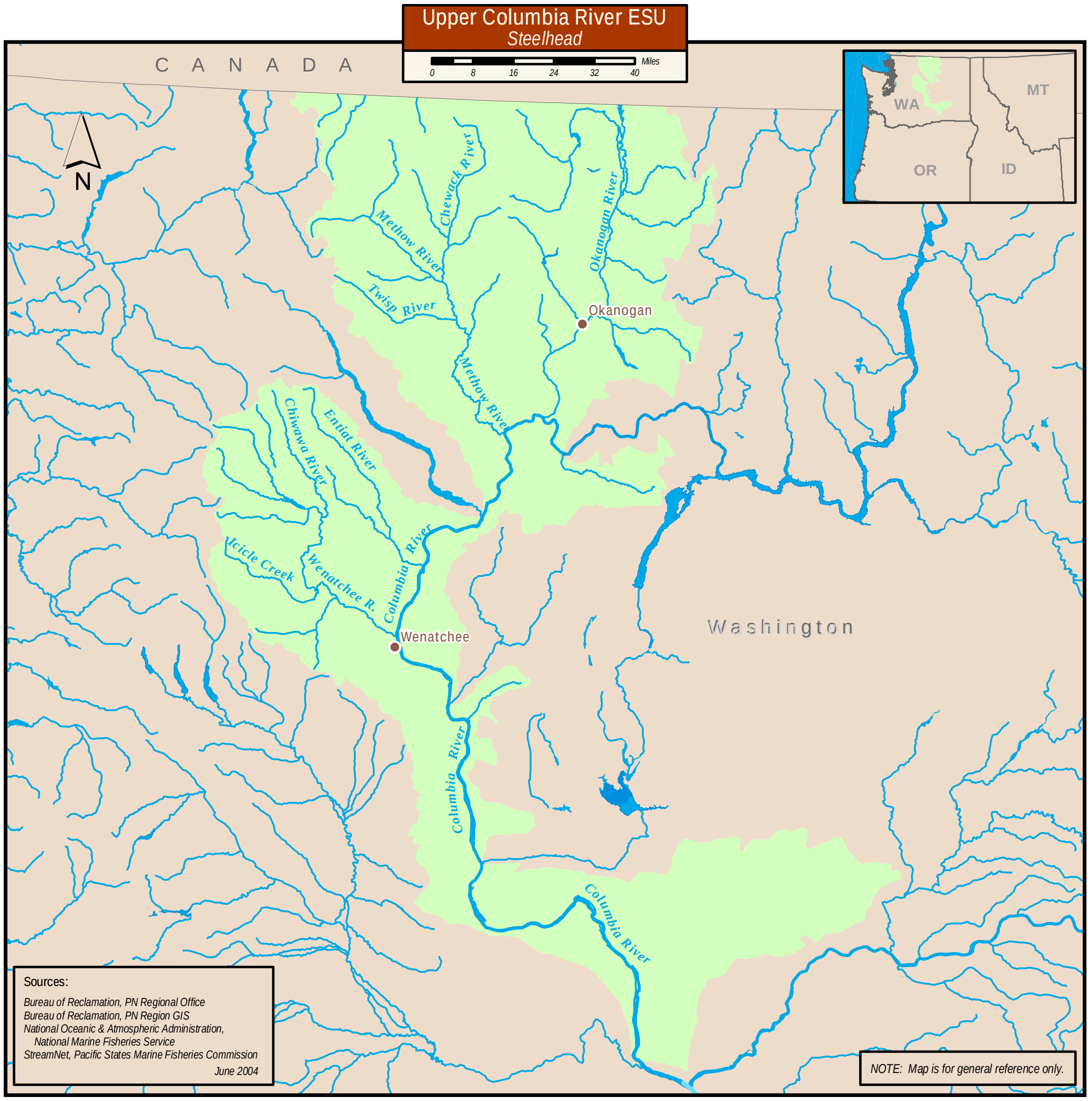

Figure 9-10. Geographic range of the Upper Columbia River steelhead ESU.

Figure 9-10 shows the geographic range of this ESU. Resident populations of *O. mykiss* below impassible barriers (natural and manmade) that co-occur with anadromous populations are included in this ESU. The ICBTRT (2003) could not identify any major groupings in this ESU because the area's size was relatively small; however, they did identify four historically independent populations. Data do not exist to assess the contribution of resident fish to these four anadromous populations. Wells Hatchery stock steelhead are also part of the listed ESU. Major river basins containing spawning and rearing habitat for this ESU comprise approximately 9,545 square miles in Washington. This ESU's geographical range for spawning, incubation, and rearing is outside the action areas; juveniles enter the action areas in the Columbia River downstream from the mouth of the Snake River, and adults leave the action areas when they pass the mouth of the Snake River.

The Upper Columbia River steelhead ESU has complex life history patterns (BRT 2003). Juveniles predominantly outmigrate as 2- or 3-year-old fish, but some spend up to seven years in freshwater before outmigrating. Some adults overwinter in the mainstem reservoirs before making the final migration to the spawning grounds. Busby et al. (1996) and Section 4.1.7 of the NOAA Fisheries 2000 biological opinion on the FCRPS provide additional information on life history, habitat requirements, and factors for decline. The BRT found high risk for the productivity VSP category, and comparatively lower risk for the abundance, diversity, and spatial structure categories (69 FR 33101).

Lohn (2002) lists 2,500 spawners for the Methow River, 500 spawners for the Entiat River, and 2,500 spawners for the Wenatchee River, for a total of 5,500 spawners as interim abundance targets. These targets are 8-year, or approximately two-generation, geometric means of annual natural spawners.

9.9.2 Current Conditions in the Action Areas

Busby et al. (1996) described trends in abundance up to the mid-1990s and environmental factors that affected this ESU. They also noted that past and present hatchery practices present the major threat to the ESU's genetic integrity. The BRT (2003) noted that recent returns of hatchery and naturally produced steelhead to the upper Columbia River have increased, but hatchery-origin fish predominate. The BRT (2003) estimated that the natural component of the run over Priest Rapids Dam increased from an average of 1,040 fish from 1992 to 1996 to an average of 2,200 fish from 1997 to 2001. Upper Columbia River steelhead peaked at 29,675 fish in 2001, declined 46.4 percent to 15,898 fish in 2002, and increased 7.9 percent increase to 17,161 fish in 2003. The count of wild steelhead also peaked in 2001 and declined in 2002 (see Table 9-16). Hatchery production is substantial in this ESU, with releases of hatchery-

Table 9-16. Number of adult steelhead counted at Priest Rapids Dam from 1981 to 2003 (FPC 2004).

Year	Steelhead	Wild [1]	Year	Steelhead	Wild
1981	8,984		1993	5,493	890
1982	11,144		1994	6,705	855
1983	31,796		1995	4,357	993
1984	26,076		1996	8,376	843
1985	34,701		1997	8,948	785
1986	22,382	2,342	1998	5,837	928
1987	14,265	4,058	1999	8,276	1,374
1988	10,208	2,670	2000	11,273	2,341
1989	10,667	2,685	2001	29,675	5,670
1990	7,830	1,585	2002	15,898	3,014
1991	14,027	2,799	2003 [2]	17,161	
1992	13,733	1,618			

1 NOAA Fisheries 2003.
2 Columbia River DART 2004.

origin juveniles occurring in the Wenatchee, Methow, and Okanogan Rivers. The Entiat River has been designated a natural “reference” drainage with no hatchery stocking.

The 1995 to 2002 8-year geometric mean for this ESU as a whole is estimated to be 1,551 wild adults as counted at Priest Rapids Dam, less than the 5,500 annual natural spawners listed as Lohn’s (2002) interim abundance target.

9.10 Middle Columbia River Steelhead

9.10.1 Background

NOAA Fisheries listed the Middle Columbia River steelhead ESU as threatened on March 25, 1999 (see Table 9-1 on page 246). This ESU includes all naturally spawned steelhead populations in streams in the Columbia River basin upstream from (but not including) the Wind and Hood Rivers to (and including) the Yakima River. The ESU excludes the Snake River basin. Resident populations of *O. mykiss* below impassible barriers (natural and manmade) that co-occur with anadromous populations are included in this ESU. Figure 9-11 shows the geographic range of this ESU.

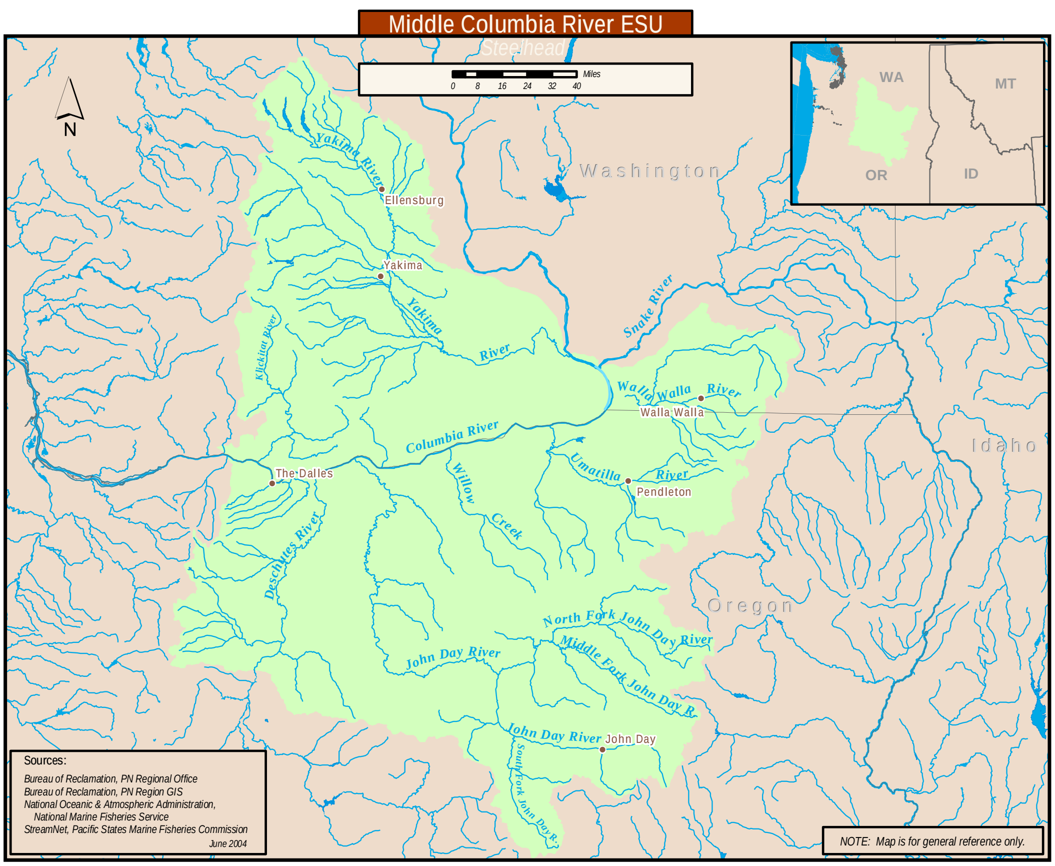

Figure 9-11. Geographic range of the Middle Columbia River steelhead ESU.

The ICBTRT (2003) identified 16 populations in 4 major groupings and one unaffiliated area in this ESU, largely based on basin topography and habitat similarity, including Cascades Eastern Slope Tributaries, John Day River, Walla Walla and Umatilla Rivers, Yakima River, and Rock Creek (unaffiliated area). Seven artificial propagation programs are considered to be part of this ESU. Major river basins containing spawning and rearing habitat for this ESU comprise approximately 26,739 square miles in Oregon and Washington. This ESU's geographical range for spawning, incubation, and rearing is outside the action areas; juveniles enter the action areas in the Columbia River when they exit their tributary river, and adults leave the action areas when they enter their tributary river.

Most of the steelhead in this ESU are summer-run fish, except for a winter-run component returning to the Klickitat River and Fifteen Mile Creek. This ESU is characterized by a balance between 1- and 2-year-old smolt outmigrants, with adults returning after one or two years at sea. Busby et al. (1996) and Section 4.1.8 of the NOAA Fisheries 2000 biological opinion on the FCRPS provide additional information on life history, habitat requirements, and factors for decline. The BRT found moderate risk in each of the four VSP categories with the greatest risk attributed to abundance (69 FR 33101).

Lohn (2002) lists 35,100 returning adults as interim abundance targets for the numerous populations within this ESU. The interim targets are 8-year, or approximately two-generation, geometric means of annual natural spawners.

9.10.2 Current Conditions in the Action Areas

Busby et al. (1996) estimate the abundance of the Middle Columbia River steelhead ESU as the number of adult steelhead counted at Bonneville Dam minus the sum of the counts at Ice Harbor and Priest Rapids Dams. The western geographic boundary of this ESU is just downriver from The Dalles Dam and excludes the Wind and Hood Rivers; using Bonneville Dam counts to enumerate the abundance of this steelhead ESU would include adult steelhead in these two rivers. Table 9-17 shows the estimated abundance of this ESU for 1977 to 2003. Abundance for combined hatchery and wild adults ranged from a low of 72,788 fish in 1980 with substantial fluctuation to a high of 348,069 fish in 2001. The 2001 count was the highest in the 27-year time series. As seen in counts of other ESUs discussed here, 2001 had the highest counts, followed by declines in 2002 and 2003. Since wild adult counts were not available, Reclamation did not attempt to estimate the 8-year geometric mean.

The BRT (2003) noted that generally, the recent 5-year (geometric mean) abundance for naturally produced steelhead in this ESU was higher than that reported in the 1999 status review. Recent returns to the Yakima River, the Deschutes River, and parts of the John Day River were up substantially compared to those from 1992 to 1997.

Table 9-17. Estimate of abundance of Middle Columbia River steelhead ESU from 1977 to 2003 (FPC 2004).

Year	Estimated Count [1]	Year	Estimated Count [1]
1977	128,805	1991	136,743
1978	73,446	1992	140,627
1979	84,809	1993	109,786
1980	72,788	1994	103,569
1981	110,845	1995	106,065
1982	73,091	1996	96,135
1983	97,903	1997	145,607
1984	195,828	1998	101,613
1985	178,591	1999	117,945
1986	210,092	2000	143,746
1987	211,721	2001	348,069
1988	168,550	2002	263,132
1989	126,034	2003	155,415
1990	120,423		

1 Based on Bonneville Dam counts minus the sum of counts at Ice Harbor and Priest Rapids Dams.

Steelhead are iteroparous spawners, unlike Pacific salmon that die after spawning. Generally speaking, though, few kelts (spawned-out adult steelhead, primarily female) survive the downstream journey to the ocean to mature again and return to spawn again. In the Yakima River basin, an effort is underway to recondition kelts by holding them in a hatchery and feeding them to improve survival rates (Hatch et al. 2003). Success of the program varies, but numerous adults have been reconditioned and released back into the Yakima River. This effort increases the number and genetic diversity of steelhead spawners in the river.

9.11 Lower Columbia River Steelhead

9.11.1 Background

NOAA Fisheries listed the Lower Columbia River steelhead ESU as threatened on March 19, 1998 (see Table 9-1 on page 246). This ESU includes all naturally spawned steelhead populations (and their progeny) in streams and tributaries to the Columbia River upstream from (and including) the Cowlitz and Wind Rivers to (and including) the Willamette and Hood Rivers. The ESU excludes steelhead in the upper Willamette River basin above Willamette Falls and steelhead from the Little and Big White Salmon Rivers in Washington. Resident populations of *O. mykiss* below

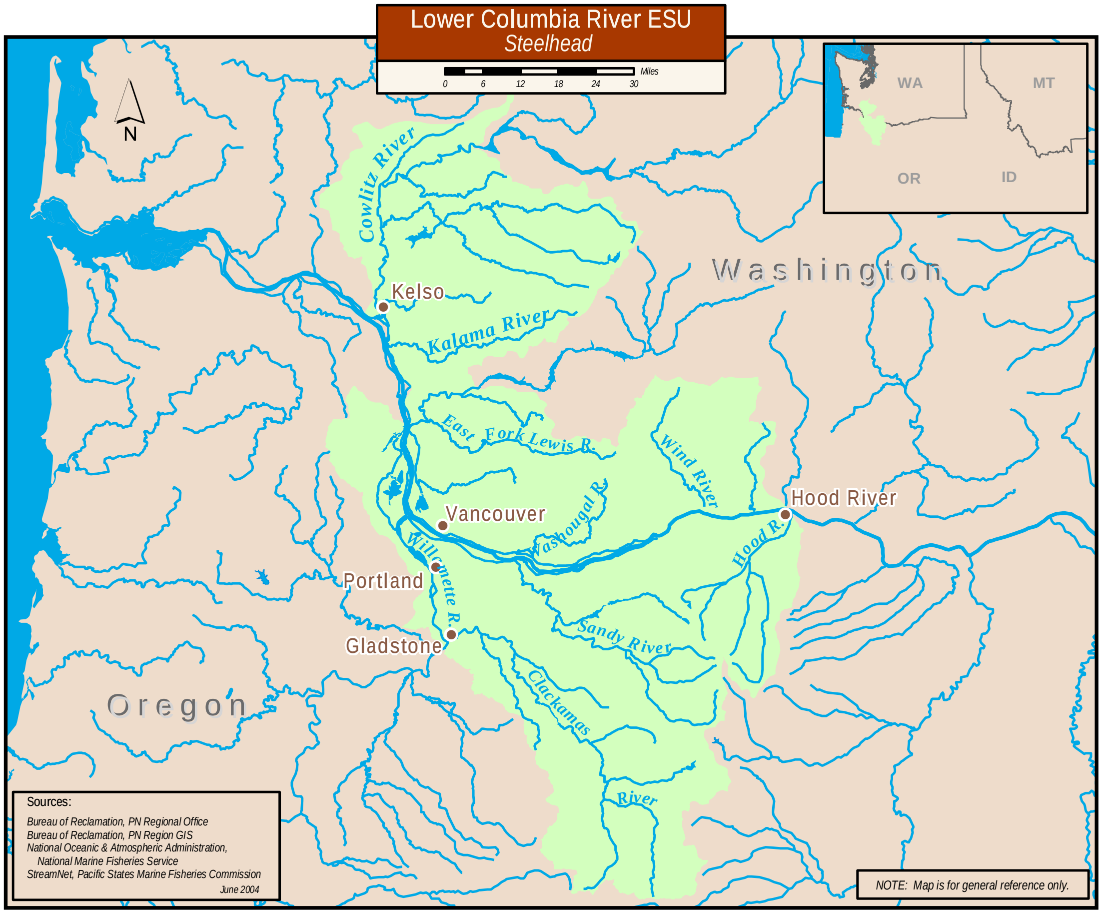

Figure 9-12. Geographic range of the Lower Columbia River steelhead ESU.

impassible barriers (natural and manmade) that co-occur with anadromous populations are included in the ESU. Figure 9-12 shows the geographic range of this ESU.

Major river basins containing spawning and rearing habitat for this ESU comprise approximately 5,017 square miles in Oregon and Washington. Ten artificial propagation programs are considered to be part of this ESU (69 FR 33101). Busby et al. (1996) and Section 4.1.10 of the NOAA Fisheries 2000 biological opinion on the FCRPS provide additional information on life history, habitat requirements, and factors for decline. The BRT found moderate risks in each of the four VSP categories (69 FR 33101).

The BRT (2003) reported that this ESU may have historically consisted of 17 winter-run populations and 6 summer-run populations, further partitioned into Cascade and Gorge ecological zones.

9.11.2 Current Conditions in the Action Areas

Busby et al. (1996) estimated abundance of adult steelhead in the Lower Columbia River ESU in the early 1980s at about 150,000 winter steelhead and 80,000 summer steelhead, of which about 75 percent of the total run was of hatchery origin. The BRT (2003) noted that it could not identify any single population in this ESU that is self-sustaining, and evidence suggested that most of the populations are in decline and in relatively low abundance, with a substantial fraction of hatchery-origin spawners. The recent abundance is estimated to be 4,050 fish, with an Ecosystem Diagnosis and Treatment (EDT) modeled historical abundance of 25,537 fish (BRT 2003). Some populations have been extirpated. Of the remaining winter-run populations, abundance ranges from 75 fish in the East Fork Lewis River to 735 fish in the Sandy River, with a fairly wide range of returns among the several populations for the varying periods of record (see Table B.2.4.1 in BRT 2003).

9.12 Upper Willamette River Steelhead

9.12.1 Background

NOAA Fisheries listed the Upper Willamette River steelhead ESU as threatened on March 25, 1999 (see Table 9-1 on page 246). This ESU includes all naturally spawned winter-run steelhead populations in the Willamette River and its tributaries upstream from Willamette Falls to (and including) the Calapooia River. Steelhead in this ESU must pass Willamette Falls. Resident populations of *O. mykiss* below impassible barriers (natural and manmade) that co-occur with anadromous populations are included in this ESU. Figure 9-13 on page 294 shows the geographic range of this ESU.

There is no artificial propagation of this ESU (69 FR 33101). Major river basins containing spawning and rearing habitat for this ESU comprise approximately 4,872 square miles in Oregon. Busby et al. (1996) and Section 4.1.9 of the NOAA Fisheries 2000 biological opinion on the FCRPS contain additional information on life history, habitat requirements, and factors for decline. The BRT found moderate risks for each of the four VSP categories (69 FR 33101).

The BRT (2003) designated four demographically independent populations for this ESU: Molalla River, South Santiam River, North Santiam River, and the Calapooia River. There was some question about the existence of an historical population in westside tributaries.

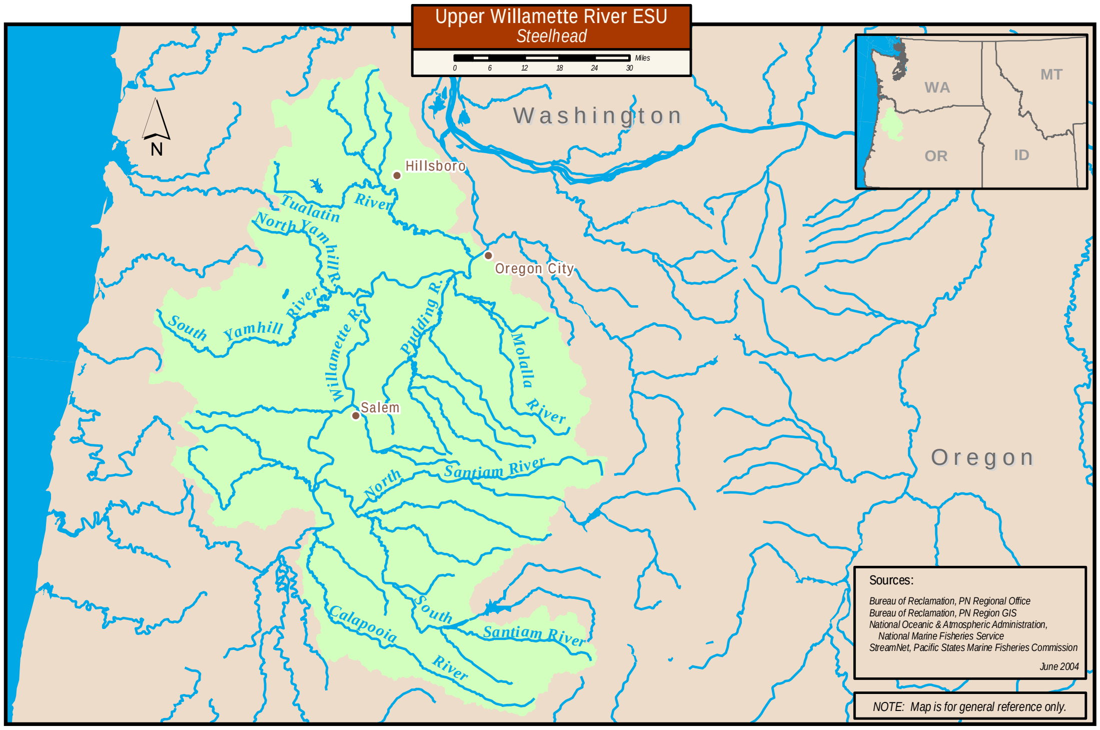

Figure 9-13. Geographic range of the Upper Willamette River steelhead ESU.

There are two groups of winter steelhead in the upper Willamette River. A "late-run" winter steelhead exhibits the historical phenotype adapted to passing the seasonal barrier at Willamette Falls; "early-run" winter steelhead were derived from steelhead from outside the Willamette River basin and are considered non-native. They apparently require a ladder to pass Willamette Falls. The ESU's geographical range for spawning, incubation, and rearing is outside the action areas; juveniles enter the action areas in the Columbia River when they exit the Willamette River, and adults leave the action areas when they enter the Willamette River. This ESU uses the lower Columbia River as a migration corridor and does not cross any Columbia River dam during its migration.

The BRT (2003) noted that expert opinion indicated that resident *O. mykiss* are rare in this ESU.

9.12.2 Current Conditions in the Action Areas

Busby et al. (1996) described trends in abundance up to the mid-1990s and environmental factors that affected this late-run winter steelhead ESU (the adults that migrate upstream in March and April). The average run size of the adult late-run winter steelhead in the Willamette River, as counted at Willamette Falls, was about 5,819 fish, ranging from 2,735 to 12,208 fish for the period 1971 to 2002

(BRT 2003), although the ODFW (2004) reported 15,793 winter-run steelhead counted at Willamette Falls in 2002 (see Table 9-18).

The BRT (2003) reported that it could not conclusively identify a single population in the Upper Willamette River steelhead ESU that was self-sustaining. All the populations are small, with a recent mean abundance less than 6,000 returning adults. However, as reported for most other salmon and steelhead ESUs in the Columbia and Snake River basins, there was a notable increase in adult returns in 2001, most likely resulting from improved ocean conditions (BRT 2003). Counts at Willamette Falls show an approximately 26 percent increase in total steelhead numbers from 2001 to 2002.

Table 9-18. Willamette Falls steelhead counts from 2001 to 2002 (ODFW 2004).

Year	Summer-run	Winter-run
2001	26,418	13,172
2002	34,291	15,793

9.13 Lower Columbia River Chum Salmon

9.13.1 Background

NOAA Fisheries listed the Columbia River chum salmon as threatened on March 25, 1999 (see Table 9-1 on page 246). This ESU includes all naturally spawned chum salmon in the Columbia River and its tributaries in Washington and Oregon (see Figure 9-14 on page 296). Three artificial propagation programs are considered to be part of this ESU (69 FR 33101).

Chum salmon generally spawn lower in major river systems than most other species of salmon. Lower Columbia River chum salmon begin spawning around November. By the end of March, most eggs have hatched and the fry emerge from the gravel. Shortly after emergence, the juvenile fish begin their downstream migration towards the estuary where they rear prior to entering the ocean. The WLCTRT (2003) partitioned the lower Columbia River chum into Coastal, Cascade, and Gorge ecological zones, with several populations in each. The Gorge was further divided into an Upper Gorge tributaries and Lower Gorge tributaries. The Lower Gorge subpopulations are those spawning downstream from Bonneville Dam. Johnson et al. (1997) and Salo (1991) contain additional life history information for Columbia River chum salmon. The BRT (2003) found high risks for each of the four VSP categories, particularly spatial structure and diversity.

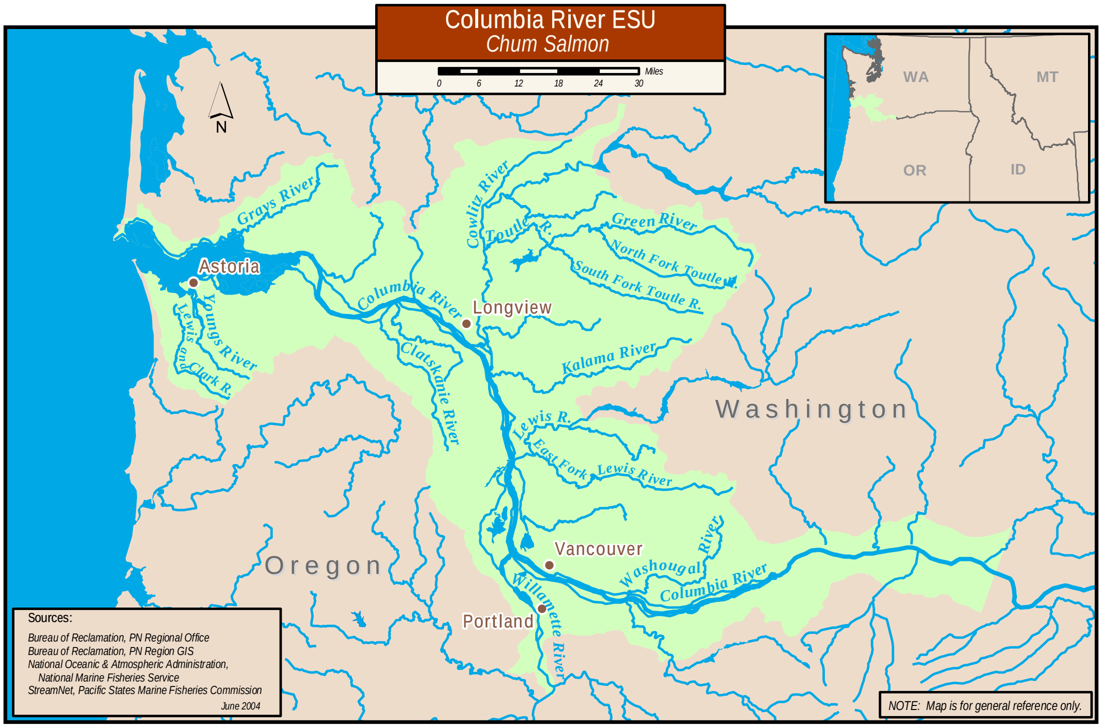

Figure 9-14. Geographic range of the Columbia River chum salmon ESU.

9.13.2 Current Conditions in the Action Areas

Lower Columbia River chum salmon are generally found downstream from Bonneville Dam. The BRT (2003) noted that the overall abundance for this ESU is low, and this ESU showed low productivity for many years. The BRT (2003) also reported that Lower Gorge populations were in relatively low abundance up to 2000, but that the population showed an increase by 2002. The BRT (2003) tentatively concluded that about 88 percent of the historical populations are extirpated or nearly so. The extant populations include the Lower Gorge and Grays River.

Spawning occurs in numerous tributaries in the lower Columbia River and in the mainstem in the area around Ives Island (RM 143) about 3 miles downstream from Bonneville Dam; the Multnomah Creek area (RM 136); and the Interstate 205 area (RM 113). Table 9-19 and Figure 9-15 show the number of chum salmon spawners at Ives Island from 1998 to 2003. Spawner numbers peaked in 2002, although data for 2003 are incomplete. Table 9-19 also shows number of redds counted in 2003. Figure 9-16, Figure 9-17, and Figure 9-18 show spawning locations documented in Hamilton and Hardy Creeks near the Ives Island area, near Multnomah Falls, and near the Interstate 205 bridge, respectively.

Table 9-19. Cumulative number of chum salmon spawners, 1998 to 2003, at Ives Island (about 3 miles downstream from Bonneville Dam), and number of redds counted in 2003 (FPC 2004).

1998		1999		2000		2001		2002		2003		
Date	No.	Date	No.	Date	No.	Date	No.	Date	No.	Date	No.	Redds
11/6	13	11/2	3	11/6	18	11/5	10	11/5	5	11/4	6	1
11/9	48	11/5	7	11/8	42	11/9	11	11/8	65	11/6	39	4
11/16	158	11/9	19	11/9	84	11/12	65	11/12	248	11/10	205	41
11/23	191	11/12	26	11/13	136	11/16	104	11/15	544	11/14	503	114
11/30	191	11/16	46	11/14	136	11/19	196	11/19	993	11/18	607	62
12/7	266	11/19	55	11/17	283	11/26	435	11/22	1,840	11/21	756	169
12/14	274	11/23	95	11/20	423	11/30	665	11/26	2,997	11/25	1,037	164
12/27	274	11/30	113	11/21	423	12/3	766	12/3	3,860	12/2	1,164	216
		12/3	131	11/27	479	12/6	873	12/6	4,875	12/5	1,335	262
		12/7	137	12/1	694	12/10	991	12/10	5,719	12/12	1,381	187
		12/10	140	12/4	883	12/13	1071	12/13	6,358	12/16	1,396	24
		12/14	147	12/8	996	12/17	1075	12/17	6,540			
		12/17	147	12/12	1057	12/20	1093	12/20	6,653			
		12/27	147	12/15	1067	12/27	1093	12/23	6,690			
				12/18	1114			12/30	6,694			
				12/27	1115							
										Total Redds		1,244

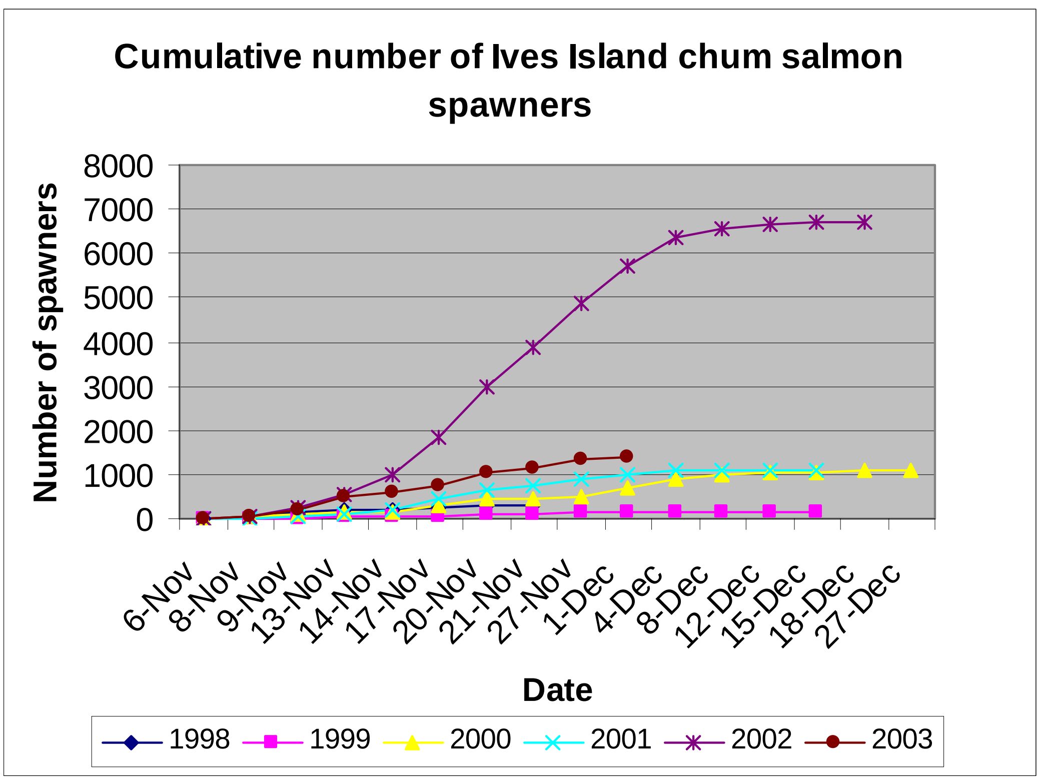

Figure 9-15. Cumulative number of Ives Island chum salmon spawners from 1998 to 2003 (FPC 2004).

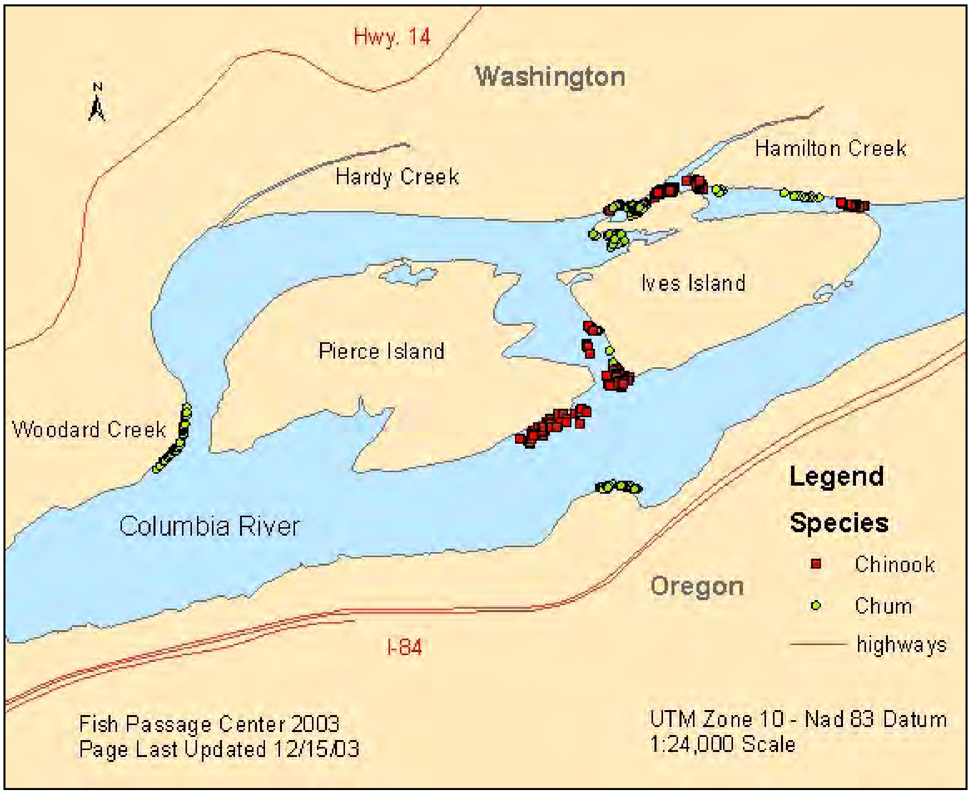

Figure 9-16. Map showing 2003 salmon redd locations in the Ives Island area (FPC 2004).

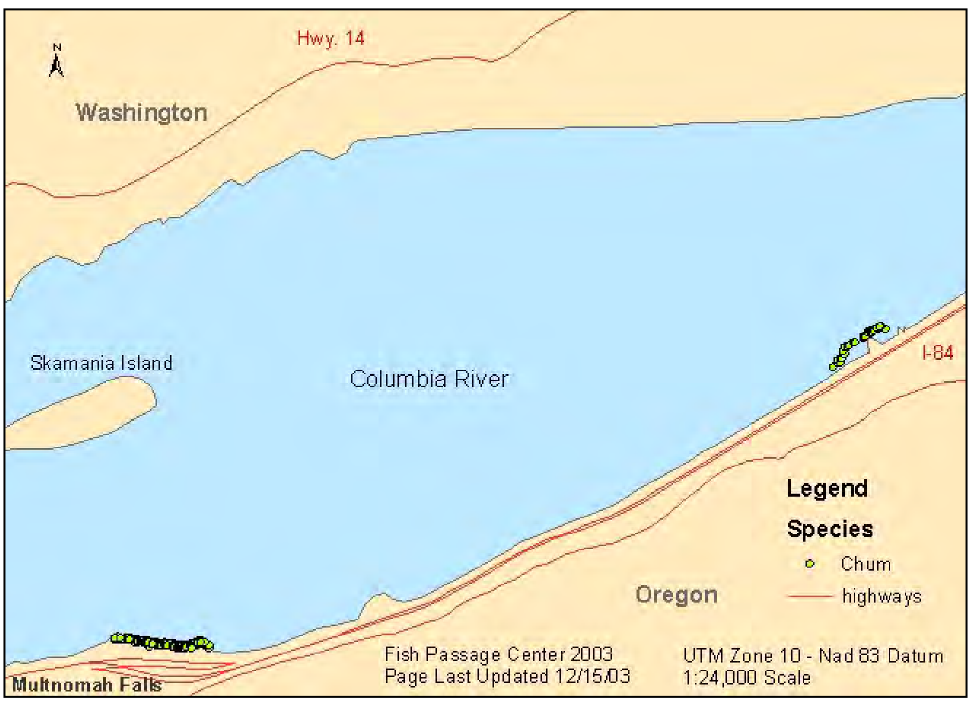

Figure 9-17. Map showing 2003 salmon redd locations in the Multnomah Falls area (FPC 2004).

Figure 9-18. Map showing 2003 salmon redd locations in the Interstate 205 area (FPC 2004).

From 1992 to 2003, some chum salmon were counted at Bonneville Dam (see Table 9-20 on page 300). It is not known if these fish spawn successfully in tributaries to the Bonneville pool.

Water management to maintain chum flows (125,000 cfs or a tailwater elevation of 11.5 feet) is for spawning areas immediately downstream from Bonneville Dam. Downstream migrating juvenile chum salmon from mainstem and tributary spawning sites all eventually use the mainstem Columbia River as a migration corridor to the estuary and ocean.

In 2000, spawning occurred at Ives Island, Hamilton Creek, and Hardy Creek, with about 160 documented redds. Additional redds were documented farther downstream near the Interstate 205 bridge. In 2003, 1,244 redds were counted at the Ives Island location (see Table 9-19 on page 297). Overall, throughout the lower Columbia River system, the number of chum salmon spawning in 2003 was greater compared to 2002 for all locations except Ives Island (FPC 2004). Table 9-19 shows temporal distribution of chum salmon spawners from 1998 to 2003 at Ives Island (FPC 2004). Chum salmon hatch in the spring and relatively rapidly begin a downstream migration. Table 9-21 on page 300 shows the estimated peak emergence dates and peak catch dates for the period from 1999 to 2002.

Table 9-20. Number of chum salmon counted at Bonneville Dam from 1992 to 2003 (FPC 2004).

Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Count	37	11	22	26	25	15	0	43	38	58	72	326

Table 9-21. Peak emergence and peak catch dates for juvenile chum salmon downstream from Bonneville Dam from 1999 to 2003 (FPC 2004).

Date	1999	2000	2001	2002	2003
Estimated Peak Emergence	April 4	March 13	March 26	Feb 25	March 12
Peak Catch	April 1	March 21	April 17	April 9	

Although the BRT (2003) does acknowledge that the actual reason for the increase in chum salmon numbers is unknown, they presented several possible reasons for the recent increase, including improved ocean conditions, mainstem flow agreements that presumably helped the Lower Gorge population, favorable freshwater conditions, increased sampling effort, and a Grays and Chinook river hatchery program.

9.14 Lower Columbia River Coho Salmon

This ESU is a candidate species proposed for listing under the ESA (69 FR 33101). Outmigrating juvenile Lower Columbia River Chinook salmon enter the action areas when they exit various lower Columbia River tributaries and enter the Mid Columbia – Hood (17070105) hydrologic unit code (HUC). The BRT (NOAA Fisheries 1991) was unable to identify whether an historical coho salmon ESU existed in the lower Columbia River. Some information in the mid-1990s indicated that it might be part of a larger ESU, and it was combined with the Southwest Washington/Lower Columbia River ESU. In 2001 the BRT (NOAA Fisheries 2001) concluded that the Lower Columbia River coho salmon is a separate ESU from the Southwest Washington coho salmon ESU, based on tagging studies, differing marine distributions, and genetics. This ESU is altered from historical conditions and natural production is limited to two Oregon populations in the Sandy and Clackamas Rivers (69 FR 33101). In addition to the two naturally spawning populations, there are 21 artificial propagation programs, the progeny of which are considered part of the ESU, because the BRT concluded that the hatchery-produced fish contain a significant portion of the historical diversity of Lower Columbia River coho salmon. The BRT found extremely high risks for each of the four VSP categories (69 FR 33101).

9.15 Effects Analysis

This section describes potential effects of Reclamation's proposed actions on ESA-listed salmon and steelhead ESUs in the action areas downstream from Hells Canyon

Dam. The area of analysis for each ESU includes those river reaches and reservoirs where the ESU's occupied geographic area overlaps the action areas of Reclamation's proposed actions. The effects discussion considers the combined hydrologic effects of all 11 proposed actions.

The ability to ascertain or determine effects of Reclamation's proposed actions on listed ESUs is complicated by numerous factors, including the presence and operation of Idaho Power's Hells Canyon Complex between Reclamation's projects and the action areas for listed ESUs; and the effects of Hells Canyon Complex operations on lower Snake River flow, water quality, and other environmental conditions. Since the 12 listed ESUs and one ESU proposed for listing enter or use the action areas at various locations downstream from Hells Canyon Dam, it is reasonable to expect that any measurable or tangible effect from Reclamation's proposed actions on listed ESUs would be most pronounced in the Snake River just downstream from Hells Canyon Dam and diminish with distance downstream from Hells Canyon Dam due to tributary inflow and an array of other environmental and anthropogenic factors.

The listed salmonid ESUs in closest proximity to Reclamation facilities in the action areas include predominately the Snake River fall Chinook salmon, and to a lesser extent, a few populations of Snake River spring/summer Chinook salmon and Snake River steelhead. Most populations of Snake River spring/summer Chinook salmon and Snake River steelhead that use the Snake River as a migration corridor exit the action areas when they enter the Salmon River, 58.8 miles downstream from Hells Canyon Dam. From the mouth of the Salmon River downstream, increasing numbers of spring/summer Chinook salmon and steelhead use the action areas, as do Snake River sockeye salmon that turn off into the Salmon River. Downstream from the mouth of the Salmon River, effects of flow and water quality stemming from Reclamation's proposed actions are attenuated by the flow of the Salmon River and other tributaries, which seasonally contribute substantial inflows.

9.15.1 Streamflows and Flow Augmentation

As described in Chapter 3, the proposed actions will continue to affect the quantity and timing of flows in the Snake and Columbia Rivers, resulting in conditions and effects similar to current conditions as presented in Table 3-7 and described in Section 3.3.1. However, Reclamation's hydrologic influence in the Columbia River is much less significant, considering that the annual flow of the Snake River averages about 14 million acre-feet per year into Brownlee Reservoir and about 37 million acre-feet below Lower Granite Dam. By comparison, the annual average flow of the Columbia River is 135 million acre-feet at The Dalles, Oregon, and 198 million at the river's mouth (see Section 3.1). The proposed actions effects on current hydrologic conditions, as described in Table 3-7 for current operations, generally will continue into the foreseeable future, except as modified through the provision of additional salmon flow augmentation water through rental or acquisition of natural flow rights (up to 487,000 acre-feet compared to 427,000 acre-feet currently) and the improved reliability of providing this water.

Flow augmentation (as described in Appendix B) is primarily for juvenile salmon migration between April and August. However, upstream migrating adults of several ESUs may be in the action areas during the period of flow augmentation. Reclamation deliveries flow augmentation water to Brownlee Reservoir. Upon receipt of Reclamation water, it is assumed that the water is passed through the Hells Canyon Complex without delay.

Table 9-22, Table 9-23, and Table 9-24 compare modeled monthly and some combined monthly inflows to Brownlee Reservoir for the current operations and the proposed actions at the 10, 50, and 90 percent exceedance levels (Appendix E provides supporting information for the model). The modeled monthly and combined monthly 10, 50, and 90 percent exceedance levels roughly approximate wet, average, and dry water years, respectively. The model predicts greater inflows to Brownlee Reservoir under the proposed actions than the current operations scenario during the flow augmentation and smolt outmigration period. In all three comparisons, the differences between the current operations and the proposed actions, by month, are a modeled compilation for the period from 1928 to 2000 and do not reflect conditions or what would actually occur in any one particular water year.

The model predicts monthly and combined monthly inflows to Brownlee Reservoir will be slightly greater under the proposed actions than under current operations for the April-to-August flow augmentation period (see Table 9-22, Table 9-23, and Table 9-24); increased inflows are greatest for the 90 percent exceedance level in June and July. At the 50 percent exceedance level for the month of April (the 50 percent exceedance is the median for the period of record), the model predicts inflows under the proposed actions will be slightly less than under current operations (see Table 9-23). However, Table 9-25 compares average modeled monthly inflows to Brownlee Reservoir for the current operations and proposed actions by month. Average modeled monthly inflows for the proposed actions are greater than under current operations for the entire April-to-August flow augmentation period.

The model predicts the proposed actions will provide greater inflows to Brownlee Reservoir during the April-through-August flow augmentation period. Assuming that modeled inflows pass through the Hells Canyon Complex on a unit volume basis and without delay, the proposed actions should benefit migrating juvenile fish and their habitat in the Snake River downstream from Hells Canyon Dam. Table 3-4 and Table 3-5 show how flows at Lower Granite and McNary Dams will change from current conditions with implementation of the proposed actions. In general, flows are slightly higher during the flow augmentation period (April through August).

Table 9-22. Ten percent exceedance in modeled monthly and combined monthly inflows to Brownlee Reservoir using water supply data from the 1928-to-2000 period of record (see Appendix E).

Month	Current Operations (cfs)	Proposed Actions (cfs)	Difference [1] (cfs)	Percent Difference
October	16,915	16,828	-87	-0.51
November	22,181	21,789	-392	-1.77
December	21,732	21,732	0	0.00
January	29,558	29,365	-193	-0.65
February	33,683	33,320	-363	-1.08
March	41,662	41,214	-448	-1.08
April	52,303	52,504	201	0.38
May	51,729	51,924	195	0.38
June	42,144	42,381	237	0.56
July	18,824	19,167	343	1.82
August	13,078	13,430	352	2.69
September	14,423	14,423	0	0.00
June-July	36,361	36,563	202	0.56
July-August	16,258	16,834	576	3.54
June-August	32,860	33,062	202	0.61
April-August	43,893	44,224	331	0.75
Oct-Sept	35,388	35,555	167	0.47

1 Proposed actions inflow minus current operations inflow.

Table 9-23. Fifty percent exceedance in modeled monthly and combined monthly inflows to Brownlee Reservoir using water supply data from the 1928-to-2000 period of record (see Appendix E).

Month	Current Operations (cfs)	Proposed Actions (cfs)	Difference [1] (cfs)	Percent Difference
October	13,752	13,752	0	0.00
November	15,579	15,579	0	0.00
December	14,980	14,980	0	0.00
January	17,258	17,260	2	0.01
February	19,046	18,630	-416	-2.18
March	20,017	19,942	-75	-0.37
April	28,163	27,822	-341	-1.21
May	27,424	27,619	195	0.71
June	23,847	24,049	202	0.85
July	12,154	12,542	388	3.19
August	11,286	11,537	251	2.22
September	12,120	11,878	-242	-2.00
June-July	15,005	15,414	409	2.73
July-August	11,478	11,869	391	3.40
June-August	12,379	12,754	375	3.03
April-August	16,640	16,850	210	1.26
Oct-Sept	15,206	15,287	81	0.53

1 Proposed actions inflow minus current operations inflow.

Table 9-24. Ninety percent exceedance in modeled monthly and combined monthly inflows to Brownlee Reservoir using water supply data from the 1928-to-2000 period of record (see Appendix E).

Month	Current Operations (cfs)	Proposed Actions (cfs)	Difference [1] (cfs)	Percent Difference
October	11,144	11,091	-53	-0.48
November	12,291	12,291	0	0.00
December	11,418	11,418	0	0.00
January	11,304	11,261	-43	-0.38
February	11,339	11,326	-13	-0.11
March	12,073	12,073	0	0.00
April	13,242	13,443	201	1.52
May	12,773	12,968	195	1.53
June	10,975	11,664	689	6.28
July	7,820	8,928	1,108	14.17
August	7,085	7,351	266	3.75
September	9,275	9,231	-44	-0.47
June-July	9,109	9,735	626	6.87
July-August	7,425	8,070	645	8.69
June-August	8,752	8,843	91	1.04
April-August	9,360	10,001	641	6.85
Oct-Sept	10,617	10,766	149	1.40

1 Proposed actions inflow minus current operations inflow.

Table 9-25. Average modeled monthly and combined monthly inflows to Brownlee Reservoir using water supply data from the 1928-to-2000 period of record (see Appendix E).

Month	Current Operations (cfs)	Proposed Actions (cfs)	Difference [1] (cfs)	Percent Difference
October	14,106	14,097	-9	-0.06
November	16,304	16,230	-74	-0.46
December	15,886	15,868	-18	-0.12
January	19,383	19,333	-51	-0.26
February	20,132	20,072	-60	-0.30
March	23,463	23,398	-65	-0.28
April	30,294	30,453	159	0.52
May	30,421	30,520	99	0.33
June	25,473	25,766	292	1.15
July	12,773	13,327	554	4.34
August	10,941	11,255	314	2.87
September	11,914	11,814	-100	-0.84
June-July	19,123	19,546	423	2.21
July-August	11,857	12,291	434	3.66
June-August	16,396	16,782	387	2.36
April-August	21,980	22,264	284	1.29
Oct-Sept	19,257	19,344	87	0.45

1 Proposed actions inflow minus current operations inflow.

Further, as Figure 3-4 shows, Reclamation's proposed actions are expected to result in improved reliability in providing at least 427,000 acre-feet in roughly three-fourths of the water years, and as much as 487,000 acre-feet in roughly one-half of the water years. This is an improvement from current operations, which would provide 427,000 acre-feet in about one-half of the water years.

Reclamation does not specifically release water from its upper Snake River projects to meet chum salmon flow objectives at Bonneville Dam during the November-to-March chum salmon spawning and incubation period. The principal source of chum salmon flows are from the upper Columbia River, including Reclamation's Lake Roosevelt.

9.15.2 Water Quality

The proposed actions will continue to affect to some degree the quality, quantity, and timing of water flowing in the Snake and Columbia Rivers. The proposed actions may have continuing effects on water quality in the mainstem Snake River and its major tributaries above Brownlee Reservoir, including the Boise, Payette, Weiser, Owyhee, Malheur, Burnt, and Powder Rivers. Primary effects are most likely related to suspended sediment, nutrients, and changes in the thermal regimes of the riverine and reservoir environments (USBR 2001).

Due to limited data, it is not possible to determine the extent to which Reclamation's future O&M actions in the upper Snake River basin have contributed or will contribute to water quality conditions in the Snake River downstream from the Hells Canyon Complex. The associated Reclamation facilities are located a substantial distance upstream from the Hells Canyon Complex, and reaches of both free-flowing river and impoundments occur between these facilities and the area of analysis for the 13 ESUs. For example, there are no data indicating how reservoir water temperatures and releases in the upper basin affect water temperatures downstream to or beyond the Hells Canyon Complex. It is unknown at this time how any shift in the temperature regime is transferred downstream.

Reclamation has initiated a comprehensive water temperature data collection program in the upper Snake River and major tributaries to provide better water temperature data. This effort, began in 2004, supports efforts to evaluate the origin of potential water temperature problems downstream from the Hells Canyon Complex. The temperature data collection activity will provide a continuous water temperature record at points upstream and downstream from major Reclamation storage reservoirs and blocks of irrigated land in the upper Snake River basin, as well as temperatures entering and leaving Idaho Power's Hells Canyon Complex. Data collection will continue through fiscal year 2006, with a project completion report by the end of fiscal year 2007 describing water temperature conditions in the upper Snake River and relationships to storage, irrigation, and hydropower facilities in the basin.

Water Temperature

The effects of Reclamation's future O&M actions in the upper Snake River basin on water temperature downstream from the Hells Canyon Complex are not well known and largely unquantifiable at this time. The types of temperature effects that may be occurring include seasonal warming or cooling, or delay in warming or cooling. It seems intuitive, however, that such effects will diminish in a downstream direction as other factors, such as additional diversions and storage projects, air temperature, tributary inflows, and return flows, influence water temperature in the action areas.

Currently, it is not possible to determine with certainty whether or how the existing water temperature regime in the action areas may be affected by the proposed actions. It seems reasonable to expect marginally cooler water temperatures in years when additional natural flows are available for flow augmentation due to shorter residence time in downstream reservoirs. Otherwise, the existing temperature regime in the action areas is expected to continue into the foreseeable future. It seems reasonable to conclude that the proposed actions will not be a major determinant of or contributor to future water temperature regime changes in the action areas.

Sediment

Reclamation's operations have most likely altered the size and quantity of sediment transported in the Snake River upstream from the Hells Canyon Complex (IDEQ and ODEQ 2001). The effect of Reclamation's future O&M actions on the sediment transport regime in the action areas downstream from the Hells Canyon Complex likely are small and will continue to be small, since Brownlee Reservoir and other reservoirs upstream trap sediment and process nutrients. It is anticipated that the existing sediment transport regime generally will continue into the foreseeable future. It seems reasonable to conclude that the proposed actions will not be a major determinant of or contributor to future sediment-related changes in the action areas.

Nutrients and Dissolved Oxygen

Brownlee Reservoir traps sediment, nutrients, pesticides, and mercury that would otherwise move freely downstream (Myers 1997; Myers and Pierce 1999; IDEQ and ODEQ 2001). Biological processes within Brownlee Reservoir also reduce nutrient loads (primarily phosphorus) downstream from the Hells Canyon Complex by processing these nutrients within the reservoir. Higher Snake River flows entering Brownlee Reservoir as a result of either flow augmentation or natural conditions reduce water residence times to some extent, which has been shown to reduce substantially the size of the anoxic area in the reservoir that occurs seasonally (Nürnberg 2001).

Dissolved oxygen levels below the criterion are most likely a secondary water quality condition attributable to excessive algal production associated with high nutrient levels in the Hells Canyon Complex reservoirs, and they occur during periods of lower flow and higher water temperatures. The results of preliminary studies of dissolved oxygen from releases from the Hells Canyon Complex are under review. An Idaho Power (2000) study suggests the problems may not extend as far downstream as originally reported. However, no conclusions have been reached regarding the nature and extent of problems or the viability of potential solutions.

It seems reasonable to expect, in years when additional natural flows are available, marginally improved dissolved oxygen levels due to marginally cooler water temperature and higher total flows through Hells Canyon Complex reservoirs and downstream areas.

Total Dissolved Gas

Reclamation typically stores water during the winter and spring when flood events in excess of generation capacity are most likely to occur at downstream hydroelectric projects. In effect, these operations serve to reduce the quantity of water spilled (and the resultant generation of supersaturated levels of TDG) at the Hells Canyon Complex (Myers et al. 1999) and FCRPS dams (EPA et al. 2000). Operations are planned to avoid voluntary spilling as much as possible.

It seems reasonable to conclude that the proposed actions will not otherwise be a major determinant of or contributor to future TDG changes in the action areas.

Mercury

Elevated concentrations of mercury in the Snake River below the Hells Canyon Complex are believed to be a result of historical gold mining and milling operations, particularly in the Jordan Creek area of the Owyhee River basin upstream from Owyhee Reservoir. Storage of water and sediment in Owyhee Reservoir may inhibit downstream transport of mercury from past mining operations, and thereby result in some reduction of mercury loads available for bioaccumulation in the river system downstream from the Hells Canyon Complex (USBR 2001; IDEQ and ODEQ 2001). Thus, Reclamation's proposed actions should continue to reduce the downstream transport of mercury within the action areas.

It seems reasonable to conclude that the proposed actions will not otherwise be a major determinant of or contributor to future changes in mercury-related parameters in the action areas.

9.15.3 Cumulative Effects

Cumulative effects include the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the action areas. Future Federal actions that are unrelated to the proposed actions are not considered in this section because they require separate consultation.

A large number of activities occur in the action areas, such as agriculture, aquaculture, sewage treatment, construction, rural and urban development, degradation of waterways and springs, and contaminant spills. These activities will continue to occur into the future, and their effects constitute cumulative effects. The impacts of these developmental activities are unknown at this time.

Section 303 of the Clean Water Act requires states and tribes to periodically publish a priority list of impaired waters, currently every two years. For waters identified on this list, states and tribes must develop TMDLs, which are water quality improvement plans that establish allowable pollutant loads set at levels to achieve water quality standards. The following TMDLs address the Snake and Columbia Rivers:

- Snake River – Hells Canyon TMDLs – approved by the EPA September 2004 (covers the Snake River between where it intersects with the Oregon/Idaho border downstream to upstream of its confluence with the Salmon River).
- Lower Columbia River Total Dissolved Gas TMDL – approved by the EPA November 2002 (covers the mainstem Columbia River from its confluence with the Snake River downstream to its mouth at the Pacific Ocean).

Implementation includes numerous activities with the goal of reducing pollutant loads to the established TMDL limits. The implementation phase of these TMDLs should result in improved water quality for the Snake and Columbia Rivers within and downstream from these reaches.

9.15.4 Analysis of Effects on Listed ESUs in the Snake River

Project operations, especially the action of seasonally storing and releasing water for irrigation, municipal, and industrial use, have been ongoing in the upper Snake River basin for decades. Development of Reclamation's upper Snake River projects resulted in incremental alterations in the hydrograph and riverine dynamics and have resulted in or contributed to environmental effects and conditions that are now part of the existing environment. Providing up to 427,000 acre-feet of flow augmentation water has been part of operations since 1993 and has likewise resulted in or contributed to environmental effects and conditions that are part of the existing environment. Any measurable effects on listed ESUs from Reclamation's proposed actions would most likely be to those in closest proximity to Reclamation's upper

Snake River projects and would be expected to diminish progressively in a downstream direction due to substantial tributary inflows as well as the sheer volume of the Columbia River.

Snake River Spring/summer Chinook Salmon

The Imnaha River population of this listed ESU enters the Snake River at RM 191.7. Populations from the Salmon River and Grande Ronde River enter the Snake River at RM 188.2 and 168.7, respectively. Juvenile and adult spring/summer Chinook salmon from these populations use the Snake River primarily as a migration corridor from spawning and rearing areas to and from the ocean. The yearling smolts outmigrate early and relatively quickly compared to subyearling fall Chinook salmon that originate in the mainstem Snake River. The peak of the wild yearling Chinook salmon outmigration was early May in 2002 and 2003 (FPC 2004).

The BRT (2003) found moderately high risk for abundance and productivity and lower risk for spatial structure and genetic diversity, indicating that low numbers of this ESU are relatively widely distributed.

Adult returns as counted at Lower Granite Dam have increased recently, although the 8-year geometric mean of 9,255 wild fish is below Lohn's (2002) annual natural spawner interim abundance target of 41,900 fish.

Since juvenile outmigration occurs in April and peaks in early May, increased flow augmentation will benefit some of these fish and those later fish outmigrating through the end of June. Modeled 50 percent exceedance levels show a slight reduction of inflows to Brownlee Reservoir for April but an increase in modeled inflows for wetter and drier years (at the 10 and 90 percent exceedance levels, respectively). The proposed actions increase inflows to Brownlee Reservoir for other months. The adult upstream migration for the spring component of the ESU is considered completed at Lower Granite Dam by June 17, and the summer component of the ESU is considered completed on August 17, therefore flow augmentation may benefit some upstream migrating adults.

Critical Habitat

The April 30, 2002, consent decree did not vacate the critical habitat designation for this ESU. Section 9.2.2 describes the designated critical habitat for Snake River spring/summer Chinook salmon.

Section 3(5)(A)(i) of the ESA defines critical habitat as specific areas that possess those physical or biological features essential to the species' conservation. Essential features of Snake River spring/summer Chinook salmon spawning and rearing areas would not be affected by the proposed actions, since spawning and rearing occurs in tributaries. Essential features of juvenile and adult migration corridors described elsewhere are met since these fish are actively migrating in the spring.

Effects Conclusion

Based on a comparison of modeled flows, Reclamation's past O&M actions have altered Snake River streamflows into Brownlee Reservoir (see Table 3-7). These flow alterations have contributed to present environmental conditions within the action areas and are expected to continue into the future except as modified through the proposed actions, which would provide up to an additional 60,000 acre-feet of salmon flow augmentation annually and would improve reliability. Continued flow alterations attributable to the proposed actions may continue to adversely affect migrating spring/summer Chinook salmon and designated critical habitat in the lower Snake River.

However, the proposed actions generally will result in somewhat improved flows and related conditions in the Snake River when compared to present conditions. The proposed actions will improve migration conditions for spring/summer Chinook salmon below Hells Canyon Dam during wetter and drier water years and during May through August of average water years. The only exception involves a marginal reduction in modeled April flows at the 50 percent exceedance level, which may result in minor adverse effects when compared to current conditions for early outmigration of spring/summer Chinook salmon smolts.

In its 2001 biological opinion on continued operation of Reclamation's upper Snake River projects, NOAA Fisheries found that Reclamation's 2001 proposed action would not jeopardize the continued existence of Snake River spring/summer Chinook salmon or destroy or adversely modify their designated critical habitat. When compared to the 2001 proposed action, Reclamation's proposed actions described herein generally will result in additional flow benefits to Snake River spring/summer Chinook salmon and its designated critical habitat.

Snake River Fall Chinook Salmon

The Snake River fall Chinook salmon ESU occurs farther upstream in the Snake River than the other ESUs. Fall Chinook salmon use the Snake River up to Hells Canyon Dam for spawning, rearing, and migrating. Almost all fish in this ESU use the action areas exclusively; some few exceptions are those fish that spawn in the several larger tributaries of the Snake River downstream from Hells Canyon Dam.

Many of the hydrologic and environmental conditions that occur in the Snake River immediately downstream from Hells Canyon Dam result from Idaho Power's operation of the Hells Canyon Complex. Progressively farther downstream, other factors or conditions such as tributary inflows influence hydrologic and environmental conditions. As described in Section 9.15.2, it is difficult to assign to Reclamation effects on many water quality parameters downstream from Hells Canyon Complex since no or limited data exist on which to base an analysis.

The number of adult Snake River fall Chinook salmon counted at Lower Granite Dam has increased substantially since 2000, and high numbers of adults have continued to return since 2001 (see Table 9-7 on page 265). The number of fall Chinook salmon redds counted in the Snake River between Hells Canyon Dam and Asotin has increased to 1,374 fish in 2003 (USFWS et al. 2003). Spawning has also been documented in some major Snake River tributaries below Hells Canyon Dam, with increasing redd counts in the Lower Clearwater River and the Grande Ronde River especially, and with modest increases in the Imnaha and Salmon Rivers. This implies an increasing abundance and spatial structure to the population. Spawn timing for Snake River fall Chinook salmon has been found to be similar to that of Hanford Reach fall Chinook salmon (Groves 2001). Although numbers of returning natural and hatchery adults are increasing (see Table 9-7 on page 265), they are not near historical levels, and they have not approached Lohn's (2002) interim abundance target of an 8-year geometric mean of 2,500 fish.

Idaho Power voluntarily implemented a program in 1991 to maintain outflows from Hells Canyon Dam relatively stable at around 9,500 cfs in October and November for spawning fall Chinook salmon and to generally increase flows after that period during winter; this substantially reduced the likelihood that redds with incubating eggs would become dewatered and die (Groves and Chandler 2003). This program occurs mostly during the period when Reclamation is storing water in upstream reservoirs for future use. Fall Chinook salmon spawn in several Snake River tributaries downstream from Hells Canyon Dam as well as in the mainstem; the incubating eggs in the mainstem should not be affected by Reclamation's proposed actions since Idaho Power maintains flows from Hells Canyon Dam to protect incubating eggs.

Connor et al. (2002) reported that fall Chinook salmon fry emergence begins as early as April 2 in some years. Modeled 50 percent exceedance levels show a reduction of inflows to Brownlee Reservoir for April but an increase in modeled inflows for wetter and drier years (at the 10 and 90 percent exceedance levels, respectively). The proposed actions increase inflows to Brownlee Reservoir for other migration months. The proposed actions would not provide additional benefit to early emerging fry in the action areas in average water years, but during wetter and drier water years, and from May through August, the proposed actions should improve rearing and migration conditions for fall Chinook salmon.

Several studies have reported that water temperature and river flow affect survival and migration rates of subyearling fall Chinook salmon in the Snake River. Limited studies by Connor et al. (2003a, 2003b) indicated that increases in flow and decreases in temperature resulting from summer flow augmentation increased survival and seaward movement of wild fall Chinook salmon passing Lower Granite Dam. Smith et al. (2003) investigated this relationship further by releasing PIT-tagged Lyons Ferry Hatchery subyearling fall Chinook salmon (which were assumed to be suitable surrogates for wild subyearling fish for their investigation) at two locations over about a 5-week period for 6 years. They reported that for both release sites, estimated survival to Lower Granite Dam tailrace generally decreased for fish released later. Estimated survival for the early release groups ranged from 45 to 76 percent but about 20 percent or less for the later release groups.

Connor et al. (2003b) noted that flow, temperature, fork length, and riverine distance influenced the rate of seaward movement of fall Chinook salmon during the period from release at tagging sites to detection at Lower Granite Dam. Connor et al. (2003b) reported that wild subyearling fall Chinook salmon spent from 10 to 15 days in the free-flowing river after release in the Snake River above the confluence of the Salmon River and about 20 to 45 days rearing in Lower Granite Reservoir before migrating past Lower Granite Dam during the summer months. Connor et al. (2003b) also reported survival of 65 to 90 percent for young fall Chinook salmon that begin migrating seaward in late May but survival of 5 to 20 percent for those fish that begin migrating seaward the first week of July. Connor et al. (2003a) reported that flow and temperature explained 92 percent of the observed variability in cohort survival to the tailrace of Lower Granite Dam.

Connor et al. (2003b) concluded "that the increases in flow and decreases in temperature resulting from summer flow augmentation increase the rate of seaward movement of fall chinook salmon in Lower Granite Reservoir (where fish spend prolonged periods of time), provided that augmentation occurs when the fish have moved offshore in the free-flowing river and are behaviorally disposed in being displaced downstream."

There is disagreement in the literature regarding the effect flow augmentation has on juvenile fish survival (Anderson 2002). Distance traveled may be a more important factor in smolt survival than travel time (Anderson and Zabel unpublished). In several studies reported by Anderson and Zabel (unpublished), fish traveling longer distances had higher mortality than fish that traveled shorter distances irrespective of the travel time for either group of fish.

Critical Habitat

The April 30, 2002, consent decree did not vacate the critical habitat designation for this ESU. Section 9.2.2 describes the designated critical habitat for Snake River fall Chinook salmon.

Section 3(5)(A)(i) of the ESA defines critical habitat as specific areas that possess those physical or biological features essential to the species' conservation. Essential features of Snake River fall Chinook salmon spawning and rearing are described elsewhere. Since fall Chinook salmon spawn in the Snake River downstream from Hells Canyon Dam, they could be affected by water quality, quantity, and temperature. Idaho Power maintains flows above a certain threshold during incubation to emergence, and the juveniles begin downstream migration shortly after emergence. Essential features of juvenile migration corridors are listed elsewhere. Water quality, quantity, and temperature might be factors affecting outmigrating juveniles. The additional flow provided by the proposed actions is not expected to degrade and will likely improve water quality, quantity, and temperature conditions to some degree. Once the migrating juveniles pass the mouth of the Salmon River, Snake River conditions will be affected to some extent by Salmon River flows.

Effects Conclusion

Based on a comparison of modeled flows, Reclamation's past O&M actions have altered Snake River streamflows into Brownlee Reservoir (see Table 3-7). These flow alterations have contributed to present environmental conditions within the action areas and are expected to continue into the future except as modified through the proposed actions, which would provide up to an additional 60,000 acre-feet of salmon flow augmentation annually and would improve reliability. Continued flow alterations attributable to the proposed actions may continue to adversely affect rearing and migrating juvenile fall Chinook salmon and designated critical habitat in the lower Snake River.

However, the proposed actions generally will result in somewhat improved flows and related conditions in the Snake River when compared to present conditions. The proposed actions will improve migration and rearing conditions for fall Chinook salmon below Hells Canyon Dam during wetter and drier water years and during May through August of average water years. The only exception involves a marginal reduction in modeled April flows at the 50 percent exceedance level, which may result in minor adverse effects when compared to current conditions for rearing and migration of early emerging fry.

In its 2001 biological opinion on continued operation of Reclamation's upper Snake River projects, NOAA Fisheries found that Reclamation's 2001 proposed action would not jeopardize the continued existence of Snake River fall Chinook salmon or destroy or adversely modify their designated critical habitat. When compared to the 2001 proposed action, Reclamation's proposed actions described herein generally will result in additional flow and related benefits to Snake River fall Chinook salmon and its designated critical habitat.

Snake River Sockeye Salmon

Juvenile sockeye salmon actively outmigrate at about the same time as juvenile spring/summer Chinook salmon. Modeled 50 percent exceedance levels show a slight reduction of inflows to Brownlee Reservoir for April but an increase in modeled inflows for wetter and drier years (at the 10 and 90 percent exceedance levels, respectively). The proposed actions increase inflows to Brownlee Reservoir for other migration months. Since juvenile outmigration occurs in April and continues into May, flow augmentation will benefit some of the later outmigrating fish but will not benefit early migrating fish. The majority of migrating adult sockeye salmon have generally crossed Lower Granite Dam in July (FPC 2004); the 2004 return of 110 adult sockeye salmon crossed Lower Granite Dam in July (Columbia River DART 2004), so flow augmentation from the proposed actions during that period will likely benefit these fish.

The BRT (2003) found extremely high risks for all four of the VSP categories. The interim abundance target of 1,000 spawners per year in one lake and 500 spawners in a second lake is far from being achieved.

Critical Habitat

The April 30, 2002, consent decree did not vacate the critical habitat designation for this ESU. Section 9.2.2 describes the designated critical habitat for Snake River sockeye salmon.

Section 3(5)(A)(i) of the ESA defines critical habitat as specific areas that possess those physical or biological features essential to the species' conservation. These features are described elsewhere. Essential features of Snake River sockeye salmon spawning and rearing areas would not be affected by the proposed actions since spawning and rearing occurs in tributaries and lakes. Some of the essential features of juvenile migration corridors described elsewhere will not be met in the early spring. Essential features of adult migration corridors described elsewhere are met since these fish migrate upstream in the Snake River in June and July.

Effects Conclusion

Based on a comparison of modeled flows, Reclamation's past O&M actions have altered Snake River streamflows into Brownlee Reservoir (see Table 3-7). These flow alterations have contributed to present environmental conditions within the action areas and are expected to continue into the future except as modified through the proposed actions, which would provide up to an additional 60,000 acre-feet of salmon flow augmentation annually and would improve reliability. Continued flow alterations attributable to the proposed actions may continue to adversely affect migrating Snake River sockeye salmon and designated critical habitat in the lower Snake River.

However, the proposed actions generally will result in somewhat improved flows and related conditions in the Snake River when compared to present conditions. The proposed actions will improve migration conditions for Snake River sockeye salmon below Hells Canyon Dam during wetter and drier water years and during May through August of average water years. The only exception involves a marginal reduction in modeled April flows at the 50 percent exceedance level, which may result in minor adverse effects when compared to current conditions for early outmigration of juvenile Snake River sockeye salmon.

In its 2001 biological opinion on continued operation of Reclamation's upper Snake River projects, NOAA Fisheries found that Reclamation's 2001 proposed action would not jeopardize the continued existence of Snake River sockeye salmon or destroy or adversely modify their designated critical habitat. When compared to the 2001 proposed action, Reclamation's proposed actions described herein generally will result in additional flow benefits to Snake River sockeye salmon and its designated critical habitat.

Snake River Basin Steelhead

Steelhead smolts actively outmigrate from Snake River tributaries in the spring at about the same time as juvenile spring/summer Chinook salmon. The effects and benefits of additional flow augmentation from the proposed actions on juvenile steelhead should be similar to that for juvenile spring/summer Chinook salmon. Modeled 50 percent exceedance levels show a slight reduction of inflows to Brownlee Reservoir for April but an increase in modeled inflows for wetter and drier years (at the 10 and 90 percent exceedance levels, respectively). The proposed actions increase inflows to Brownlee Reservoir for other migration months. Adults are migrating upstream from mid- to late summer to spring, with some adults overwintering in the lower Snake River. Adult steelhead have generally completed their upstream migration into Snake River tributaries and spawned by spring, so early flow augmentation may provide some benefit to adult spring migrants, while those adult summer steelhead that enter the Snake River in mid- to late summer might benefit from flow augmentation in August.

Effects Conclusion

Based on a comparison of modeled flows, Reclamation's past O&M actions have altered Snake River streamflows into Brownlee Reservoir (see Table 3-7). These flow alterations have contributed to present environmental conditions within the action areas and are expected to continue into the future except as modified through the proposed actions, which would provide up to an additional 60,000 acre-feet of salmon flow augmentation annually and would improve reliability. Continued flow alterations attributable to the proposed actions may continue to adversely affect migrating Snake River Basin steelhead in the lower Snake River.

However, the proposed actions generally will result in somewhat improved flows and related conditions in the Snake River when compared to present conditions. The proposed actions will improve migration conditions for Snake River Basin steelhead below Hells Canyon Dam during wetter and drier water years and during May through August of average water years. The only exception involves a marginal reduction in modeled April flows at the 50 percent exceedance level, which may result in minor adverse effects when compared to current conditions for early outmigration of juvenile Snake River Basin steelhead.

In its 2001 biological opinion on continued operation of Reclamation's upper Snake River projects, NOAA Fisheries found that Reclamation's 2001 proposed action would not jeopardize the continued existence of Snake River Basin steelhead or destroy or adversely modify their designated critical habitat. When compared to the 2001 proposed action, Reclamation's proposed actions described herein generally will result in additional flow benefits to Snake River Basin steelhead.

9.15.5 Analysis of Effects on Listed ESUs in the Columbia River

The listed ESUs discussed in this section occur in the action areas only in the Columbia River downstream from its confluence with the Snake River. Most spawn and rear in numerous tributaries to the Columbia River and use the Columbia River primarily for upstream and downstream migration. Some ESUs, however, use the lower Columbia River for spawning, rearing, as well as migration. This part of the action areas starts 397 km downstream from Hells Canyon Dam and even farther from Reclamation's facilities. Juvenile or adult salmonids migrating through this area will experience substantially greater flows than fish migrating in the Snake River. In addition, those listed ESUs farther down the Columbia River will encounter even greater flows due to the substantial inflows from other large and small tributaries. Any effects on fish in this area as a result of Reclamation's proposed actions are expected to be beneficial although difficult to quantify and will be overwhelmed by the much greater flows in the Columbia River and other environmental factors.

Upper Columbia River Spring Chinook Salmon

This ESU spawns and rears in the Columbia River outside the action areas, and enters the defined action areas in the Columbia River at the confluence with the Snake River, 397 km downstream from Hells Canyon Dam and even farther from Reclamation's upper Snake River projects. This ESU has a stream-type life history, with juveniles outmigrating as yearlings in the spring. Since the Upper Columbia River spring Chinook salmon use the action areas for migration, the effects of Reclamation's proposed actions are likely to be minimal.

Effects Conclusion

Based on a comparison of modeled flows, Reclamation's past O&M actions have altered Snake River streamflows into Brownlee Reservoir (see Table 3-7). These flow alterations have contributed in some degree to present environmental conditions within the action areas and are expected to continue into the future except as modified through the proposed actions, which would provide up to an additional 60,000 acre-feet of salmon flow augmentation annually and would improve reliability. Continued flow alterations attributable to the proposed actions may continue to affect migrating Upper Columbia River spring Chinook salmon in the Columbia River to the extent that such alterations affect flow conditions for migration. However, given the magnitude of flows in the Columbia River relative to Snake River inflows, the effects of such flow alterations are insignificant.

Similarly, the proposed actions generally are expected to produce insignificant improvements in flows and related conditions in the Columbia River when compared to present conditions. Such flows would improve migration conditions for Upper Columbia River spring Chinook salmon during wetter and drier water years and during May through August of average water years.

In summary, the proposed actions may affect but are not likely to adversely affect Upper Columbia River spring Chinook salmon. In its 2001 biological opinion on continued operation of Reclamation's upper Snake River projects, NOAA Fisheries found that Reclamation's 2001 proposed action would not jeopardize the continued existence of Upper Columbia River spring Chinook salmon. When compared to the 2001 proposed action, Reclamation's proposed actions described herein generally will result in additional, although insignificant, flow benefits to Upper Columbia River spring Chinook salmon.

Lower Columbia River Chinook Salmon

This ESU contains populations downstream from the Klickitat River that enter the action areas about 629 km downstream from Hells Canyon Dam and even farther from Reclamation's upper Snake River projects. This ESU includes both spring-run and fall-run populations. Reclamation's proposed actions are likely to affect less those ESUs further downstream or farther downstream in the action areas.

Effects Conclusion

Based on a comparison of modeled flows, Reclamation's past O&M actions have altered Snake River streamflows into Brownlee Reservoir (see Table 3-7). These flow alterations have contributed in some degree to present environmental conditions within the action areas and are expected to continue into the future except as modified through the proposed actions, which would provide up to an additional 60,000 acre-feet of salmon flow augmentation annually and would improve reliability. Continued flow alterations attributable to the proposed actions may continue to affect migrating Lower Columbia River Chinook salmon in the Columbia River to the extent that such alterations affect flow conditions for migration. However, given the magnitude of flows in the Columbia River relative to Snake River inflows, the effects of such flow alterations are insignificant.

Similarly, the proposed actions generally are expected to produce insignificant improvements in flows and related conditions in the Columbia River when compared to present conditions.

In summary, the proposed actions may affect but are not likely to adversely affect Lower Columbia River Chinook salmon. In its 2001 biological opinion on continued operation of Reclamation's upper Snake River projects, NOAA Fisheries found that Reclamation's 2001 proposed action would not jeopardize the continued existence of Lower Columbia River Chinook salmon. When compared to the 2001 proposed action, Reclamation's proposed actions described herein generally will result in additional, although insignificant, flow benefits to Lower Columbia River Chinook salmon.

Upper Willamette River Chinook Salmon

This ESU spawns, incubates, and rears outside of the action areas. This ESU only occurs in the action areas when juveniles exit the Willamette River and enter the Columbia River about 755 km downstream from Hells Canyon Dam, and it is even farther from Reclamation's upper Snake River projects. Upstream migrating adults leave the action areas and enter the Willamette River. Adults and juveniles use the lower 163 km of the Columbia River for migration. Reclamation's proposed actions are likely to have minimal if any effect on this ESU.

Effects Conclusion

Based on a comparison of modeled flows, Reclamation's past O&M actions have altered Snake River streamflows into Brownlee Reservoir (see Table 3-7). These flow alterations have contributed in some degree to present environmental conditions within the action areas and are expected to continue into the future except as modified through the proposed actions, which would provide up to an additional 60,000 acre-feet of salmon flow augmentation annually and would improve reliability. Continued flow alterations attributable to the proposed actions may continue to affect migrating Upper Willamette River Chinook salmon in the Columbia River to the extent that such alterations affect flow conditions for migration. However, given the magnitude of flows in the Columbia River relative to Snake River inflows, the effects of such flow alterations are insignificant.

Similarly, the proposed actions generally are expected to produce insignificant improvements in flows and related conditions in the Columbia River when compared to present conditions.

In summary, the proposed actions may affect but are not likely to adversely affect Upper Willamette River Chinook salmon. In its 2001 biological opinion on continued operation of Reclamation's upper Snake River projects, NOAA Fisheries found that Reclamation's 2001 proposed action would not jeopardize the continued existence of Upper Willamette River Chinook salmon. When compared to the 2001 proposed action, Reclamation's proposed actions described herein generally will result in additional, although insignificant, flow benefits to Upper Willamette River Chinook salmon.

Upper Columbia River Steelhead

Adults and juveniles of this ESU use the Columbia River downstream from the confluence with the Snake River as part of their migration corridor. This ESU enters the action areas about 397 km downstream from Hells Canyon Dam and even farther from Reclamation's upper Snake River projects. This ESU has a stream-type life history with smolts outmigrating rapidly in the spring. Since the Upper Columbia River steelhead use the action areas for migration, the effects of Reclamation's proposed actions are likely to be beneficial, although minimal, and Reclamation's proposed actions are likely to have little effect on this ESU.

Effects Conclusion

Based on a comparison of modeled flows, Reclamation's past O&M actions have altered Snake River streamflows into Brownlee Reservoir (see Table 3-7). These flow alterations have contributed in some degree to present environmental conditions within the action areas and are expected to continue into the future except as modified through the proposed actions, which would provide up to an additional 60,000 acre-feet of salmon flow augmentation annually and would improve reliability. Continued flow alterations attributable to the proposed actions may continue to affect migrating Upper Columbia River steelhead in the Columbia River to the extent that such alterations affect flow conditions for migration. However, given the magnitude of flows in the Columbia River relative to Snake River inflows, the effects of such flow alterations are insignificant.

Similarly, the proposed actions generally are expected to produce insignificant improvements in flows and related conditions in the Columbia River when compared to present conditions. Such flows would improve migration conditions for Upper Columbia River steelhead during wetter and drier water years and during May through August of average water years.

In summary, the proposed actions may affect but are not likely to adversely affect Upper Columbia River steelhead. In its 2001 biological opinion on continued operation of Reclamation's upper Snake River projects, NOAA Fisheries found that Reclamation's 2001 proposed action would not jeopardize the continued existence of Upper Columbia River steelhead. When compared to the 2001 proposed action, Reclamation's proposed actions described herein generally will result in additional, although insignificant, flow benefits to Upper Columbia River steelhead.

Middle Columbia River Steelhead

Juvenile steelhead from the Yakima River population of this ESU enter the action areas in the Columbia River at the mouth of the Snake River about 397 km downstream from Hells Canyon Dam and cross McNary Dam. Upstream migrating adults leave the action areas once they pass the mouth of the Snake River. Juveniles and adults from other populations in this ESU enter the action areas as far downstream as the Deschutes River, or about 590.4 km downstream from Hells Canyon Dam, and even farther from Reclamation's upper Snake River projects. Any effects from the proposed actions will diminish progressively downstream and will likely have less effect on listed ESUs farther downstream. The potential effect as a result of the proposed actions on Yakima River Middle Columbia River steelhead would be similar to that on the Upper Columbia River steelhead ESU. Those populations entering the action areas farther downstream would be less affected.

Effects Conclusion

Based on a comparison of modeled flows, Reclamation's past O&M actions have altered Snake River streamflows into Brownlee Reservoir (see Table 3-7). These flow alterations have contributed in some degree to present environmental conditions within the action areas and are expected to continue into the future except as modified through the proposed actions, which would provide up to an additional 60,000 acre-feet of salmon flow augmentation annually and would improve reliability. Continued flow alterations attributable to the proposed actions may continue to affect migrating Middle Columbia River steelhead in the Columbia River to the extent that such alterations affect flow conditions for migration. However, given the magnitude of flows in the Columbia River relative to Snake River inflows, the effects of such flow alterations are insignificant.

Similarly, the proposed actions generally are expected to produce insignificant improvements in flows and related conditions in the Columbia River when compared to present conditions. Such flows would improve migration conditions for Middle Columbia River steelhead during wetter and drier water years and during May through August of average water years.

In summary, the proposed actions may affect but are not likely to adversely affect Middle Columbia River steelhead. In its 2001 biological opinion on continued operation of Reclamation's upper Snake River projects, NOAA Fisheries found that Reclamation's 2001 proposed action would not jeopardize the continued existence of Middle Columbia River steelhead. When compared to the 2001 proposed action, Reclamation's proposed actions described herein generally will result in additional, although insignificant, flow benefits to Middle Columbia River steelhead.

Lower Columbia River Steelhead

Steelhead of this ESU enter the action areas downstream from the Hood and Wind Rivers, about 681 km downstream from Hells Canyon Dam and even farther from Reclamation's upper Snake River projects, where Reclamation's proposed actions are likely to have a negligible effect.

Effects Conclusion

Based on a comparison of modeled flows, Reclamation's past O&M actions have altered Snake River streamflows into Brownlee Reservoir (see Table 3-7). These flow alterations have contributed in some degree to present environmental conditions within the action areas and are expected to continue into the future except as modified through the proposed actions, which would provide up to an additional 60,000 acre-feet of salmon flow augmentation annually and would improve reliability. Continued flow alterations attributable to the proposed actions may continue to affect migrating Lower Columbia River steelhead in the Columbia River to the extent that such alterations affect flow conditions for migration. However, given the magnitude of flows in the Columbia River relative to Snake River inflows, the effects of such flow alterations are insignificant.

Similarly, the proposed actions generally are expected to produce insignificant improvements in flows and related conditions in the Columbia River when compared to present conditions.

In summary, the proposed actions may affect but are not likely to adversely affect Lower Columbia River steelhead. In its 2001 biological opinion on continued operation of Reclamation's upper Snake River projects, NOAA Fisheries found that Reclamation's 2001 proposed action would not jeopardize the continued existence of Lower Columbia River steelhead. When compared to the 2001 proposed action, Reclamation's proposed actions described herein generally will result in additional, although insignificant, flow benefits to Lower Columbia River steelhead.

Upper Willamette River Steelhead

Adults and juveniles of this ESU use the action areas in the Columbia River downstream from the confluence with the Willamette River for migration. This ESU enters the action areas about 755 km downstream from Hells Canyon Dam and even farther from Reclamation's upper Snake River projects. Adults and juveniles use the lower 163 km of the Columbia River for migration. The effects of the proposed actions would be substantially reduced, in fact, hardly measurable, in this downstream reach of the Columbia River below Bonneville Dam.

Effects Conclusion

Based on a comparison of modeled flows, Reclamation's past O&M actions have altered Snake River streamflows into Brownlee Reservoir (see Table 3-7). These flow alterations have contributed in some degree to present environmental conditions within the action areas and are expected to continue into the future except as modified through the proposed actions, which would provide up to an additional 60,000 acre-feet of salmon flow augmentation annually and would improve reliability. Continued flow alterations attributable to the proposed actions may continue to affect migrating Upper Willamette River steelhead in the Columbia River to the extent that such alterations affect flow conditions for migration. However, given the magnitude of flows in the Columbia River relative to Snake River inflows, the effects of such flow alterations are insignificant.

Similarly, the proposed actions generally are expected to produce insignificant improvements in flows and related conditions in the Columbia River when compared to present conditions.

In summary, the proposed actions may affect but are not likely to adversely affect Upper Willamette River steelhead. In its 2001 biological opinion on continued operation of Reclamation's upper Snake River projects, NOAA Fisheries found that Reclamation's 2001 proposed action would not jeopardize the continued existence of Upper Willamette River steelhead. When compared to the 2001 proposed action, Reclamation's proposed actions described herein generally will result in additional, although insignificant, flow benefits to Upper Willamette River steelhead.

Columbia River Chum Salmon

Adults of this ESU use the action areas in the Columbia River downstream from Bonneville Dam for migration and spawning. This ESU uses the portion of the action areas that begins about 694 km downstream from Hells Canyon Dam and even farther from Reclamation's upper Snake River projects. A chum salmon flow objective of about 125,000 cfs from the start of chum salmon spawning in November until the end of fry emergence in March is established, although river stage downstream from Bonneville Dam rather than actual flow has been used to provide adequate habitat for spawning and rearing chum salmon. Flows were to be adjusted to compensate for tidal influence and any effect from the flows out of the Willamette River. Adult chum salmon use the action areas at a time when Reclamation is not providing flow augmentation from the upper Snake River basin. Flows for incubation up to fry emergence are provided for the most part from upper Columbia River water management.

Effects Conclusion

Based on a comparison of modeled flows, Reclamation's past O&M actions have altered Snake River streamflows into Brownlee Reservoir (see Table 3-7). These flow alterations have contributed in some degree to present environmental conditions within the action areas and are expected to continue into the future except as modified through the proposed actions, which would provide up to an additional 60,000 acre-feet of salmon flow augmentation annually and would improve reliability. Continued flow alterations attributable to the proposed actions may continue to affect spawning and migrating Columbia River chum salmon in the Columbia River to the extent that such alterations affect flow conditions for spawning and migration. However, given the magnitude of flows in the Columbia River relative to Snake River inflows, the effects of such flow alterations are insignificant.

Similarly, the proposed actions generally are expected to produce insignificant improvements in flows and related conditions in the Columbia River when compared to present conditions.

In summary, the proposed actions may affect but are not likely to adversely affect Columbia River chum salmon. In its 2001 biological opinion on continued operation of Reclamation's upper Snake River projects, NOAA Fisheries found that Reclamation's 2001 proposed action would not jeopardize the continued existence of Columbia River chum salmon. When compared to the 2001 proposed action, Reclamation's proposed actions described herein generally will result in additional, although insignificant, flow benefits to Columbia River chum salmon.

Lower Columbia River Coho Salmon

This ESU is a candidate species proposed for listing under the ESA (69 FR 33101). Outmigrating juvenile Lower Columbia River coho salmon enter the action areas when they exit various lower Columbia River tributaries and enter the Mid Columbia – Hood HUC (17070105).

Effects Conclusion

Based on a comparison of modeled flows, Reclamation's past O&M actions have altered Snake River streamflows into Brownlee Reservoir (see Table 3-7). These flow alterations have contributed in some degree to present environmental conditions within the action areas and are expected to continue into the future except as modified through the proposed actions, which would provide up to an additional 60,000 acre-feet of salmon flow augmentation annually and would improve reliability. Continued flow alterations attributable to the proposed actions may continue to affect migrating Lower Columbia River coho salmon in the Columbia River to the extent that such alterations affect flow conditions for migration. However, given the magnitude of flows in the Columbia River relative to Snake River inflows, the effects of such flow alterations are insignificant.

Similarly, the proposed actions generally are expected to produce insignificant improvements in flows and related conditions in the Columbia River when compared to present conditions.

In summary, the proposed actions may affect but are not likely to adversely affect Lower Columbia River coho salmon.

9.16 Effects Conclusion Summary

Reclamation has determined that the 11 proposed actions may affect but are not likely to adversely affect 9 salmon and steelhead ESUs: Lower Columbia River, Upper Columbia River, and Upper Willamette River Chinook salmon ESUs; Columbia River chum salmon ESU; Lower Columbia River coho salmon ESU; and Lower Columbia River, Middle Columbia River, Upper Columbia River, and Upper Willamette River steelhead ESUs.

Reclamation has also determined that the 11 proposed actions may affect and are likely to adversely affect 4 salmon and steelhead ESUs: Snake River spring/summer and Snake River fall Chinook salmon ESUs, the Snake River sockeye salmon ESU, and the Snake River Basin steelhead ESU. Adverse effects to these ESUs include continued flow alternations in the lower Snake River.

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Chapter 10 ESSENTIAL FISH HABITAT

10.1 Background

Essential fish habitat (EFH) has been designated for federally managed groundfish, coastal pelagics, Chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), and Puget Sound pink salmon (*O. gorbuscha*) fisheries within the waters of Washington, Oregon, and California (PFMC 1999).

In previous consultations for Reclamation's upper Snake River projects, NOAA Fisheries (2001) stated that:

> [d]esignated EFH for groundfish and coastal pelagic species encompasses all waters from the mean high water line, and upriver extent of saltwater intrusion in river mouths, along the coasts of Washington, Oregon and California, seaward to the boundary of the U.S. exclusive economic zone (370.4 km) (PFMC 1998a, 1998b). Detailed descriptions and identification of EFH for the groundfish species are found in the Final Environmental Assessment/Regulatory Impact Review for Amendment 11 to The Pacific Coast Groundfish Management Plan (PFMC 1998a) and NOAA Fisheries Essential Fish Habitat for West Coast Groundfish Appendix (Casillas et al. 1998). Detailed descriptions and identifications of EFH for the coastal pelagic species are found in Amendment 8 to the Coastal Pelagic Species Fishery Management Plan (PFMC 1998b).
>
> Freshwater EFH for federally managed Pacific salmon includes all those rivers, streams, lakes, ponds, wetlands, and other water bodies currently or historically accessible to salmon in Washington, Oregon, Idaho, and California, except above the impassable barriers identified by PFMC (1999). Chief Joseph Dam, Dworshak Dam, and the Hells Canyon Complex (Hells Canyon, Oxbow, and Brownlee dams) are among the listed man-made barriers that represent the upstream extent of the Pacific salmon fishery EFH. Freshwater salmon EFH excludes areas upstream of longstanding, naturally impassable barriers (e.g., natural waterfalls in existence for several hundred years). In estuarine and marine areas, designated salmon EFH extends from the nearshore and tidal submerged environments within state territorial waters out to the full extent of the exclusive economic zone (370.4 km) offshore of Washington, Oregon, and California north of Point Conception to the Canadian border. Detailed descriptions and identification of EFH for Pacific salmon are found in Appendix A to Amendment 14 to the Pacific Coast Salmon Plan (PFMC 1999).

Appendix A to Amendment 14 of the Pacific Coast Salmon Plan (PFMC 1999) listed EFH for Chinook salmon and coho salmon in the Snake and Columbia Rivers downstream from Hells Canyon Dam. EFH was delineated by 4th field hydrologic unit codes (HUCs). EFH for the two salmon species was listed without regard for whether the several ESUs of the two species were federally listed under the ESA, and the particular Chinook or coho salmon ESUs that occupied the area were not considered when designating EFH. For this consultation, Reclamation considers both ESA-listed and non-listed Chinook and coho salmon ESUs that spawn, rear, and/or migrate in the action areas.

10.2 Proposed Actions

The proposed actions are the future O&M in the Snake River system above Milner Dam, future operations in the Little Wood River system, future O&M in the Owyhee, Boise, Payette, Malheur, Mann Creek, Burnt, upper Powder, and lower Powder River systems, and future provision of salmon flow augmentation from the rental or acquisition of natural flow rights. The associated 12 Federal projects are all in the Snake River basin upstream from Brownlee Reservoir. Chapter 2 and Appendix B describe the proposed actions. Appendix B describes the flow augmentation component of Reclamation's proposed actions.

10.3 Action Areas

The action areas with regard to EFH consultation include the farthest upstream point at which federally managed salmon fisheries smolts enter (or adults exit) the Snake River and Columbia River (at, and downstream from, its confluence with the Snake River) to the farthest downstream point at which smolts exit (or adults enter) the migration corridor to the ocean. The action areas in the Snake River include the area immediately downstream from Hells Canyon Dam, or wherever an occupied tributary stream meets the Snake River below Hells Canyon Dam, to the confluence of the Snake and Columbia Rivers, and in the Columbia River, or wherever a tributary stream meets the Columbia River, downstream to the farthest point at the Columbia River estuary and nearshore ocean environment for which designated EFH for groundfish, coastal pelagics, and Chinook and coho salmon might be influenced by the proposed actions.

This area encompasses nine 4th field hydrologic unit codes (HUCs) beginning just downstream from Hells Canyon Dam and progressing through the lower Snake River and from the mouth of the Snake River in the Columbia River to its mouth. Figure 10-1 and Table 10-1 show the geographic extent and Snake or Columbia River kilometers (Rkm) of these 4th field HUCs; delineations of some of these 4th field HUCs are estimated from maps and may be approximate.

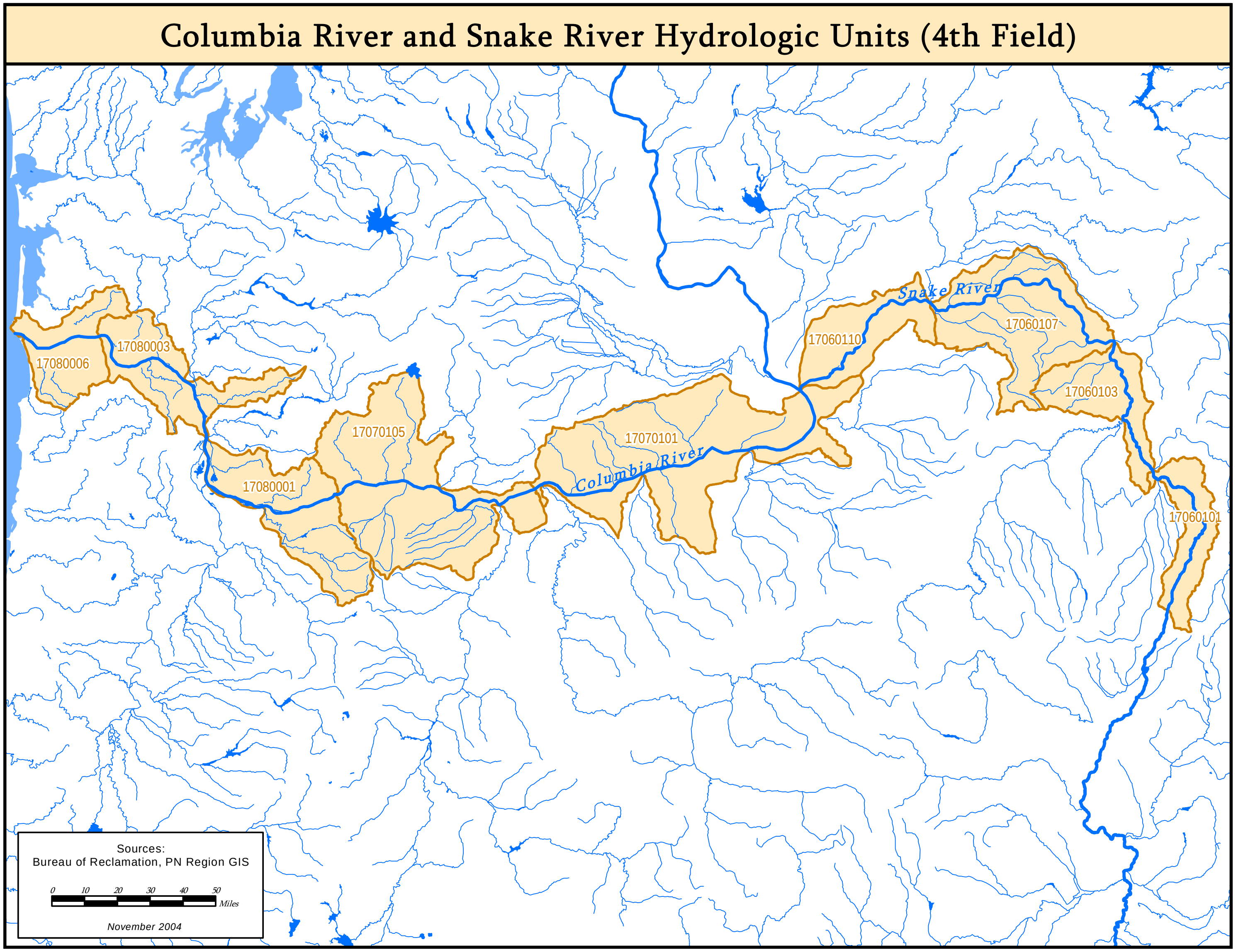

Figure 10-1. Map showing the nine 4th field HUCs in the action areas.

Table 10-1. Approximate HUC starting and ending points in the EFH action areas.

HUC	Hydrologic Unit Name	From	To
Snake River			
17060101	Hells Canyon	Hells Canyon Dam at Rkm 397.5	Mouth of Salmon River at Rkm 303.0
17060103	Lower Snake – Asotin Creek	Mouth of Salmon River at Rkm 303.0	Mouth of Clearwater River at Lewiston, ID, at Rkm 224.2
17060107	Lower Snake – Tucannon River	Mouth of Clearwater River at Lewiston, ID, at Rkm 224.2	Mouth of Tucannon River at Rkm 100.1
17060110	Lower Snake River	Mouth of Tucannon River at Rkm 100.1	Mouth of Snake River at Rkm 0
Columbia River			
17070101	Mid Columbia – Lake Wallula	Mouth of Snake River at Rkm 522	John Day Dam at Rkm 347.0
17070105	Mid Columbia – Hood	John Day Dam at Rkm 347.0	Bonneville Dam at Rkm 235.1
17080001	Lower Columbia – Sandy River	Bonneville Dam at Rkm 235.1	Mouth of Willamette River at Rkm 163.3
17080003	Lower Columbia – Clatskanie River	Mouth of Willamette River at Rkm 163.3	Jones Beach at Rkm 75
17080006	Lower Columbia River	Jones Beach at Rkm 75	Mouth of Columbia River at Rkm 0

EFH is designated for Chinook and/or coho salmon in the nine HUCs in Appendix A of Amendment 14 (PFMC 1999). Table 10-2 shows these nine HUCs with the EFH-designated species, affected ESU, and life history use.

In the case of the Lower Snake River HUC (17060110), Table A-1 of Appendix A of Amendment 14 (PFMC 1999) lists only Chinook salmon, while Table A-6 indicates that this HUC has currently accessible but unutilized historical habitat for coho salmon. Similarly, for the Mid Columbia – Lake Wallula HUC (17070101), Table A-1 of Appendix A of Amendment 14 (PFMC 1999) lists only Chinook salmon, while Table A-6 indicates that this HUC is current habitat for coho salmon. Reclamation will focus on the species listed in Appendix A, Table A-1 (PFMC 1999). EFH listing did not differentiate specific Chinook or coho salmon ESUs, nor consider any ESA listing status. For purposes of this EFH consultation, Reclamation includes all Snake and Columbia River Chinook and coho salmon ESUs, whether ESA-listed or not, that use the Snake and Columbia River action areas for either spawning, rearing, or migrating. Many of the ESUs use the action areas only for migration.

Table 10-2. Snake and Columbia River basin HUCs with designated Chinook and coho salmon EFH, ESU, and life history use (from Tables A-1 and A-6 in PFMC 1999).

HUC	Hydrologic Unit Name	Species	Current or Historical Distribution	ESU	Life History Use [1]
17060101	Hells Canyon	Chinook salmon	Current habitat	Snake River fall Chinook salmon Snake River spring/summer Chinook salmon	S, R, M
17060103	Lower Snake – Asotin Creek	Chinook salmon	Currently accessible but unutilized historical habitat	Snake River fall Chinook salmon Snake River spring/summer Chinook salmon	S, R, M M
		Coho salmon	Currently accessible but unutilized historical habitat	None	M
17060107	Lower Snake – Tucannon River	Chinook salmon	Current habitat	Snake River fall Chinook salmon Snake River spring/summer Chinook salmon	S, R, M M
		Coho salmon	Currently accessible but unutilized historical habitat	None	M
17060110 [2]	Lower Snake River	Chinook salmon (Coho salmon)	Current habitat (Currently accessible but unutilized historical habitat)	Snake River fall Chinook salmon Snake River spring/summer Chinook salmon	S, R, M M
17070101 [3]	Mid Columbia – Lake Wallula	Chinook salmon (Coho salmon)	Current habitat (Current habitat)	Snake River fall Chinook salmon Snake River spring/summer Chinook salmon Upper Columbia River spring Chinook salmon Middle Columbia River spring Chinook salmon Upper Columbia River summer/fall Chinook salmon	R, M M M M M
17070105	Mid Columbia – Hood	Chinook salmon	Current habitat	Snake River fall Chinook salmon Snake River spring/summer Chinook salmon Upper Columbia River spring Chinook salmon Middle Columbia River spring Chinook salmon Upper Columbia River summer/fall Chinook Deschutes River summer/fall Chinook salmon	R,M M M M M M
		Coho salmon	Current habitat	Lower Columbia River coho salmon	S, R, M
17080001	Lower Columbia – Sandy River	Chinook salmon	Current habitat	Snake River fall Chinook salmon Snake River spring/summer Chinook salmon Upper Columbia River spring Chinook salmon Middle Columbia River spring Chinook salmon Upper Columbia River summer/fall Chinook Deschutes River summer/fall Chinook salmon Lower Columbia River Chinook salmon	M M M M M M S, R, M

Table 10-2. Snake and Columbia River basin HUCs with designated Chinook and coho salmon EFH, ESU, and life history use (from Tables A-1 and A-6 in PFMC 1999), continued.

HUC	Hydrologic Unit Name	Species	Current or Historical Distribution	ESU	Life History Use [1]
17080001, cont.	Lower Columbia – Sandy River, cont.	Coho salmon	Current habitat	Lower Columbia River coho salmon	S, R, M
				Southwest Washington coho salmon	M
17080003	Lower Columbia – Clatskanie River	Chinook salmon	Current habitat	Snake River fall Chinook salmon	M
				Snake River spring/summer Chinook salmon	M
				Upper Columbia River spring Chinook salmon	M
				Middle Columbia River spring Chinook salmon	M
				Upper Columbia River summer/fall Chinook salmon	M
				Deschutes River summer/fall Chinook salmon	M
				Lower Columbia River Chinook salmon	S, R, M
				Upper Willamette River Chinook salmon	M
		Coho salmon	Current habitat	Lower Columbia River coho salmon	S, R, M
				Southwest Washington coho salmon	M
17080006	Lower Columbia River	Chinook salmon	Current habitat	Snake River fall Chinook salmon (T) [4]	M
				Snake River spring/summer Chinook salmon (T)	M
				Upper Columbia River spring Chinook salmon (E)	M
				Middle Columbia River spring Chinook salmon (N)	M
				Upper Columbia River summer/fall Chinook (N)	M
				Deschutes River summer/fall Chinook salmon (N)	M
				Lower Columbia River Chinook salmon (T)	S, R, M
				Upper Willamette River Chinook salmon (T)	M
		Coho salmon	Current habitat	Lower Columbia River coho salmon (C)	S, R, M
				Southwest Washington coho salmon (N)	M

1 S = spawning, R = rearing, M = migration

2 EFH is listed for Chinook salmon in HUC 17060110 on table A-1 (PFMC 1999), while table A-6 lists current habitat for Chinook salmon and currently accessible but unutilized historical habitat for coho salmon in that HUC (PFMC 1999). Since Table A-1 lists EFH for species within HUCs, Reclamation shall not consider EFH for coho salmon in this HUC.

3 EFH is listed for Chinook salmon in HUC 17070101 on table A-1 (PFMC 1999), while table A-6 lists current habitat for both Chinook and coho salmon in the same HUC (PFMC 1999). Since Table A-1 lists EFH for species within HUCs, Reclamation shall not consider EFH for coho salmon in this HUC.

4 ESA listing status as of June 17, 2004 (69 FR 33101): E = Endangered, T = Threatened, N = Not Warranted, C = Candidate.

Reclamation considers the following Chinook and coho salmon ESUs in this EFH consultation, listed from upstream (closest to the downstream extent of Reclamation's upper Snake River projects) to downstream:

- Snake River fall Chinook salmon
- Snake River spring/summer Chinook salmon
- Upper Columbia River spring Chinook salmon
- Middle Columbia River spring Chinook salmon
- Upper Columbia River summer/fall Chinook salmon
- Deschutes River summer/fall Chinook salmon
- Lower Columbia River Chinook salmon
- Upper Willamette River Chinook salmon
- Lower Columbia River coho salmon
- Southwest Washington coho salmon

Some of these ESUs are ESA-listed, while others that are not warranted for ESA listing have relatively robust populations, although not at historical levels of abundance.

10.4 Status, Life History, Habitat Requirements and Effects Analysis

The Chinook and coho salmon ESUs are listed and discussed as they are encountered in geographic order proceeding downstream from Hells Canyon Dam to the mouth of the Snake River, then from the upper Columbia River to its mouth. Discussion of the Columbia River ESUs will follow Snake River ESUs.

10.4.1 Snake River Fall Chinook Salmon

Species Information

Section 9.3 contains information about the life history and population status of the Snake River fall Chinook salmon ESU and is incorporated here by reference. This ESU is currently listed threatened, and proposed for relisting as threatened (69 FR 33101).

Specific to this EFH consultation, many Snake River fall Chinook salmon spawn, rear, and migrate in the mainstem downstream from Hells Canyon Dam, primarily in the Hells Canyon (17060101), Lower Snake – Asotin Creek (17060103), and Lower Snake – Tucannon River (17060107) HUCs. This HUC is farther downstream and receives substantial inflow from the Salmon River, Clearwater River, and other tributaries. Spawning in the Lower Snake River HUC (17060110) is uncertain, although the BRT (2003) noted that spawning occurs in small mainstem sections in the tailraces of Lower Snake River hydroelectric dams.

Table 9-7 on page 265 shows the number of adults returning to Lower Granite Dam from 1977 to 2003. These fish are primarily destined for the Hells Canyon (17060101) and Lower Snake – Asotin Creek (17060103) HUCs. Fall Chinook salmon also spawn in several of the larger Snake River tributaries downstream from Hells Canyon Dam. Table 9-9 on page 268 shows the several Snake River tributaries in addition to the mainstem where fall Chinook salmon spawning has been documented. Across most years, spawning occurs predominantly in the Snake River mainstem, as indicated by the redd counts from the mainstem and tributaries (see Table 9-9 on page 268). This area encompasses the Hells Canyon (17060101) and Lower Snake – Asotin Creek (17060103) HUCs. The Lower Snake River HUC (17060110) supports fall Chinook salmon rearing and migration for all the juveniles produced there or upstream in the mainstem and tributaries. Once juvenile fall Chinook salmon leave the Snake River and enter the Columbia River, they continue to rear and migrate to the ocean through five additional 4th field HUCs.

The number of adult Snake River fall Chinook salmon counted at Lower Granite Dam has increased substantially since 2000, and high numbers of adults have continued to return since 2001. Redd counts in the mainstem Snake River between Asotin, Washington, and Hells Canyon Dam, as reported by USFWS et al. (2003), have also increased and in 2003 numbered 1,374 redds, exceeding the recovery goal of sufficient habitat upstream of Lower Granite Reservoir to support 1,250 redds (Groves and Chandler 2003). However, this one-year exceedance of the redd recovery goal should be viewed as a positive sign but not in itself as evidence of recovery of Snake River fall Chinook salmon. These numbers may include some hatchery-origin fish spawning in the wild, and abundance of returning adults has varied in the past and may continue to do so in the future. The interim abundance target for fall Chinook salmon is an 8-year geometric mean of 2,500 annual natural spawners (Lohn 2002). The eight-year geometric mean for the period from 1995 to 2002 is 1,023 wild adults as counted at Lower Granite Dam.

Downstream migration proceeds mostly from early June through August, with a peak in the passage index at Lower Granite Dam about June 9 (FPC 2004). Connor (2004) indicated that subyearling Chinook salmon in the Snake River migrate rapidly in the free-flowing river and may spend a substantial amount of time in Lower Granite Reservoir. In 2004, most Snake River fall Chinook salmon migrants were out of the mainstem Snake River by the end of June, and 72 percent of the Snake River fall

Chinook salmon outmigrants passed Lower Granite Dam by July 1. However, outmigration timing was unusually early in 2004 (see Figure 9-3 on page 270). Connor (2004) also indicated that water temperature increases in the Snake River downstream from Hells Canyon Dam in the summer stimulate downstream migration of juvenile fall Chinook salmon. The juvenile fall Chinook salmon that are counted at Lower Granite Dam in the fall may be from the cooler Clearwater River population or those that spent more time in the cooler water of the reservoir.

Effects Analysis

Fall Chinook salmon spawn in several Snake River tributaries downstream from Hells Canyon Dam as well as in the mainstem. Although Reclamation's proposed actions may slightly reduce February inflows to Brownlee Reservoir (see Table 9-22, Table 9-23, and Table 9-24, beginning on page 303), Idaho Power maintains flows of about 9,500 cfs from Hells Canyon Dam from spawning to fry emergence.

Fry emerging in the action areas in the late spring benefit from the proposed actions since increased flow augmentation volumes under the proposed actions should provide better rearing and migration conditions. Although 2004 had an unusually early outmigration, the usual timing is later in the summer when the proposed actions should provide additional flow, particularly in July during drier water years.

Effects Conclusion

Based on a comparison of modeled flows, Reclamation's past O&M actions have altered Snake River streamflows into Brownlee Reservoir (see Table 3-7). These alterations in streamflow have contributed to present conditions of EFH within the action areas downstream from Hells Canyon Dam, and these flow alterations are expected to continue into the future as part of the proposed actions.

Past flow alterations have affected EFH for fall Chinook salmon in 4th field HUCs in the lower Snake River to the extent that such alterations affect flow conditions for rearing and migration. The proposed actions, which include providing up to an additional 60,000 acre-feet of salmon flow augmentation annually, will result in somewhat improved flows and related conditions in the Snake River when compared to present conditions. Most but not all of the modeled 10, 50, and 90 percent exceedance levels of inflow to Brownlee Reservoir show measurable increases during the juvenile rearing and outmigration period with the proposed actions compared to current operations. The proposed actions will improve rearing and migration conditions for fall Chinook salmon below Hells Canyon Dam from April through August during wetter and drier water years, approximated by the 10 and 90 percent exceedance values, respectively, and during May through August of average water years. The only exception involves a marginal reduction in modeled April flows into

Brownlee Reservoir at the 50 percent exceedance level, which may result in minor adverse effects to EFH when compared to current conditions for rearing and migration of early emerging fall Chinook salmon fry in the Hells Canyon (17060101) and Lower Snake – Asotin Creek (17060103) HUCs. The effects of the proposed actions on EFH will diminish progressively downstream.

10.4.2 Snake River Spring/summer Chinook Salmon

Section 9.2 contains information about the life history and population status of the Snake River spring/summer Chinook salmon ESU and is incorporated here by reference. This ESU is currently listed as threatened and is proposed for relisting as threatened (69 FR 33101).

The Snake River spring/summer Chinook salmon ESU consists of 31 demographically independent populations (ICBTRT 2003). One population inhabits the Imnaha River basin in the Hells Canyon HUC (17060101), while the majority occupies other major tributaries such as the Salmon River, Grande Ronde River, and Clearwater River that flow into the Lower Snake – Asotin Creek HUC (17060103).

Some spawning occurs in tributaries downstream from Hells Canyon Dam in the Hells Canyon HUC (17060101), such as the Imnaha River, but most of the production occurs in tributaries of the Salmon, Grande Ronde, and Clearwater Rivers that flow into but are not part of the Lower Snake – Asotin Creek HUC (17060103). Table 9-4 on page 258 shows the number of spring and summer Chinook salmon counted at Lower Granite Dam from 1977 to 2003. Most of these fish are destined for the tributaries in the two uppermost HUCs. Outmigrating juveniles enter the action areas from the tributaries, and as they migrate farther downstream, they are subjected to greater river flows from numerous tributary inflows, as well as other physical conditions in the river, including the passage at the several hydropower projects.

The BRT (2003) found moderately high risk for abundance and productivity and lower risk for spatial structure and genetic diversity, indicating that low numbers of this ESU are relatively widely distributed.

Adult returns as counted at Lower Granite Dam have increased recently, although the 8-year geometric mean of 9,255 wild fish is below Lohn’s (2002) annual natural spawner interim abundance target of 41,900 fish.

Effects Analysis

The effect of the proposed actions on Snake River spring/summer Chinook salmon EFH in the Snake River is predominantly on migration for both juvenile fish and adults in the four Snake River HUCs and the five Columbia River HUCs. Snake River spring/summer Chinook salmon outmigrate in the spring as yearlings, when the proposed actions contribute to increased flows under some conditions as shown in Table 9-22, Table 9-23, and Table 9-24, beginning on page 303.

Effects Conclusion

Based on a comparison of modeled flows, Reclamation's past O&M actions have altered Snake River streamflows into Brownlee Reservoir (see Table 3-7). These alterations in streamflow have contributed to present conditions of EFH within the action areas downstream from Hells Canyon Dam, and these flow alterations are expected to continue into the future as part of the proposed actions.

Past flow alterations have affected EFH for spring/summer Chinook salmon in 4^{th} field HUCs in the lower Snake River to the extent that such alterations affect flow conditions for migration. The proposed actions, which include providing up to an additional 60,000 acre-feet of salmon flow augmentation annually, will result in somewhat improved flows and related conditions in the Snake River when compared to present conditions. Most but not all of the modeled 10, 50, and 90 percent exceedance levels of inflow to Brownlee Reservoir show measurable increases during the juvenile outmigration period with the proposed actions. The proposed actions will improve migration conditions for spring/summer Chinook salmon below Hells Canyon Dam from April through August during wetter and drier water years, approximated by the 10 and 90 percent exceedance values, respectively, and during May through August of average water years. The only exception involves a marginal reduction in modeled April flows into Brownlee Reservoir at the 50 percent exceedance level, which may result in minor adverse effects to EFH when compared to current conditions for migration of early migrating spring/summer Chinook salmon in the Hells Canyon (17060101) and Lower Snake – Asotin Creek (17060103) HUCs. The effects of the proposed actions on EFH will diminish progressively downstream.

10.4.3 Upper Columbia River Spring Chinook Salmon

Section 9.6 contains information about the life history and population status of the Upper Columbia River spring Chinook salmon ESU and is incorporated here by reference. This ESU is currently listed as endangered and is proposed for relisting as threatened (69 FR 33101).

Outmigrating juvenile fish from this ESU enter the action areas when they pass the mouth of the Snake River and enter the Mid Columbia – Lake Wallula HUC (17070101) on their downstream migration. This is about 397 km downstream from Hells Canyon Dam and even farther from Reclamation's upper Snake River projects. These stream-type fish outmigrate actively in the spring.

Returning adults are in the action areas up to the time they pass the mouth of the Snake River. Adults are counted at Rock Island Dam. A substantial number of returning adults are from artificial propagation programs in the basin. Up to 80 percent of adults returning to the Methow River in 2001 and an estimated 70 percent returning to the Wenatchee River were of hatchery origin. The peak of the adult return is around the middle of May, based on 10-year average returns at Rock Island Dam (FPC 2004, www.fpc.org/adultqueries/Adult_Query_Graph_Results.asp), although in 2004 there was a pronounced peak in very early May, with a second but somewhat lower peak just after mid-May.

The BRT (2003) had strong concerns regarding abundance and productivity and comparatively less concern regarding spatial structure and diversity of the VSP categories for this ESU.

The 8-year geometric mean of 2,137 wild adults is below Lohn's (2002) interim abundance target of 6,250 annual natural spawners.

Effects Analysis

This ESU spawns and rears upstream from the action areas and uses the action areas for juvenile and adult migration. The effect of the proposed actions on Columbia River EFH for Upper Columbia River spring Chinook salmon is predominantly on juvenile and adult migration. Reclamation's proposed actions include an additional 60,000 acre-feet of flow augmentation that increases modeled inflows to Brownlee Reservoir except for the modeled 50 percent exceedance level in April. The magnitude of the 1.21 percent reduction at Brownlee Reservoir is much reduced by the time the Snake River enters the Columbia River in the Mid Columbia – Lake Wallula HUC (17070101) because of substantial tributary inflows between Hells Canyon Dam and the mouth of the Snake River, and the effect of this reduction in April on EFH and aquatic habitat in the Columbia River is difficult to quantify, although it is probably negligible. Except for April, the proposed actions increase modeled inflows to Brownlee Reservoir, thus benefiting aquatic habitat downstream.

Effects Conclusion

Based on the distance downstream from Reclamation's upper Snake River projects where this ESU enters the action areas in the Mid Columbia – Lake Wallula HUC (17070101), and the much greater flows in the Columbia River compared to the contribution from Reclamation's proposed actions at this point in the action areas, Reclamation concludes that its proposed actions will not adversely affect EFH in the Columbia River for Upper Columbia River spring Chinook salmon.

10.4.4 Middle Columbia River Spring Chinook Salmon

NOAA Fisheries concluded that this ESU was not warranted for listing under the ESA (NOAA Fisheries 2004). It includes stream-type Chinook salmon spawning in the Klickitat, Deschutes, John Day, and Yakima Rivers, excluding the Snake River basin (Myers et al. 1998). Juveniles from this ESU emigrate to the ocean as yearlings. Some artificial propagation programs have been implemented for this ESU; an early attempt in 1899 was eventually unsuccessful, while programs established in the late 1940s and 1950s were more successful. Substantial artificial propagation occurs in the Deschutes River basin. A rough estimate of the total in-river returns of this ESU can be made by subtracting hatchery returns and Zone 6 fishery landings from the difference between Bonneville Dam counts and the sum of Priest Rapids and Ice Harbor Dams. A 1997 estimate of abundance calculated as described above resulted in a 5-year geometric mean of about 25,000 adults, but this is probably an upper bound of escapement (Myers et al. 1998).

Downstream migrants from the Yakima River population of this ESU enter the action areas in the Mid Columbia – Lake Wallula HUC (17070101) when they pass the mouth of the Snake River. This is about 397 km downstream from Hells Canyon Dam and even farther from Reclamation's upper Snake River projects. Other populations enter the action areas farther downstream. The ESU primarily uses the action areas for juvenile and adult migration; spawning and rearing occur in the major tributaries listed above.

Effects Analysis

The effects of Reclamation's proposed actions diminish substantially with distance downstream from the upper Snake River projects, and effects to EFH for this ESU will likely be minimal. Because of the distance downstream from Reclamation's upper Snake River projects, and the much larger volume of water in the Columbia River at this point, the effects of the proposed actions on EFH for this ESU are unquantifiable but likely negligible.

Effects Conclusion

Based on the distance downstream from Reclamation's upper Snake River projects where this ESU enters the action areas, and the much greater flows in the Columbia River compared to the contribution from Reclamation's proposed actions at this point in the action areas, Reclamation concludes that its proposed actions will not adversely affect EFH in the Columbia River for Middle Columbia River spring Chinook salmon.

10.4.5 Upper Columbia River Summer/fall Chinook Salmon

NOAA Fisheries concluded that this ESU was not warranted for listing under the ESA (NOAA Fisheries 2004). It was formerly referred to as Middle Columbia River summer/fall Chinook salmon ESU (Myers et al. 1998) and includes all ocean-type Chinook salmon spawning in areas between McNary and Chief Joseph Dams. A large portion of this ESU consists of the “upriver brights” from the Hanford Reach of the Columbia River that enter the action areas as outmigrants once they pass the mouth of the Snake River and enter the Mid Columbia – Lake Wallula HUC (17070101). This is about 397 km downstream from Hells Canyon Dam and even farther from Reclamation’s upper Snake River projects.

The Hanford Reach fall run is the predominant population; the 1990-1994 geometric mean was about 58,000 fish (Myers et al. 1998). Long-term trends for the three largest populations are positive, but they are mixed for smaller populations. The summer run is heavily influenced by hatchery releases (Wells Dam stock). Freshwater spawning and rearing habitat has experienced degradation, with hydro project-related inundation of mainstem spawning grounds and degradation of the migration corridor (NOAA Fisheries 1999). However, these conditions exist for the most part on the Columbia River upstream from the action areas. The action areas downstream from the mouth of the Snake River in the Mid Columbia – Lake Wallula HUC (17070101) and other Columbia River 4^{th} field HUCs are used primarily for rearing and migration. Although rearing habitat has been degraded, the proposed actions, including providing an additional 60,000 acre-feet of augmentation flow, do not adversely affect these existing conditions but instead may improve conditions slightly.

Typically, summer/fall Chinook salmon in the mid-Columbia region begin spawning in late September, peak in mid-October, and complete spawning in late November (Chapman et al. 1994, cited in Myers et al. 1998). Developing eggs incubate in the gravel for an extended period (5 to 7 months) until they emerge as fry from the gravel in late winter or spring (mid-February to April).

Effects Analysis

Adults from this ESU spawn outside the action areas, but the subyearlings outmigrate and rear throughout the mid- to late summer. As the fry migrate downstream, they enter the action areas in the Mid Columbia – Lake Wallula HUC (17070101). Because of the distance downstream from Reclamation’s upper Snake River projects, and the much larger volume of water in the Columbia River at this point, the effects of the proposed actions on EFH for this ESU are unquantifiable but likely negligible.

Effects Conclusion

Based on the distance downstream from Reclamation's upper Snake River projects where this ESU enters the action areas, and the much greater flows in the Columbia River compared to the contribution from Reclamation's proposed actions at this point in the action areas, Reclamation concludes that its proposed actions will not adversely affect EFH in the Columbia River for Upper Columbia River summer/fall Chinook salmon.

10.4.6 Deschutes River Summer/fall Chinook Salmon

The ESU includes all naturally spawned populations of Chinook salmon from the Deschutes River. It is not warranted for listing under the ESA (NOAA Fisheries 2004). Major river basins containing spawning and rearing habitat for this ESU comprise approximately 2,687 square miles in the Deschutes River basin of Oregon. Outmigrating juvenile Deschutes River summer/fall Chinook salmon enter the action areas when they exit the Deschutes River and enter the Mid Columbia – Hood HUC (17070105) at Rkm 328.5. This is about 590.4 km downstream from Hells Canyon Dam and even farther from Reclamation's upper Snake River projects. Fish in this ESU use this HUC and three additional HUCs downstream primarily as a migration corridor.

The Deschutes River population continues to increase. Most recent data shows annual returns to be at a five-year average of about 16,000 fish, increasing at about 18 percent a year.

Concerns remain over the possible extinction of the summer-run life history type in the Deschutes Basin and the loss of fall-run fish from adjacent river basins (Umatilla, John Day, and Walla Walla River basins) that may have shared a common ESU with Deschutes Chinook salmon (NOAA Fisheries 1999).

Effects Analysis

Adults from this ESU spawn outside the action areas, but the subyearlings outmigrate and rear throughout the mid- to late summer. The subyearlings migrate down the Deschutes River and enter the action areas when they enter the Columbia River in the Mid Columbia – Hood HUC (17070105). Because of the distance downstream from Reclamation's upper Snake River projects, and the much larger volume of water in the Columbia River at this point, the effects of the proposed actions on EFH for this ESU are unquantifiable but likely negligible.

Effects Conclusion

Based on the distance downstream from Reclamation's upper Snake River projects where this ESU enters the action areas, and the much greater flows in the Columbia River compared to the contribution from Reclamation's proposed actions at this point in the action areas, Reclamation concludes that its proposed actions will not adversely affect EFH in the Columbia River for Deschutes River summer/fall Chinook salmon.

10.4.7 Lower Columbia River Chinook Salmon

Section 9.7 contains information about life history and population status of the Lower Columbia River Chinook salmon ESU and is incorporated here by reference. This ESU is currently listed as threatened and is proposed for relisting as threatened (69 FR 33101). This ESU contains populations downstream from the Klickitat River that enter the action areas. This is about 629 km downstream from Hells Canyon Dam and even farther from Reclamation's upper Snake River basin projects. This ESU includes both spring-run and fall-run populations.

The BRT (2003) found moderately high risk for all VSP categories, and that the majority of these fish appear to be hatchery produced. The artificial propagation programs in the ESU may provide slight benefits to ESU abundance, spatial structure, and diversity, but may have uncertain effects in productivity. Population abundance has increased recently, but the long-term trends in productivity are below replacement for the majority of populations in the ESU (69 FR 33101). Literally millions of hatchery-produced Chinook salmon juveniles are released into the lower Columbia River each year (BRT 2003).

Effects Analysis

The effects of Reclamation's proposed actions are likely to affect less the EFH of those ESUs farther downstream or farther removed from the action areas. Because of the distance downstream from Reclamation's upper Snake River projects, and the much larger volume of water in the Columbia River at this point, the effects of the proposed actions on EFH for this ESU are unquantifiable but likely negligible.

Effects Conclusion

Based on the distance downstream from Reclamation's upper Snake River projects where this ESU enters the action areas in the Lower Columbia – Sandy River HUC (17080001), and the much greater flows in the Columbia River compared to the contribution from Reclamation's proposed actions at this point in the action areas, Reclamation concludes that its proposed actions will not adversely affect EFH in the Columbia River for Lower Columbia River Chinook salmon.

10.4.8 Upper Willamette River Chinook Salmon

Section 9.8 contains information about life history and population status of the Upper Willamette River Chinook salmon ESU and is incorporated here by reference. This ESU is currently listed as threatened, and proposed for relisting as threatened (69 FR 33101).

The WLCTRT (2003) reported that this ESU has a spring run-timing, and estimated that there were 7 populations historically. All Upper Willamette River spring Chinook salmon except those migrating to the Clackamas River must pass Willamette Falls. As of August 15, 2004, 95,968 adult Chinook salmon had been counted at Willamette Falls (ODFW 2004). In 2001, 52,685 adults were counted, with 82,111 adults counted in 2002, and 117,600 adults counted in 2003. While there is no assessment of the ratio of hatchery-origin to natural-origin fish, the BRT (2003) states that the majority are likely hatchery-origin spring Chinook salmon. The BRT (2003) estimated that the hatchery portion of the runs into seven tributaries ranged from about 64 to almost 100 percent. Despite the substantial hatchery component to the run, adult returns have increased substantially since the mid-1990s when the adult return was around 20,000 fish (estimated from Figure A.2.6.2, BRT 2003). Because of the heavy reliance on artificial propagation in this ESU, the BRT (2003) concluded that most natural spring Chinook populations were extirpated or nearly so, and that the only potentially self-sustaining population is in the McKenzie River. The BRT (2003) noted that productivity of this ESU would be below replacement if it were not for artificial propagation. The BRT (2003) found moderately high risks for all VSP categories.

Effects Analysis

This ESU spawns, incubates, and rears outside of the action areas. This ESU only occurs in the action areas when juveniles exit the Willamette River and enter the Lower Columbia – Clatskanie River HUC (17080003) or when upstream migrating adults exit the Lower Columbia – Clatskanie River HUC (17080003) and enter the Willamette River. This is about 755.5 km downstream from Hells Canyon Dam and even farther from Reclamation's upper Snake River basin projects. Adults and juveniles use the lower 163 km of the Columbia River for migration. The effects of Reclamation's proposed actions are likely to have minimal if any effect on the EFH of this ESU. Because of the distance downstream from Reclamation's upper Snake River projects, and the much larger volume of water in the Columbia River at this point, the effects of the proposed actions on EFH for this ESU are unquantifiable but likely negligible.

Effects Conclusion

Based on the distance downstream from Reclamation's upper Snake River projects where this ESU enters the action areas, and the much greater flows in the Columbia River compared to the contribution from Reclamation's proposed actions at this point in the action areas, Reclamation concludes that its proposed actions will not adversely affect EFH in the Columbia River for Upper Willamette River Chinook salmon.

10.4.9 Lower Columbia River Coho Salmon

This ESU is a candidate proposed for listing under the ESA (69 FR 33101). Outmigrating juvenile Lower Columbia River Chinook salmon enter the action areas when they exit various lower Columbia River tributaries and enter the Mid Columbia – Hood HUC (17070105). The BRT (NOAA Fisheries 1991) was unable to identify whether an historical coho salmon ESU existed in the Lower Columbia River. Additional information obtained in the mid-1990s indicated that it might be part of a larger coho salmon ESU, and it was combined with the Southwest Washington/Lower Columbia River ESU. In 2001, the BRT (NOAA Fisheries 2001) concluded that the Lower Columbia River coho salmon ESU is separate from the Southwest Washington coho salmon ESU, based on tagging studies, differing marine distributions, and genetics.

This ESU is altered from historical conditions and natural production is limited to two Oregon populations in the Sandy and Clackamas Rivers (69 FR 33101). Because the BRT concluded that the hatchery-produced fish contain a significant portion of the historical diversity of Lower Columbia River coho salmon, the progeny of 21 artificial propagation programs are considered, along with the two naturally spawning populations, part of the ESU.

Effects Analysis

This ESU spawns, incubates, and rears far downstream from Hells Canyon Dam and Reclamation's upper Snake River projects; juvenile outmigrants encounter EFH when they enter the Mid Columbia – Hood HUC (17070105). Because of the distance downstream from Reclamation's upper Snake River projects, and the much larger volume of water in the Columbia River at this point, the effects of the proposed actions on EFH for this ESU are unquantifiable but likely negligible.

Effects Conclusion

Based on the distance downstream from Reclamation's upper Snake River projects where this ESU enters the action areas and encounters EFH, and the much greater flows in the Columbia River compared to the contribution from Reclamation's proposed actions at this point in the action areas, Reclamation concludes that its proposed actions will not adversely affect EFH in the Columbia River for Lower Columbia River coho salmon.

10.4.10 Southwest Washington Coho Salmon

This ESU was originally combined with the Lower Columbia River coho salmon ESU but has recently been separated from this ESU. In July 1995, NOAA Fisheries originally determined that the combined Southwest Washington/Lower Columbia River coho salmon ESU was not warranted for listing. The combined ESU included all naturally spawned populations of coho salmon from Columbia River tributaries below the Klickitat River on the Washington side and below the Deschutes River on the Oregon side (including the Willamette River as far upriver as Willamette Falls), as well as coastal drainages in southwest Washington between the Columbia River and Point Grenville. Although the June 17, 2004, table of Status of West Coast Salmon and Steelhead (NOAA Fisheries 2004) shows the Southwest Washington coho salmon ESU as separate from the Lower Columbia River coho salmon ESU, Reclamation was unable to locate definitive information regarding the geographic range of this ESU. One could surmise that the Southwest Washington coho salmon ESU includes those populations of coho salmon in Columbia River tributaries below the Klickitat River on the Washington side, as well as coastal drainages in southwest Washington between the Columbia River and Point Grenville. The coho salmon from the coastal drainages in southwest Washington between the mouth of the Columbia River and Point Grenville are for the most part outside the action areas.

Effects Analysis

Some populations of this ESU enter and use the action areas in the lower Columbia River when juvenile outmigrants encounter EFH when they enter the Lower Columbia – Sandy River HUC (17080001) and those HUCs farther downstream. Because of the distance downstream from Reclamation's upper Snake River projects, and the much larger volume of water in the Columbia River at this point, the effects of the proposed actions on EFH for this ESU are unquantifiable but likely negligible.

Effects Conclusion

Based on the distance downstream from Reclamation's upper Snake River projects where this ESU enters the action areas and encounter EFH, and the much greater flows in the Columbia River compared to the contribution from Reclamation's proposed actions at this point in the action areas, Reclamation concludes that its proposed actions will not adversely affect EFH in the Columbia River for Southwest Washington coho salmon.

10.5 Summary of Effects Analysis

Reclamation concludes that the proposed actions will not adversely affect EFH for Upper Columbia River spring Chinook salmon, Middle Columbia River spring Chinook salmon, Upper Columbia River summer/fall Chinook, Deschutes River summer/fall Chinook salmon, Lower Columbia River Chinook salmon, Upper Willamette River Chinook salmon, Lower Columbia River coho salmon, and Southwest Washington coho salmon.

Reclamation concludes that the proposed actions will adversely affect EFH for Snake River fall Chinook salmon and Snake River spring/summer Chinook salmon.

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PART IV

APPENDIX A THROUGH APPENDIX E

Appendix A LIST OF SPECIES

A.1 USFWS ESA-listed Species Occurring in the Action Areas

Table A-1 presents the USFWS ESA-listed species that occur in the action areas. The USFWS verified this list in a letter dated September 28, 2004.

Reclamation reviewed the listed species that may occur in the action areas. During the information-gathering and initial analysis stages, Reclamation concluded that some of the ESA-listed species were not found in the action areas, were strictly terrestrial species, or, if they were found in the action areas, would not be affected by the proposed actions. Reclamation determined that further analysis for these species was unnecessary. Section A.3 presents, for information only, the rationale behind these determinations.

Table A-1. USFWS ESA-listed species in the action areas.

Common Name	Scientific Name	Status
Bald eagle	*Haliaeetus leucocephalus*	Threatened
Banbury Springs lanx	*Lanx* sp.	Endangered
Bliss Rapids snail	*Taylorconcha serpenticola*	Threatened
Bruneau hot springsnail	*Pyrgulopsis bruneauensis*	Endangered
Bull trout	*Salvelinus confluentus*	Threatened
Canada lynx	*Lynx canadensis*	Threatened
Gray wolf	*Canis lupus*	Experimental/ non-essential
Grizzly bear	*Ursus arctos*	Threatened
Idaho springsnail	*Pyrgulopsis idahoensis*	Endangered
MacFarlane’s four o’clock	*Mirabilis macfarlanei*	Threatened
Northern Idaho ground squirrel	*Spermophilus brunneus brunneus*	Threatened
Snake River physa	*Physa natricina*	Endangered
Utah valvata snail	*Valvata utahensis*	Endangered
Ute ladies’-tresses	*Spiranthes diluvialis*	Threatened
Water howellia	*Howellia aquatilis*	Threatened

A.2 NOAA Fisheries ESA-listed Species Occurring in the Action Areas

Table A-2 presents the NOAA Fisheries ESA-listed and proposed species that occur in the action areas. It also shows the three species for which NOAA Fisheries has designated critical habitat. NOAA Fisheries verified this list in a letter dated October 20, 2004.

Table A-2. NOAA Fisheries ESA-listed and proposed species in the action areas.

Common Name	Scientific Name	Status
Chinook salmon	*Oncorhynchus tshawytscha*	
Snake River spring/summer run ESU [1]		Threatened
Snake River fall run ESU [1]		Threatened
Lower Columbia River ESU		Threatened
Upper Columbia River spring run ESU		Endangered
Upper Willamette River ESU		Threatened
Columbia River chum salmon ESU	*Oncorhynchus keta*	Threatened
Lower Columbia River coho salmon ESU	*Oncorhynchus kisutch*	Proposed
Snake River sockeye salmon ESU [1]	*Oncorhynchus nerka*	Endangered
Steelhead	*Oncorhynchus mykiss*	
Lower Columbia River ESU		Threatened
Middle Columbia River ESU		Threatened
Upper Columbia River ESU		Endangered
Upper Willamette River ESU		Threatened
Snake River Basin ESU		Threatened

1 These species have designated critical habitat in the action areas.

A.3 ESA-listed Species for which Reclamation Determined No Effect

A.3.1 Banbury Springs Lanx

Banbury Springs lanx (*Lanx* sp.), currently listed as endangered, is a snail found only in three alcove spring complexes adjacent to the mainstem Snake River at Banbury Springs, Box Canyon Springs, and Thousand Springs upstream from Hagerman (RM 584.6 to 589). These springs are all located 50 miles or more downstream from Milner Dam (RM 639.1). Cazier (1997) notes that this species has shown no range expansion and remains confined to the three known spring areas. Hydroelectric operations and high spring-time river flows do not affect these three springs. Reclamation has determined that the proposed actions will have no effect on the Banbury Springs lanx or habitat important to its survival.

A.3.2 Bruneau Hot Springsnail

Bruneau hot springsnail (*Pyrgulopsis bruneauensis*), currently listed as endangered, is found only in a few small spring complexes in the lower Bruneau River. Reclamation operation and maintenance activities do not affect or influence the Bruneau River subbasin. Reclamation has determined that the proposed actions will have no effect on the Bruneau hot springsnail or habitat important to its survival.

A.3.3 Canada Lynx

The Canada lynx (*Lynx canadensis*) was listed as threatened for the contiguous United States on April 24, 2000. In the action areas, the Canada lynx occurs in subalpine coniferous forest in Idaho and Wyoming that receive deep snowfall.

Canada lynx primarily prey on the snowshoe hare (*Lepus americanus*) that inhabits forests with dense understories. The hare has evolved to survive in areas that also receive deep snow. There is habitat suitable to support Canada lynx and snowshoe hare primarily near the action areas of Lake Cascade, Jackson Lake, and Deadwood and Palisades Reservoirs. Reservoir drawdown does not affect the surrounding habitat, which occurs above the maximum high-water line. Further, no evidence has been found to show that the Canada lynx requires the use of riverine habitats. Reclamation has determined that the proposed actions will have no effect on the Canada lynx or habitat important to its survival.

A.3.4 Grizzly Bear

In 1975, the 8-year-old endangered listing for the grizzly bear (*Ursus arctos*) was amended to threatened in the lower 48 states (except where listed as an experimental population) (40 FR 31734). Currently, there are five grizzly bear sub-populations outside Alaska and Canada, in Wyoming, Washington, Idaho, and Montana. Distribution of the grizzly bear in the action areas occurs in the Greater Yellowstone Area (GYA), which encompasses parts of Idaho, Wyoming, and Montana. The grizzly population in the GYA has grown steadily since it was listed and is now being considered for delisting. Reclamation's operations at facilities in the GYA have had and will continue to have no effect on the species (USBR 2004). Reclamation has determined that the proposed actions will have no effect on the grizzly bear or habitat important to its survival.

A.3.5 MacFarlane's Four-o'clock

MacFarlane's four-o'clock (*Mirabilis macfarlanei*) was first listed as endangered in 1979 but reclassified as threatened in 1996 (61 FR 10693). This perennial plant has a deep tap root and grows about 18 inches high. The vibrant magenta flowers are broadly tubular and grow in the leaf axils. It is found in three disjunct locations, one of which is along the Snake River in Hells Canyon in both Idaho and Oregon. It is an upland species, found generally at low elevation on steep talus slopes in canyonland corridors where the climate is regionally warm and there is little precipitation. Reclamation has determined that the proposed actions will have no effect on MacFarlane's four-o'clock or habitat important to its survival.

A.3.6 Northern Idaho Ground Squirrel

The northern Idaho ground squirrel (*Spermophilus brunneus brunneus*) was federally listed as a threatened species on April 5, 2000. A USFWS-published recovery plan (2003) provides the following data on the ground squirrel.

This subspecies is known to exist only in Adams and Valley Counties in western Idaho. The entire range of the subspecies is about 1,200 square miles. As of 2002, 34 of 40 known population sites were extant. The subspecies declined from an estimated 5,000 individuals in 1985, to less than 1,000 individuals by 1998 when it was proposed for listing. Following extensive census data from the spring of 2002, the USFWS estimated the population to be 450 to 500 animals.

The northern Idaho ground squirrel is known to occur in shallow, dry rocky meadows usually associated with deeper, well-drained soils and surrounded by ponderosa pine and Douglas-fir forests at elevations of about 3,000 to 5,400 feet. Similar habitat occurs up to at least 6,000 feet. Consequently, ponderosa pine/shrub-steppe habitat association with south-facing slopes less than 30 percent at elevations below 6,000 feet is considered to be potentially suitable habitat. Forest encroachment into formerly suitable meadow habitats is the species' primary threat. Forest encroachment causes habitat fragmentation, eliminates dispersal corridors, and confines squirrel populations into small isolated habitat islands. The subspecies is also threatened by land use changes, recreational shooting, poisoning, genetic isolation, genetic drift, random naturally occurring events, and competition from the larger Columbian ground squirrel (*S. columbianus*).

Lake Cascade is the only Reclamation facility located within the area of the northern Idaho ground squirrel's probable historical distribution (USFWS 2003). However, none of the known populations are adjacent to Lake Cascade or along the North Fork Payette River downstream from the lake (USFWS 2003). The northern Idaho ground squirrel probably does not occur adjacent to any Reclamation facilities and is not associated with shoreline or riparian habitats. Reclamation has determined that the proposed actions will have no effect on the northern Idaho ground squirrel or habitat important to its survival.

A.3.7 Water Howellia

Water howellia (*Howellia aquatilis*), currently listed as threatened, is an annual that grows as a submerged plant in bottom sediments of ponds, sloughs, and cutoff river meanders. It is known to occur at one site in Latah County, Idaho, and in Washington and Montana. These locations are outside the areas of Reclamation's influence. Suitable habitat to support this species is not likely present in the Snake River basin (Moseley 1997). Reclamation has determined that the proposed actions will have no effect on water howellia or habitat important to its survival.

A.4 Literature Cited

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Appendix B OPERATIONS AND MAINTENANCE ADDENDUM

Reclamation's *Operations Description for Bureau of Reclamation Projects in the Snake River Basin above Brownlee Reservoir* (2004) provides an overview of future operations at Reclamation facilities in the upper Snake River basin. During this consultative process, Reclamation determined that this document did not fully reflect some facets of the proposed actions. This appendix presents this addendum of operations and routine maintenance information.

B.1 Salmon Flow Augmentation

This section first describes how Reclamation will provide up to 487,000 acre-feet annually for salmon flow augmentation. Flow augmentation is a component of four proposed actions: future O&M in the Snake River system above Milner Dam, the Boise River system, the Malheur River System, and the Payette River system; and future provision of salmon flow augmentation from the rental or acquisition of natural flow rights. Current State of Idaho legislation allowing flow augmentation expires on January 1, 2005. These proposed actions are contingent on State legislation for salmon flow augmentation and are consistent with a proposed Nez Perce water rights settlement agreement.

B.1.1 Sources for Flow Augmentation

Uncontracted Space

Space not under contract in Reclamation's storage reservoirs is a reliable source of water in most years. Currently, uncontracted space is administratively assigned to a variety of purposes, including mitigation, conservation pools, reservoir evaporation, streamflow maintenance, and salmon flow augmentation. Reclamation relies on this space as much as possible in meeting its commitment to provide augmentation flows. By 1998, Reclamation had acquired reservoir space for 22,896 acre-feet in the reservoirs upstream from Milner Dam and 37,378 acre-feet in the Boise River basin. In addition, Reclamation has administratively assigned for salmon flow augmentation 3,554 acre-feet of storage in the Boise River basin and 95,000 acre-feet of storage in the Payette River basin. This uncontracted space has been assigned for salmon flow augmentation for as long as it is needed for ESA-listed anadromous fish runs. Reclamation treats reacquired space the same as space not under contract. It has the same reliability of refill and is used as much as possible for salmon flow augmentation.

Rental Pools

Reclamation does not control sufficient uncontracted storage or natural flow water rights to provide the 487,000 acre-feet for flow augmentation, so Reclamation will attempt annually to rent additional water to meet part of its commitment of 487,000 acre-feet from rental pools.

Reclamation complies with State law, State regulations, water bank rules, and local rental pool procedures when acquiring and providing water for salmon flow augmentation. The State of Idaho enacted legislation (Idaho Code, Chapter 17, Section 42-1763B) to provide interim approval for Reclamation to rent storage water through the Idaho rental pools' water banks. This legislation expires on January 1, 2005.

Water rental pools operate under State law and at the direction and under the rules of the Idaho Water Resource Board (IWRB). The local water rental pool organization determines local water rental pool rules and leasing prices; the IWRB then approves or denies these rules and prices. The watermaster administers the rental pool under the guidance of the local water rental pool organization. Reclamation, as a storage facility owner and contractor, is also involved and must also approve the rules and rates for Federal storage.

Water rentals reduce the volume of reservoir carry-over at the end of the irrigation season. This reduces the likelihood that reservoirs will refill the following year. Since the mid-1980s and prior to Reclamation's current efforts to provide augmentation flows, the rental pools have been governed by a "last to fill" provision for water used downstream from Milner Dam or outside the Boise and Payette River systems. This rule avoids injury to storage rights of those who rely on carryover storage the following year. Thus, the parties making water available for salmon flow augmentation have assumed any risks that the evacuated space may fail to refill the following year.

For the rental pools, a proposed Nez Perce water rights settlement agreement contemplates that the agreement's parties will not exercise agricultural preferences over Reclamation's reacquired or uncontracted space.

The Shoshone-Bannock Tribes have rights to contract space in American Falls Reservoir, which they may rent for downstream uses in accordance with the terms of their water rights settlement. The settlement provides that the Tribes' rentals will be in accordance with a Tribal water bank. The Tribes and Reclamation have entered into a long-term lease for 38,000 acre-feet of space in American Falls Reservoir. Drought prevented this water from being available in 2002, 2003, and 2004 because the water was used to meet irrigation commitments for the Fort Hall Project.

Reclamation may also arrange for Idaho Power to rent Boise Project, Arrowrock Division uncontracted and powerhead space under a separate provision of Idaho law (Idaho Code, Section 42-108A), if necessary. Reclamation does not anticipate exercising this provision.

Natural Flows

Malheur River Basin

Reclamation has permanently acquired 17,847 acre-feet of natural flow rights in Oregon. These are rights to the Malheur River with supplemental Snake River rights. To the degree the Malheur primary rights would be curtailed under the prior appropriation doctrine, the supplemental rights on the Snake River would be available. The acquired Snake River rights have never been curtailed to meet senior rights.

Snake River below Milner Dam

In recent years, severe drought conditions restricted the volume of storage water available for salmon flow augmentation. This condition was not unpredicted; Reclamation's hydrologic modeling since the mid-1990s had predicted that water would not be available in all years. Beginning in 2002, Reclamation rented water from holders of natural flow water rights along the Snake River in Idaho below Milner Dam.

Future provision of salmon flow augmentation from the rental or acquisition of natural flow rights constitutes an additional source for flow augmentation water. Reclamation will rent or acquire consumptive natural flow water rights from the Snake River between Milner and Swan Falls Dams (high-lift pumpers) during the salmon flow augmentation period. When added to the other sources, this water increased the total water available for flow augmentation to 487,000 acre-feet.

Powerhead

Reclamation may use powerhead at Anderson Ranch Reservoir to meet salmon flow augmentation objectives (this occurred in 1993, 1994, and 2002).

As a last resort source for flow augmentation, Palisades Reservoir powerhead space. Reclamation has not used Palisades Reservoir powerhead recently. The Idaho

Department of Water Resources asserts that the water rights licenses for Reclamation projects only authorized filling powerhead space at Palisades Reservoir one time, and that powerhead water is not eligible for State protection through the State-authorized rental pools.

Reclamation will seek a water right for its Palisades powerhead space. No more than 78,500 acre-feet of water stored in that space (one-half of the inactive space or the total accrual to that space, if less) would then be available for salmon flow augmentation in accordance with these provisions:

- Palisades Reservoir powerhead can only be used if the sum of all other sources in this and other proposed actions is less than 427,000 acre-feet. If water from all other sources, including natural flows, is sufficient to provide 427,000 acre-feet for flow augmentation, Reclamation will not release powerhead.
- Use of powerhead cannot interfere with provision of established minimum conservation pools.
- When used for flow augmentation, powerhead space is last of the last space to refill.
- Use of powerhead space shall comply with State law.
- Use of powerhead cannot interfere with diversions of water in reservoir pools or natural flow, or the ability of spaceholders to refill and use active storage.
- Use of powerhead will not affect rates for hydroelectric power and energy paid by irrigation entities that receive preference pumping power from Reclamation.

B.1.2 Releases of Water

Flow augmentation is primarily for juvenile salmon migration between April 20 and August 31. Reclamation generally assumes the 487,000 acre-feet would be needed in July and August with recession of natural flows and the beginning of storage draft for irrigation. Storage releases for irrigation generally begin by early July but may begin as early as April or May in low water years.

The strategy for releasing flow augmentation water depends on the volume of water available and the timing of the natural runoff. Typically, Reclamation does not release augmentation water as long as natural flows are sufficient to meet the flow objectives at Lower Granite Dam. All released water must reach Brownlee Reservoir by about August 31 each year. The State watermasters are responsible for the regulation of rental water delivery. Reclamation, the State, spaceholders, and contract holders discuss and determine the timing and release of flow augmentation water.

Boise River Releases

The Boise River system reservoirs have released about 41,000 acre-feet of water for flow augmentation in recent good water years. Reclamation has typically requested that releases for salmon flow augmentation begin when storage releases for irrigation begin. This release at Lucky Peak Dam is usually 400 cfs above the volume of stored water released for irrigation. Flows are usually about 1500 cfs below the Boise River Diversion Dam. The Ada County Parks and Waterways Department considers flows above 1,500 cfs unsafe for floaters in the lower Boise River, and flows above 1,500 cfs damage gravel pushup dams.

Payette River Releases

The Payette River system reservoirs have provided about 160,000 acre-feet of water for flow augmentation in good water years. The Payette River Watershed Council meets on a regular basis to discuss a variety of operational issues. Reclamation participates in these meetings and has attempted to develop consensus on a flow release plan.

Payette River augmentation releases typically begin when the reservoir system begins to draft for irrigation, usually by late June or early July, although this has occurred earlier in dry years. With the final volume of available water and the start time known, Reclamation formulates release strategies that derive the maximum benefit to other functions, such as flows for recreational floating, recreational levels for lake boating, water quality, power production, etc., and still delivers augmentation volumes by August 31. Payette River Watershed Council recommendations are also taken into consideration when possible. Flow augmentation rates average from about 800 cfs to 1,500 above irrigation deliveries, depending on volume, start time, and natural flows in the system.

Snake River Releases above Milner Dam

Flow augmentation releases are made at Milner Dam, a private dam and the lowest point of regulation within the Minidoka and Palisades storage system. Milner Pool has a modest volume of storage, so release from up-river storage reservoirs are necessary to provide the water needed and sustain Milner Pool storage volumes at adequate levels.

Reclamation will adjust the timing and volume of salmon flow augmentation at Milner Dam to facilitate delivery of the upper Snake storage water in a timely manner. The Milner Agreement, which limited flows at Milner Dam to 1,500 cfs, expired in 1999. The proposed Nez Perce water rights settlement agreement contemplates a renewed Milner Agreement with a modified flow limitation. Release rates and starting times will be flexible enough to ensure that the entire augmentation volume will reach the lower Snake River by August 31.

Absent a new Milner Agreement, Reclamation proposes to release salmon augmentation flows of up to 3,000 cfs past Milner Dam. Salmon releases will begin on or after June 20 and will continue until complete, usually by August 20. Augmentation will begin after the maximum reservoir fill is achieved and after flood releases past Milner Dam are over. Ramp-up will be limited to about 500 cfs per day with hourly changes greater than 100 cfs avoided. Ramp-down will be at approximately 100 cfs per day to accommodate listed snails. The maximum flow release at Milner Dam will be adjusted based on the volume of water available but will be no less than 1,200 cfs. Salmon augmentation releases of up to 3,000 cfs at Milner Dam may be necessary before the end of the flow augmentation period in order to satisfy USFWS ramping criteria. This will occur only when flow augmentation is delayed beyond July 4 due to late runoff conditions. In order to maintain a relatively constant pool elevation at the Milner Pool, gradual changes in releases at American Falls and Minidoka Dams will be necessary. Providing flow augmentation below Milner Dam will require close coordination with Idaho Power.

The water Reclamation provides for salmon flow augmentation will be added to the minimum flow established under the October 1984 Swan Falls Agreement. The proposed Nez Perce water rights settlement agreement also incorporated the Swan Falls Agreement between the State of Idaho and Idaho Power into the settlement in part to continue to protect Snake River flows at the Murphy gage (immediately downstream from Swan Falls Dam). This agreement stipulates that minimum flow levels in the Snake River at the Murphy gage are 3,900 cfs from April 1 to October 31, and 5,600 cfs from November 1 to March 31. The rights will be honored in priority in accordance with the terms of the Swan Falls Agreement.

B.2 Additional Payette River System Water to Supplement Irrigation in Dry Years

A proposed Nez Perce water rights settlement contemplates Reclamation providing up to an additional 30,000 acre-feet of water from the Payette River system for Boise and/or Payette River basin irrigation rental in extremely dry years. This water would be from sources exclusive of Reclamation’s 95,000 acre-feet of reassigned space used for flow augmentation (69,600 acre-feet from Lake Cascade and 25,400 acre-feet from Deadwood Reservoir).

This provision is triggered when Reclamation's April 1 forecast for the Boise River at Lucky Peak is less than 570,000 acre-feet or when Reclamation's April 1 forecast for the Payette River at Horseshoe Bend is less than 700,000 acre-feet. For the 83-year period of record from 1920 to 2002, this condition occurred in 8.4 percent of the years (7 out of 83 years) in both the Boise and Payette River basins. When this trigger occurs, Reclamation may consign water to either or both Water District 63 or 65 rental pools for one-year rental.

Operationally, Reclamation will use uncontracted space at Deadwood Reservoir. Reclamation has administratively reserved 30,000 acre-feet of space in Deadwood Reservoir to maintain a 50-cfs winter instream flow downstream from the dam. This entails uncontracted space in the reservoir and is not part of the volume reserved to maintain a conservation pool of 50,000 acre feet or that used for flow augmentation.

Reclamation would provide 30,000 acre-feet of water for irrigation by making this water available during those years when a trigger occurs. Boise River basin water users would obtain this water through an exchange. Reclamation has similarly used this uncontracted water several times in the past, most recently in 2002 and 2003, without violating the 50,000-acre-foot minimum pool in Deadwood Reservoir and the 50-cfs winter streamflow because natural inflow to Deadwood Reservoir has been greater than 50-cfs during the winter months. For example, in all years for the 1971 through 2003 period, including the very dry years of 1977, 1992, 1994, and 2001, winter inflows at Deadwood Reservoir have exceeded 50 cfs. Therefore, Reclamation has been able to maintain the 50-cfs outflow at Deadwood Dam and a 50,000-acre-foot conservation pool, even if the beginning winter reservoir elevation is already at conservation pool elevation.

Water released to maintain the winter instream flow is deducted from Reclamation's uncontracted storage space. Inflow to the reservoir accrues to reservoir spaceholders on a pro rata basis, and Reclamation accrues some of the inflow to its uncontracted space even while releasing 50 cfs. This means at least 50,000 acre-feet of water will physically remain in Deadwood Reservoir, although technically some of this water may be accruing to irrigation storage accounts. Space evacuated for salmon flow augmentation is subject to a last-to-fill rule.

This operation does risk the possibility that if there are multiple consecutive dry years, and if Deadwood Reservoir fails to fill, Reclamation may not be able to maintain a 50,000-acre-foot conservation pool. Reclamation's uncontracted space would also have failed to fill, and consequently, as Reclamation released water to honor irrigation storage contract obligations, the reservoir may drop below the conservation pool elevation.

Despite this risk, it is unlikely that a full 30,000-acre-foot shortage would ever occur. System flexibility allows water to be supplied for irrigation or salmon flow augmentation through exchanges with other reservoirs. Another reservoir may be able to supply water to meet a potential shortfall for a year or two following this operation. For example, Reclamation may use up to 7,000 acre-feet of conservation pool at Lake Cascade. In the years Reclamation has employed this operational strategy, Deadwood Reservoir volume has not fallen below the conservation pool volume, and Reclamation has been able to provide the winter instream flow below Deadwood Reservoir. At most, Reclamation estimates the conservation pool could be reduced by up to 10,000 acre-feet (down to 40,000 acre-feet) in a small percentage of years, mainly multiple successive dry years. The modeled proposed actions predict that up to about 4,000 acre-feet of the conservation pool may be used about 7 percent of the time. In addition, at Lake Cascade, the modeled proposed actions predict that the conservation pool will be maintained. As the modeled tables in Appendix D show, the extreme minimum volume of contents at Deadwood Reservoir would be 46,621 acre-feet.

B.3 Minimum Winter Flows below Owyhee Dam

The *Operations Description for Bureau of Reclamation Projects in the Snake River Basin above Brownlee Reservoir* (USBR 2004) notes that at the discretion of the Joint Committee (Owyhee, Gem, and Ridgeview Irrigation Districts), releases below Owyhee Dam are made to maintain instream flows of 15 to 20 cfs between the irrigation seasons in years of good carryover. In the summer of 2004, the irrigation districts adopted an environmental commitment to provide a 30-cfs minimum flow below Owyhee Dam from October 15 through April 15. The districts have agreed to adhere to this environmental commitment except during or immediately following times of irrigation shortage. During these periods, the districts would proportionately reduce the releases.

B.4 Routine Maintenance

Water conveyance and control facilities require periodic inspection, maintenance, and repair. Those proposed actions that include routine maintenance, inspection, and repair activities are limited to those actions' associated features and facilities. Reclamation (or the operating entity) prepares a yearly program for routine maintenance activities for review, approval, and execution. Reclamation (with the operating entity, where applicable) also inspects the major features described in this document every three to six years. Inspection reports are developed and recommendations are incorporated into the yearly routine maintenance programs where applicable. Some maintenance, inspection, and repair activities are not routine; these activities are not part of the proposed action, and they would be consulted on separately.

Reclamation (or the operating entity) will take advantage of low river conditions or low reservoir elevations when possible to accomplish repairs or inspections so that there is little or no affect on normal operations. In some cases, however these activities may require reducing or temporarily suspending river flows. However, this is avoided whenever possible and depends on the water conditions of that particular year.

Scheduled maintenance and inspections usually occur during lower flows in the late summer, fall, or winter. If possible, Reclamation (or the operating entity) reroutes river or waterway flows around the work area. For example, inspection, maintenance, and repair of the spillway discharge tunnel at Owyhee Dam can occur if river flows are routed through the river outlet works or the powerplant; in this scenario, the activity does not affect river flows. Where this is not possible, river flows may be temporarily suspended for the duration of the work. This can potentially occur at Agency Valley, Black Canyon Diversion, Boise River Diversion, Deadwood, Island Park, Mason, Ririe, Thief Valley, Unity, and Warm Springs Dams. Normal operation of Grassy Lake and Ririe Dams includes shut down at the end of the irrigation season.

The following eight subsections summarize the categories of routine maintenance activities that are part of the proposed actions. It is difficult to predict the details associated with activities for each of the facilities over a 30-year term. Therefore, as part of the proposed action, Reclamation will annually review its maintenance program activities and meet with USFWS and NOAA Fisheries to discuss routine maintenance program activities that require operations outside the range described in this biological assessment. The Services and Reclamation would then determine if any upcoming routine maintenance activities require supplemental analysis and/or consultation.

Routine Inspection of All Discharge Features

Reclamation inspects spillways, canal headworks, river outlet works, powerplant outlet works, pumping plant equipment, and associated equipment at least every six years. These inspections are typically performed under dewatered conditions but can be performed by divers, climbers, and other specially trained personnel. Whenever possible, inspections are scheduled to minimize effects to water deliveries and environmental and other interests. The inspection of these features may require temporary suspension or diversion of flow via another discharge feature for minutes or hours to ensure the safety of inspection personnel.

Periodic Testing of All Mechanical Equipment

Reclamation strives to operate each gate and valve through at least one complete cycle each year. Gate and valve operation under both balanced (operation in dry conditions or equal head on both sides of the gate or valve) and unbalanced head is critical to ensure the reliability of the equipment. In many cases, spillway gate testing is limited to operation during dewatered conditions or a portion of the full operating cycle due to potential impacts downstream. The testing of gates and valves typically results in minor or no fluctuation in the downstream waterway.

Periodic testing of other mechanical equipment such as compressors for air bubbler ice prevention systems, emergency backup generators, and pumps, is required to ensure that the equipment is operating satisfactorily.

Routine Maintenance of Discharge Features and Associated Equipment

This work includes concrete repairs, protective coating repairs, and maintenance of mechanical equipment. Whenever possible, Reclamation schedules maintenance such that impacts to streamflows, water deliveries, or environmental or other interests are minimal. Maintenance activities may require dewatering, temporary suspension or rerouting of flow via another discharge feature to allow access to the pertinent feature, curing of repair material such as concrete and protective coatings, or to ensure the safety of maintenance personnel. A reservoir may be temporarily surcharged to allow diversion of flow via a spillway to allow repair of river outlet works features.

Vegetation Control

Reclamation must prevent the growth of trees and other deep-rooted vegetation on and adjacent to all embankments, concrete structures and other appurtenant features, and along the alignment of buried features. This work is necessary to reduce the risk of structural problems associated with root systems and rodent burrows. In addition, vegetation control is needed such that visual inspection of the facilities is not compromised. Methods of vegetation control include pulling, cutting, or herbicide application, which is employed in accordance with EPA label and other applicable rules and regulations.

Rodent Control

Reclamation must prevent or minimize rodent populations on and near embankments because of the risk of structural problems associated with burrows. Methods of rodent control include shooting, poisoning, and trapping and relocation, which are employed in accordance with EPA label and other applicable rules and regulations.

Crest Roadway Grading

The roadway surface across the top of embankment dams requires periodic grading to ensure that surface runoff drains toward a protected slope (typically the upstream face of the dam).

Debris Removal

Debris carried into a reservoir must be removed to avoid complications related to controlled discharges. Methods for debris removal include manual collection and disposal and flushing the debris via spillway discharges. Manually collected debris is disposed of through burning, stockpiled in a public area, or removed by another party (for example, a landscape business) through a mutual agreement.

Maintenance of Instrumentation Devices

Reclamation must maintain the instrumentation installed in and near a dam to ensure the quality of the data collected. This work may entail removal of moss, algae, or a beaver dam adjacent to a seepage measurement device; vegetation control adjacent to an instrument; or repair of vandalism damage.

Appendix C HISTORICAL HYDROLOGIC DATA

C.1 Historical Reservoir Contents and Outflows

Table C-1 and Table C-2 show the maximum, median, and minimum end-of-month reservoir contents and outflows for the period of record from 1971 to 2003. These tables depict the entire range of operations that have occurred for the period of record. The tabulated data does not represent a single water year, but rather they are a composite of the records for each individual day within each month. These tables show companion data to the summary hydrographs presented in Appendix B of the Reclamation's *Operations Description for Bureau of Reclamation Projects in the Snake River Basin above Brownlee Reservoir* (2004). This appendix provides the information summarized in the tables for all reservoirs included in this consultation.

C.2 Historical Record of Salmon Flow Augmentation Sources and Volumes

The flow augmentation tables in Table C-3 and Table C-4 show the volumes of salmon flow augmentation Reclamation has provided from the upper Snake River since 1991 and the storage sources for these volumes. In the early 1990s, drought conditions severely reduced the availability of rental water. In 1992, there was no rental water available for salmon flow augmentation. In 1993 and 1994, Reclamation used powerhead space to ensure flow augmentation. In 2001, there was very little water available to rent; further, the declared "power emergency" prevented Reclamation from using powerhead space. The severe drought of recent years continued into 2004. For the Snake River at Heise, 2001, 2002, 2003, and 2004 have been among the driest years of record. Taken consecutively, they represent the driest period of record.

Table C-1. Historical maximum, median, and minimum end-of-month reservoir contents at Federal reservoirs (1971 to 2003).
(Table reflects total capacity including active, inactive, and dead storage)

Location	Reservoir Contents (acre-feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
Jackson Lake (reservoir storage does not include an unquantified natural lake storage)												
Maximum	664,626	657,849	679,929	694,322	693,345	674,572	716,643	850,838	874,138	854,200	843,181	764,712
Median	549,214	546,700	557,670	566,857	566,385	556,734	555,192	493,900	708,298	772,686	610,502	545,820
Minimum	57,708	59,310	68,000	82,300	82,700	90,600	74,525	46,200	132,500	207,000	119,600	55,000
Palisades Reservoir												
Maximum	1,399,684	1,401,158	1,396,730	1,378,639	1,364,499	1,399,351	1,406,000	1,410,542	1,419,174	1,411,033	1,400,672	1,403,907
Median	1,098,878	1,084,500	1,119,382	1,168,000	1,119,399	1,026,000	848,973	863,373	1,232,219	1,312,960	1,096,440	1,025,330
Minimum	206,524	218,764	318,428	390,706	453,849	397,953	258,826	239,549	557,936	373,936	268,917	206,925
American Falls Reservoir												
Maximum	1,548,027	1,347,000	1,407,099	1,537,334	1,588,022	1,682,000	1,703,000	1,715,000	1,735,769	1,712,000	1,672,590	1,527,808
Median	421,875	683,939	864,490	983,556	1,172,534	1,382,000	1,536,207	1,571,694	1,473,949	1,103,340	711,097	349,590
Minimum	0	130,980	403,180	671,333	902,296	861,400	972,700	869,060	615,910	168,880	13,500	0
Lake Walcott												
Maximum	213,350	210,408	199,010	192,340	198,930	213,840	220,430	218,140	218,380	217,734	216,930	215,970
Median	192,666	158,813	153,300	154,017	154,856	169,938	207,273	209,900	209,945	210,296	209,945	209,341
Minimum	109,960	108,790	107,450	117,889	136,060	142,661	154,327	200,399	199,345	198,311	133,970	13,560
Arrowrock Reservoir												
Maximum	193,688	230,005	281,919	284,090	292,152	286,600	286,600	288,736	291,616	290,400	251,136	197,569
Median	62,030	106,192	143,095	187,950	219,175	215,020	205,822	200,820	257,155	205,330	88,130	37,820
Minimum	0	23,150	48,227	67,727	68,254	41,551	16,470	9,380	7,800	5,292	1,757	0

Table C-1. Historical maximum, median, and minimum end-of-month reservoir contents at Federal reservoirs (1971 to 2003), continued. Table reflects total capacity including active, inactive, and dead storage.

Location	Reservoir Contents (acre-feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
Anderson Ranch Reservoir												
Maximum	492,095	492,002	457,373	463,032	461,160	442,800	477,432	497,500	502,600	500,487	493,048	491,100
Median	382,970	370,850	369,086	350,600	335,998	312,076	306,455	373,204	474,202	472,900	422,530	396,515
Minimum	62,870	56,754	50,592	44,449	40,156	39,333	76,681	124,468	124,344	92,338	81,058	71,086
Lucky Peak Reservoir												
Maximum	255,097	254,197	252,797	253,197	260,597	270,997	294,237	298,197	302,867	299,367	295,947	295,197
Median	82,116	80,581	86,836	95,187	103,709	120,728	204,058	252,305	288,854	292,946	291,906	185,056
Minimum	28,767	29,502	39,197	36,703	29,147	52,885	60,367	43,897	77,997	76,823	37,605	29,869
Lake Cascade												
Maximum	622,700	653,811	674,481	644,936	580,614	601,642	673,900	708,768	717,800	711,148	696,688	662,779
Median	439,820	446,253	453,186	445,129	442,975	426,801	436,832	506,952	667,060	675,987	583,081	491,700
Minimum	213,830	224,150	243,870	265,350	294,580	274,000	262,800	264,900	363,800	308,500	241,900	209,100
Deadwood Reservoir												
Maximum	127,000	131,479	136,185	137,576	130,614	130,529	145,211	171,040	172,250	170,380	163,790	126,102
Median	67,688	72,925	77,235	82,817	88,114	92,447	96,115	109,684	154,379	151,109	100,996	70,126
Minimum	0	3,860	15,530	21,630	32,560	39,050	53,190	69,572	78,750	55,670	0	0
Beulah Reservoir												
Maximum	36,252	40,466	47,540	52,000	60,388	60,190	61,461	61,059	60,577	59,349	47,956	36,548
Median	12,628	15,720	19,744	24,333	28,595	39,310	56,692	56,896	51,987	37,941	22,998	14,639
Minimum	0	1,242	3,849	7,043	10,490	13,716	19,763	7,042	185	0	0	0

Table C-2. Historical maximum, median, and minimum streamflows below Federal dams (1971 to 2003).

Location	Streamflow (cfs)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
Jackson Lake Outflow (Snake River near Moran gage)												
Maximum	2,852	1,590	826	1,200	1,530	3,500	6,050	8,880	11,700	9,030	6,000	6,690
Median	452	402	405	416	414	430	451	2,510	3,545	2,520	2,500	2,149
Minimum	151	138	144	140	86	89	78	191	177	198	935	180
Palisades Reservoir Outflow (Snake River near Irwin gage)												
Maximum	8,870	8,160	6,000	7,470	13,100	16,400	17,400	21,400	40,300	22,900	13,300	12,452
Median	3,210	1,810	1,810	2,250	2,005	2,100	6,105	12,000	13,758	13,458	8,600	6,847
Minimum	873	700	699	692	571	556	556	1,220	7,116	7,110	4,177	2,280
American Falls Reservoir Outflow (Snake River at Neeley gage)												
Maximum	14,500	14,600	12,900	15,200	19,900	22,100	26,100	29,900	46,000	26,800	16,500	16,300
Median	3,020	1,960	2,880	3,970	2,310	3,240	8,840	11,643	12,800	12,600	11,500	7,645
Minimum	239	114	177	187	201	280	720	3,870	6,800	8,290	2,320	1,570
Minidoka Reservoir Outflow (Snake River near Minidoka Dam gage)												
Maximum	15,600	14,400	13,600	15,400	20,000	20,697	24,700	27,900	42,700	25,400	14,700	14,800
Median	3,190	2,710	3,210	4,036	2,665	2,750	8,605	9,240	9,545	9,680	9,180	6,390
Minimum	329	333	87	84	303	362	408	2,720	6,030	7,335	1,357	1,262
Milner Dam Outflow (Snake River at Milner gage)												
Maximum	15,700	14,200	13,800	16,322	20,079	20,656	21,400	19,700	30,919	17,064	7,091	7,156
Median	1,010	2,165	3,320	3,980	2,570	2,800	5,455	2,685	1,105	482	480	461
Minimum	0	2	216	232	157	5	1	1	1	0	0	0

Table C-2. Historical maximum, median, and minimum streamflows below Federal dams (1971 to 2003), continued.

Location	Streamflow (cfs)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
Anderson Ranch Reservoir Outflow (South Fork Boise River gage)												
Maximum	1,140	1,550	1,590	3,020	3,040	3,050	3,880	7,890	7,820	3,970	2,760	1,730
Median	300	302	306	310	316	318	615	1,530	1,700	1,530	1,204	526
Minimum	23	139	191	189	130	97	99	121	551	278	172	122
Lucky Peak Reservoir Outflow (Boise River near Boise gage)												
Maximum	4,600	2,000	3,500	6,950	7,030	7,810	10,600	10,848	13,200	10,500	4,850	4,600
Median	204	156	242	238	272	1,190	3,014	4,710	4,585	4,450	4,150	3,000
Minimum	0	0	2	28	90	8	92	2,210	2,190	2,310	400	217
Lake Cascade Outflow (North Fork Payette River at Cascade gage)												
Maximum	2,300	1,700	2,230	3,780	3,820	4,880	2,980	4,780	6,970	5,560	2,980	3,050
Median	214	216	272	287	237	265	615	692	1,310	1,310	1,730	1,535
Minimum	16	14	122	125	118	110	127	23	127	155	236	134
Deadwood Reservoir Outflow (Deadwood River below Deadwood Dam gage)												
Maximum	769	100	509	526	1,300	750	900	2,220	2,200	1,720	1,650	1,600
Median	3	3	3	3	3	3	4	53	490	709	765	73
Minimum	0	0	0	0	1	1	1	1	1	4	2	0
Beulah Reservoir Outflow (North Fork Malheur River at Beulah gage)												
Maximum	233	10	10	520	2,060	1,630	1,458	1,330	1,110	490	450	374
Median	1	0	0	0	1	2	229	327	305	297	238	102
Minimum	0	0	0	0	0	0	0	4	8	40	26	0
Brownlee Reservoir Inflow (Brownlee Reservoir gage)												
Maximum	31,036	30,686	61,375	70,250	84,721	75,671	84,244	90,600	66,930	41,701	21,631	22,536
Median	14,133	14,855	16,174	17,405	18,605	22,775	28,049	26,151	20,512	10,204	10,834	12,828
Minimum	7,003	9,193	6,739	8,187	6,931	8,106	5,300	5,474	4,674	4,172	4,941	5,808

Table C-3. Historical record of water provided for salmon flow augmentation (in acre-feet) from 1991 to 2004.

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004 [1]
Snake River above Milner Dam														
Reclamation Space	15,000	0	206,617	285,954	22,396	22,396	22,396	22,896	21,824	22,896	4,717	0	0	0
Rentals, Water Dist. 01	84,000	0	65,000	44,325	232,839	194,667	202,104	200,325	148,397	162,325	0	0	0	0
Rentals, Tribes	—	0	0	0	0	0	0	0	38,000	38,000	36,724	0	0	0
Subtotal	*99,000*	*0*	*271,617*	*330,279*	*255,235*	*217,063*	*224,500*	*223,221*	*208,221*	*223,221*	*41,441*	*0*	*0*	*0*
Snake River below Milner Dam (Snake River High Lift Pumpers [2])														
Idaho Rentals	0	0	0	0	0	0	0	0	0	0	0	37,889	43,135	115,660
Oregon Rentals	0	0	0	0	0	0	0	0	0	0	0	9,600	0	50,000
Subtotal	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*47,489*	*43,135*	*165,660*
Boise River Basin														
Reclamation Space	0	0	23,000	35,950	25,000	38,000	38,000	40,932	40,932	40,932	0	60,198	58,628	41,700
Rentals	0	0	0	0	2,000	0	2,000	0	0	0	0	0	0	0
Subtotal	*0*	*0*	*23,000*	*35,950*	*27,000*	*38,000*	*40,000*	*40,932*	*40,932*	*40,932*	*0*	*60,198*	*58,628*	*41,700*
Payette River Basin														
Reclamation Space	28,874	90,000	95,000	61,883	94,242	95,000	95,000	95,000	95,000	95,000	30,000	110,000	110,000	115,510
Rentals	73,651	0	34,971	0	50,758	56,300	60,000	50,000	65,000	50,000	0	50,000	54,500	0
Subtotal	*102,525*	*90,000*	*129,971*	*61,883*	*145,000*	*151,300*	*155,000*	*145,000*	*160,000*	*145,000*	*30,000*	*160,000*	*164,500*	*115,510*
Lemhi River Basin														
Rentals	0	0	0	0	0	0	0	0	0	0	1,000	1,000	1,000	1,000
Oregon Natural Flows														
Skyline Farms	0	0	0	0	0	15,714	17,649	17,649	17,649	17,649	17,649	17,649	17,649	17,649
Oregon Water Trust	0	0	0	0	0	64	132	198	198	198	198	198	198	198
Subtotal	*0*	*0*	*0*	*0*	*0*	*15,778*	*17,781*	*17,847*	*17,847*	*17,847*	*17,847*	*17,847*	*17,847*	*17,847*
Total	**201,525**	**90,000**	**424,588**	**428,112**	**427,235**	**422,141**	**437,281**	**427,000**	**427,000**	**427,000**	**90,288**	**286,534**	**285,110**	**341,717**

1 Projected as of September 2004.

2 Reclamation entered into an agreement with IDWR to lease natural flows from high lift pumpers between Milner Dam and King Hill. IDWR monitors compliance to ensure that crops are taken out of production. IDWR is still verifying final volumes.

Table C-4. Historical record of Reclamation storage sources used for salmon flow augmentation.

Reclamation Space	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004 [1]
Snake River above Milner Dam (Minidoka, Palisades, and Ririe Projects)														
American Falls Reservoir	—	—	0	0	8,951	8,951	8,951	8,951	8,884	8,951	4,717	0	0	0
Jackson Lake	—	—	0	0	3,923	3,923	3,923	3,923	3,795	3,923	0	0	0	0
Palisades Reservoir	—	—	13,615	15,754	9,522	9,522	9,522	10,022	9,145	10,022	0	0	0	0
Palisades Dam powerhead	—	—	18,794	153,530	0	0	0	0	0	0	0	0	0	0
Minidoka Dam powerhead	—	—	95,575	99,240	0	0	0	0	0	0	0	0	0	0
Ririe Reservoir	—	—	78,633	17,430	0	0	0	0	0	0	0	0	0	0
Subtotal	*15,000* [2]	*0*	*206,617*	*285,954*	*22,396*	*22,396*	*22,396*	*22,896*	*21,824*	*22,896*	*4,717*	*0*	*0*	*0*
Boise Project, Arrowrock Division														
Anderson Ranch Reservoir	—	—	0	0	3,000	3,000	3,000	0	0	0	0	0	0	0
Anderson Ranch Reservoir (inactive space)	—	—	20,000	10,950	0	0	0	0	0	0	0	36,260	0	0
Lucky Peak Reservoir	—	—	3,000	25,000	22,000	35,000	35,000	40,932	40,932	40,932	0	23,938	58,628	41,700
Subtotal	*0*	*0*	*23,000*	*35,950*	*25,000*	*38,000*	*38,000*	*40,932*	*40,932*	*40,932*	*0*	*60,198*	*58,628*	*41,700*
Boise Project, Payette Division														
Lake Cascade	—	—	69,600	26,845	68,842	69,600	69,600	69,600	69,600	69,600	0	69,600	69,600	69,600
Deadwood Reservoir	—	—	25,400	35,038	25,400	25,400	25,400	25,400	25,400	25,400	30,000	40,400	40,400	46,060
Subtotal	*28,874* [2]	*90,000* [2]	*95,000*	*61,883*	*94,242*	*95,000*	*95,000*	*95,000*	*95,000*	*95,000*	*30,000*	*110,000*	*110,000*	*115,660*

1 Projected as of September 2004.
2 Exact sources not tracked prior to 1993.

Appendix D MODELED HYDROLOGIC DATA

Table D-1 and Table D-2 show the modeled maximum, median, and minimum end-of-month reservoir contents and outflows if all the proposed actions are implemented. These tables only provide information for river reaches and reservoirs where there may be issues with ESA-listed species.

Table D-1. Modeled proposed actions maximum, median, and minimum end-of-month reservoir contents at Federal reservoirs. (Table reflects total capacity including active, inactive, and dead storage)

Location	Reservoir Contents (acre-feet)											
	Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**
Jackson Lake (reservoir contents do not reflect an unquantified natural lake volume)												
Maximum	659,539	666,677	681,277	698,003	699,903	649,903	724,978	847,008	847,008	847,008	750,007	697,077
Median	635,096	638,167	647,002	646,003	645,765	627,753	592,325	730,029	847,003	800,004	716,948	635,256
Minimum	0	5,509	15,309	27,609	32,509	41,809	70,472	221,030	508,205	336,298	57,254	0
Palisades Reservoir												
Maximum	1,300,002	1,300,002	1,300,002	1,336,903	1,400,001	1,400,001	1,400,001	1,400,002	1,400,008	1,400,008	1,300,007	1,300,002
Median	1,083,636	1,179,094	1,259,200	1,180,844	1,166,449	1,058,005	1,094,613	1,178,321	1,400,003	1,319,562	1,190,537	1,036,006
Minimum	139,810	200,201	249,701	287,401	314,201	353,301	300,007	612,025	902,544	454,118	200,201	118,554
American Falls Reservoir												
Maximum	1,200,001	1,300,000	1,500,001	1,400,004	1,500,003	1,672,592	1,672,598	1,672,598	1,672,598	1,600,007	1,400,007	1,259,170
Median	420,081	753,500	1,029,940	1,223,554	1,379,834	1,550,353	1,627,703	1,671,415	1,672,593	1,035,545	472,378	380,506
Minimum	85,366	260,489	410,367	649,046	843,794	1,065,082	874,945	443,654	100,356	0	0	50,178
Lake Walcott												
Maximum	171,000	151,000	151,000	151,000	171,000	205,000	210,200	210,200	210,200	210,200	210,200	210,200
Median	171,000	151,000	151,000	151,000	171,000	205,000	210,200	210,200	210,200	210,200	210,200	210,200
Minimum	171,000	151,000	151,000	151,000	171,000	205,000	210,200	210,200	210,200	210,200	210,200	210,200
Arrowrock Reservoir [1]												
Maximum	150,000	180,002	230,007	233,987	242,564	281,967	286,608	286,608	286,607	286,608	201,997	216,713
Average	114,644	147,999	190,500	160,781	161,650	221,800	247,822	274,796	286,604	227,995	114,604	97,132
Minimum	28,661	29,135	54,935	57,322	28,661	56,700	28,661	114,644	28,661	28,661	28,661	28,075

1 Capacity does not reflect recent sedimentation survey from 1997, 1998 or 2002.

Table D-1. Modeled proposed actions maximum, median, and minimum reservoir contents at several reservoirs by month, continued. (Table reflects total capacity including active, inactive, and dead storage)

Location	Reservoir Contents (acre-feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
Anderson Ranch Reservoir [1]												
Maximum	463,766	464,502	448,990	435,071	424,578	413,684	442,985	493,186	493,190	493,191	461,148	464,469
Median	353,928	357,476	361,028	353,928	3392328	330,865	364,175	450,506	493,186	432,488	386,814	373,405
Minimum	52,432	56,432	61,132	65,932	69,833	69,833	119,056	150,489	69,833	49,408	49,408	49,408
Lucky Peak Reservoir												
Maximum	148,769	148,769	168,767	219,625	266,142	268,846	288,567	293,025	293,024	293,025	293,025	262,373
Median	128,767	138,767	138,767	158,383	186,725	211,857	228,119	266,600	293,021	293,021	247,719	154,431
Minimum	28,767	55,193	58,193	68,180	93,116	128,574	108,767	175,000	205,117	85,584	28,7670	28,767
Lake Cascade												
Maximum	566,669	604,227	566,664	557,120	553,392	561,165	611,552	693,125	693,130	693,129	620,675	586,665
Median	492,053	507,109	518,635	504,270	505,171	512,799	570,988	661,198	693,126	638,218	530,365	482,866
Minimum	293,936	297,661	303,797	301,880	300,021	316,112	389,187	421,478	461,516	366,532	293,936	293,936
Deadwood Reservoir [1]												
Maximum	123,376	130,000	135,000	129,320	131,727	133,204	146,267	162,003	162,008	160,007	130,006	120,006
Median	73,227	77,100	80,100	81,680	83,290	88,726	99,284	135,857	162,004	115,619	79,339	71,140
Minimum	46,621	46,831	47,931	47,901	47,191	49,551	58,122	81,005	64,804	50,001	47,481	46,671

1 Capacity does not reflect most recent sedimentation surveys from 1997, 1998 or 2002.

Table D-2. Modeled proposed actions maximum, median, and minimum streamflows (reservoir outflows) at several river gages by month.

Location	Streamflow (cfs)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
Jackson Lake Outflow (Snake River near Moran gage)												
Maximum	976	840	651	651	651	735	2,879	6,831	7,076	5,083	5,334	3,546
Median	336	304	390	468	507	392	710	1,952	3,892	2,762	2,542	2,218
Minimum	273	282	273	273	292	273	282	293	807	1,654	976	1,008
Palisades Reservoir Outflow (Snake River near Irwin gage)												
Maximum	6,545	4,736	3,872	7,439	8,236	8,631	18,570	18,028	30,284	19,849	12,686	11,871
Median	3,065	1,465	1,073	2,773	2,555	2,572	5,917	10,837	14,697	11,368	8,654	6,496
Minimum	1,756	958	927	927	991	927	1,109	3,911	8,105	8,420	6,357	4,033
American Falls Reservoir Outflow (Snake River at Neeley gage)												
Maximum	9,323	11,399	7,498	14,143	12,174	12,167	22,935	24,531	34,440	17,970	15,614	10,982
Median	3,299	2,017	1,952	3,402	3,617	4,305	7,313	11,655	11,936	12,841	11,517	7,622
Minimum	835	202	195	195	417	342	2,864	7,470	8,796	8,742	6,733	2,751
Lake Walcott Outflow (Snake River near Minidoka Dam gage)												
Maximum	9,992	11,320	8,372	14,288	12,141	11,887	23,140	22,796	31,345	16,064	13,676	9,718
Median	3,537	2,421	2,046	3,601	3,474	3,836	6,554	10,597	9,667	10,389	9,462	6,362
Minimum	1,343	580	133	224	277	60	2,510	6,025	7,151	7,668	5,274	2,128
Milner Dam Outflow (Snake River at Milner gage)												
Maximum	6,536	11,982	8,422	15,160	12,453	11,754	20,075	15,468	22,554	7,347	5,729	3,903
Median	488	2,498	2,247	3,756	3,580	3,677	3,730	4,204	2,283	1,833	1,501	303
Minimum	195	488	390	488	522	146	202	149	5	5	5	5

Table D-2. Modeled proposed actions maximum, median, and minimum streamflows (reservoir outflows) at several river gages by month, continued.

Location	Streamflow (cfs)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
Anderson Ranch Reservoir Outflow (South Fork Boise River gage)												
Maximum	1,038	810	719	1,930	3,241	2,927	4,852	3,868	3,692	2,244	1,561	504
Median	390	303	293	293	324	480	1,478	1,561	1,875	1,561	976	504
Minimum	122	126	122	122	157	293	504	585	1,613	521	114	131
Lucky Peak Reservoir Outflow (Boise River near Boise gage)												
Maximum	3,539	949	2,518	6,184	6,847	6,864	10,083	9,758	8,090	5,775	4,597	3,516
Median	1,179	202	234	669	741	915	4,599	5,583	5,353	4,081	3,951	3,235
Minimum	475	81	78	78	86	98	768	2,746	3,716	2,923	1,364	452
Lake Cascade Outflow (North Fork Payette River at Cascade gage)												
Maximum	1,073	3,025	1,783	2,440	3,161	1,952	2,929	3,462	4,918	2,196	2,196	1,480
Median	293	222	215	340	359	391	539	1,254	1,904	1,403	1,890	1,036
Minimum	82	202	195	195	156	195	202	215	807	1,064	1,339	283
Deadwood Reservoir Outflow (Deadwood River below Deadwood Dam gage)												
Maximum	67	60	101	266	294	340	1,062	962	968	1,013	1,208	252
Median	49	50	49	49	54	49	50	114	501	624	817	50
Minimum	49	50	49	49	52	49	50	49	202	98	49	50
Brownlee Reservoir Inflow (Brownlee Reservoir gage)												
Maximum	22,655	26,858	26,391	48,543	48,843	64,610	81,463	67,572	57,980	25,034	17,240	17,868
Median	13,752	15,579	14,980	17,260	18,630	19,942	27,822	27,619	24,049	12,542	11,537	11,878
Minimum	9,128	10,751	9,711	10,119	8,184	10,621	8,906	8,592	7,748	6,423	5,350	6,864

The folder entitled Pisces contains Pisces and the model results. First, copy the folder's contents onto the hard drive.

Appendix E THE UPPER SNAKE RIVER MODSIM MODEL

Reclamation used the Upper Snake River MODSIM model (version date 7/13/04) to simulate project operations under the proposed actions. Reclamation then used the modeled output to evaluate the hydrologic effects of the proposed actions on ESA-listed species in the action areas. MODSIM is a general purpose river and reservoir operations computer simulation model. Colorado State University and Reclamation jointly developed the model.

The following is a list of items on the enclosed CD-ROM with additional information about how to use the feature or where to access the information. Before accessing any of the CD-ROM's files, first copy the contents onto the computer's hard drive.

E.1 *Pisces*

This software acts as the general user interface for the data contained on the CD-ROM. After copying the CD-ROM's contents onto the hard drive, run the pisces.exe application. Clicking "Help!" on the *Pisces* menu bar will open an HTML file in the browser entitled "How to View Model Output Using Pisces." This page contains helpful information for viewing and manipulating data from the CD-ROM.

Through this interface, a user can view the following modeled output as tables or graphs:

- time series data for river flows and reservoir contents and elevations (a time series is a hydrograph for the period of record)
- exceedance data for river flows and reservoir contents and elevations (an exceedance curve shows how often a river reach or reservoir equals or exceeds a specific flow or volume)

The data are output as monthly flows or end-of-month reservoir contents or elevations.

E.2 Model Description

Since 1992, Reclamation and Colorado State University (CSU) have jointly enhanced the MODSIM river simulation model in order to address various river system operation analyses requirements. Early emphasis on water rights, storage allocation, water banking/rental pool, and water exchange accounting was very successful in developing a procedure that allows integration of simulation of very complex large scale physical river systems and, optionally, detailed water rights/entitlements accounting. More recently, efforts have been made to streamline the use of groundwater response functions as an option for analyzing conjunctive management practices. Most recently, the MODSIM model and user interface have been ported to the .NET software platform to allow for a wider audience of users and enhancements for the “scripting” capability (used to create customized basin specific models).

MODSIM uses a state-of-the-art Lagrangian Relaxation network flow cost minimization procedure to simulate an “optimized” distribution of water in the river system for each of a series of time steps. Linear equations represent the river topology mass balance constraints and the objective function of minimizing the “cost” of the flow that will flow through all links in the network. The modeler (through a user interface) creates a data set for the model in terms of the river system physical features (reservoir area, capacity, elevation tables; location of local gains; diversion location and temporal distribution; etc), the operational considerations (for example, meeting a flow objective below Palisades Dam of 1,100 cfs or 1,500 cfs, depending on forecasted runoff), and, optionally, water rights and storage allocation constraints.

The Snake River data set for MODSIM represents major river, reservoir, and water demand features of the Snake River upstream from Brownlee Reservoir. Many of the smaller tributaries are modeled as a single local gain; some tributaries, such as the Malheur and Wood Rivers have separate model data sets that can generate sub-basin simulation for inclusion with the main Snake River data set.

Simulation results are expressed in terms of anticipated monthly volume river flows, irrigation diversions, and end-of-month reservoir contents. Where applicable, other output includes reservoir evaporation, seepage, power generation, groundwater pumping, depletion, return flows, and consumptive and nonconsumptive demand shortage. In addition, if the basin model uses MODSIM’s water allocation constructs, model output includes reservoir priority accrual, natural flow diversion at each demand, storage contract accrual, carryover, use, and rental pool activity.

E.3 Modeling River System Features

In the simulations, river reaches, reservoirs, diversion “groups,” and other major features of the Snake River were originally taken from “planning” models from the Idaho Department of Water Resources (IDWR). These models were used to complete analysis for many long-term operation proposals before the Upper Snake River

MODSIM model was developed. Data from various sources has since replaced and augmented that obtained from the IDWR model data sets.

River reaches are designated by long-term river gage locations; some of the river gages have been introduced since 1928 (the first year of the temporal period of record simulated); some river gages that were in existence through many years of the period of record have been discontinued. Usually, if a gage location has an important operational consideration and is currently being used, the gage is modeled; if a discontinued gage has a long period of historical record and is used in developing model parameters such as return flows, these gages are many times retained in the model. If a historical gage location is not used operationally and water budgets for model parameter derivation can be produced without reference to the discontinued gage, the gage is not modeled. Operation flow objectives are modeled for 31 river reaches in the Snake River 2004 biological assessment data set. Flow objectives are modeled as nonconsumptive demands. Some of the flow objectives are for aquatic life support, fish and wildlife considerations, river head maintenance for diversion capability, recreation, and flood control objectives. Many flow objectives are multi-purpose. Some trans-basin diversions, such as Reservation Canal and Eagle Rock, are modeled as nonconsumptive diversions similar to flow objective demands.

Diversion "group" nodes represent one or more diversion demands combined out of convenience for modeling purposes. If one can reasonably assume that model parameters (such as return flow coefficients) can be shared by diversions in the same proximity from modeled river gages, then one can safely combine the diversions. If the diversions must be analyzed to account for their own unique parameters or constraints (such as water rights), then the diversions should be modeled separately. Natural flow water rights were obtained from IDWR files used in their water rights allocation models of the Idaho Water Districts. Storage contracts are from Reclamation files. Each natural flow right and storage contract, along with rent pool agreements, are modeled with individual links from a river node to the demand node. The Snake River 2004 biological assessment data set analyses have 103 irrigation diversion groups. The following sections list the diversion groups by sub-basin; the last section describes reservoirs.

E.3.1 Henrys Fork

Abv_Asht	Yellow-M	Sqrl-Che	Farm_Own	Enterpri
Fall_Riv	Chest_Cu	Fall_R_C	Last_Cha	StAnth_U
Asht-StA	FarmFr_S	Egin_Ind	Consol_F	Abv_StAn
Siddoway	MiscTt	Wilford	Teton_Is	RexburgC
Dewey				

E.3.2 Snake above AMF

Wyom_Irr	Abv_Heis	Riley	Heis-Lrz	Anderson
FarmF-En	Harrison	Burgess	LowerDry	Sunnydel
LrzIFall	ButteMrk	Osgood	GreatWes	Idaho
AbTexDiv	BlwRRdiv	SandCDiv	BlwSandC	SnkRivVa
IFallShy	Woodville	ShyBlkft	BlkftCor	NewLavas
PeopAber	FortHall	Parsons		

E.3.3 Snake AMF-Milner

FallsID	NlyMndka	MindkInc	MndkaMil	SSideTwi
A_BPump	MilGood	NorthSid	MilLowLi	BurleyID

E.3.4 Snake below Milner

RaftRive	LowLine	SalFallC	BellRapi	BlackMes
KngHlPP	MiscKH_S	CJPPdiv	CJMurpDi	SnakeRID
GrandvID	GrandMut	KngHillP	Owydown	OWCO
599	710	720		

E.3.5 Boise

Sebree	Riversid	Eureka2	Nots_Par	Settlers
ThurmanM	FarmersU	9EagleIs	NEagleIs	CanyonCn
Phyllis	CaldwHig	NewYork	DeerFlat	Ridenbau
BubbBois	Penitent			

E.3.6 Payette

SsBlkCan	NsBlkCan	640	655	660_670
NFStorRt				

E.3.7 System Reservoirs

Reservoirs modeled are those that have significant impact on the physical flows in the river system or accounting for water use entitlement. Area, capacity, elevation, and hydraulic capacity data are obtained from Standard Operating Procedures, design drawings, HYDROMET tables, and personal contact with operation agency personnel. Eighteen reservoirs are modeled in the Snake River 2004 biological assessment data set. Listed below are the 18 reservoirs with their modeled maximum contents.

Cbtt Name	Acre-feet	Cbtt Name	Acre-feet
GRS	15,200	HEN	90,400
ISL	135,000	JCK	847,000
PAL	1,400,000	BLK	350,000
AMF	1,672,590	MIN	210,200
RIR	80,500	OWY	735,000
CSC	646,461	DED	162,000

PAY	35,000	EMM	30,880
AND	464,200	ARK	286,600
LUC	264,250	LOW	159,400

E.4 Snake River Water Supply Gains and Demands

A critical element of this analysis is the derivation of a data set of past river gains modified to the year 2000 level of irrigation. Period of record (from 1928 to 2000) water supply gains and diversion demand are computed for the Snake River basin upstream from Brownlee Dam. Previous analyses were performed using a 1928-1989 data set modified to the year 1989 level of irrigation (Robertson and Sutter 1989). Since 1989, river gains have decreased in some areas and a longer data set was needed which reflected this phenomena. Diversion demand is summarized for the period from 1991 to 2000 and grouped/averaged for dry, average, or wet water supply conditions. These three diversion patterns are considered to be water year 2000 development level and will be used in modeling analyses to represent anticipated diversion demands in near future operation simulation analyses. The water supply gains are in some cases unregulated river gains derived from historical recorded streamflow and diversion data; in some cases unregulated river gains are adjusted by various means to represent a "present condition" influence from groundwater interaction.

E.4.1 Snake River above King Hill

Unregulated local river gains are computed using historical streamflow and diversion records. Streamflow records are obtained from USGS, IDWR and USBR; diversion records are provided by IDWR and Reclamation data bases. Correlations are used to fill in and extend unrecorded data to obtain a complete record from 1928 to 2000. Short term return flow factors are taken from Garabedian (1992). Computations are completed using Excel spreadsheets or, where the reach is complex with return flow computations, small MODSIM networks. The basic mass balance equation is:

Equation 1 Unregulated Local Gain = Downstream gage – Upstream gage + historical diversions – short-term return flow + change in reservoir storage + reservoir evaporation

Reclamation's Science and Technology program sponsored activities to investigate the use of groundwater response functions to quantify the influence of groundwater interaction on river gains in the Snake River upstream from King Hill. Response functions from the East Snake Plain Aquifer groundwater model are supplied in the form of an Access database from Idaho Water Resources Research Institute (IWRRI). Procedures are developed to apply the response functions to areas of historical irrigation practice (see Reclamation's Science and Technology Program Procedures for Conjunctive Management Analyses in the Upper Snake River Basin).

Historical irrigated acreage is taken from Garabedian and IDWR GIS maps. Consumptive use is estimated using the estimated acreage, crop patterns, and historical temperature and precipitation data with a Blaney Criddle method (see Computer Procedure XCons Denver Technical Service Center). MODSIM networks are created with response functions, historical diversions, short-term return flow factors, and consumptive use for 26 surface water irrigation areas per Garabedian and in 21 groundwater diversion zones per IWRRI (see Johnson and Cosgrove 1999) to compute aquifer recharge and the lagged influence in 7 reaches of the Snake River from the surface water recharge and groundwater use. This influence is removed from the unregulated river gains to derive a more naturalized streamflow. The response functions are used with current average surface and groundwater diversions to estimate "steady state present conditions" influence to river gains; these are added to the "naturalized" gains to represent current conditions water supply over the historical period of record. Implicit to the MODSIM networks are the following equations:

Equation 2	Aquifer Recharge = Surface irrigation diversion – consumptive use – short-term return flow
Equation 3	Aquifer Depletion = Groundwater irrigation consumptive use
Equation 4	"Naturalized Local River Gain" = Unregulated local gain – lagged Aquifer Recharge + lagged Aquifer Depletion
Equation 5	"Steady State Present Condition Local River Gain" = "Naturalized Local River Gain" + lagged influence from future surface irrigation diversions – lagged influence from future groundwater irrigation use

Future surface and groundwater diversions, for the above computations, are estimated as the average historical diversions from 1996 to 2000.

E.4.2 Boise River

Spreadsheets and MODSIM networks are used with historical USGS streamflow and IDWR estimated diversion data to derive unregulated local gains for the period of record from 1928 to 2000. Estimated diversion data is based on spotted records of historical data from the mid-1950s, 1977, and more complete records after 1985.

Correlations are used to estimate historical streamflows and river gains where streamflow data was not recorded. Historical return flows are estimated from the IDWR estimated diversion data to match annual volumes of drain data derived as part of the Treasure Valley Hydrologic Project. GIS methods are used to assign diversion infiltration rates for the major diversions.

For the period from 1928 to 1949, significant negative gains result from the use of the historical streamflow, estimated diversion, and return flows in the reach from Boise River at Glenwood to Notus. The computed negative gain is not dependent on the estimated flow at Glenwood (even with zero flow at Glenwood the gain would compute negative) but is dependent on the estimated diversion and return flows in this reach. Anderson Ranch Reservoir filled for the first time in 1951; before this time, diversions patterns were considerably different than after. Rates of diversions and efficiencies changed (rates went up and efficiencies went down) with the added water supply in summer months. The computed gain for this reach is correlated with the flow at Glenwood (estimated flow), which made the computed gain between Glenwood and Notus consistent throughout the period of record. The gain plus return flow from Glenwood to Middleton is estimated as a percent of the total gain plus return flow from the IDWR planning model. The gain from Glenwood to Middleton needs to meet estimated diversions in the reach with the estimated flow at Glenwood. The final gain from Glenwood to Middleton is taken as the maximum of the ratio of the Glenwood to Notus gain and the gain needed to meet estimated diversion. The remainder of the Glenwood to Notus gain is assigned downstream of Middleton. In below average water supply years some small negative gains are computed; these are retained as an adjustment to the static efficiencies assumed in deriving return flows.

E.4.3 Payette River and Snake River downstream of King Hill

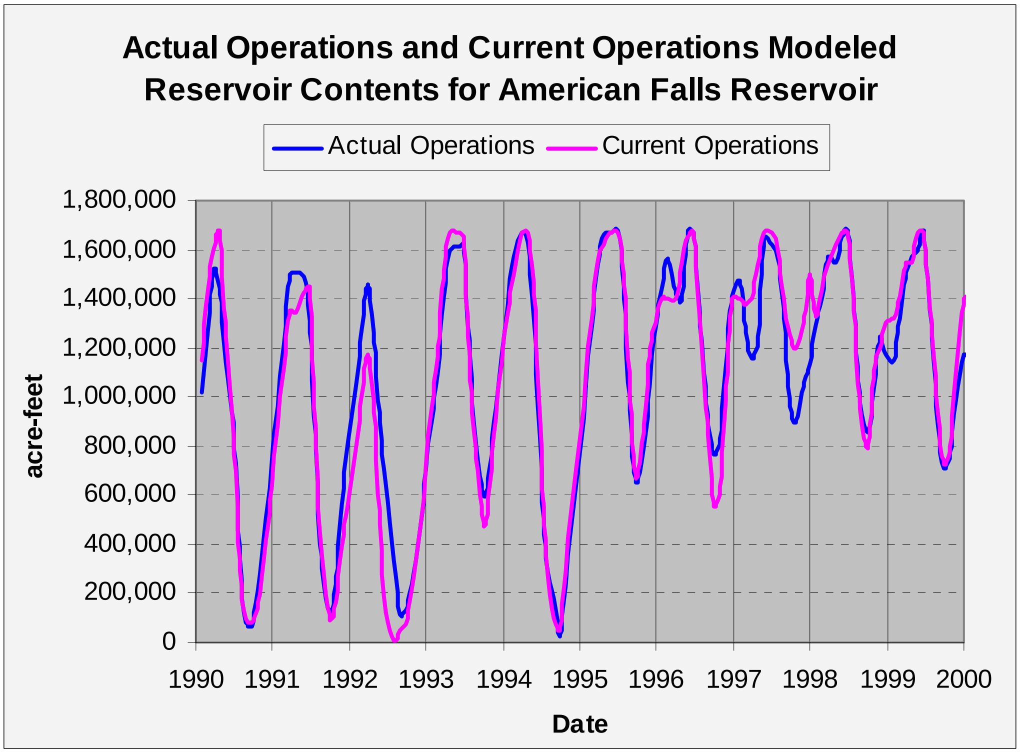
Spreadsheets are used with USGS and Reclamation recorded streamflow data and IDWR recorded/estimated diversion data to compute unregulated local gains for flow points in the existing MODSIM model data set. Return flows on the Snake River are estimated using infiltration and lag factors that originated from IDWR. No return flows were estimated for diversions in the Payette and Owyhee River basins. In many cases, where there are discontinuous records at intermediate river gage locations, a composite gain is computed for a larger area between gages with a complete record and a simple correlation of the smaller area gain to the composite gain is used to disaggregate the larger area gain. No adjustments are made to the unregulated local gains; the gains are assumed to represent the period of record water supply under envisioned modeling studies.

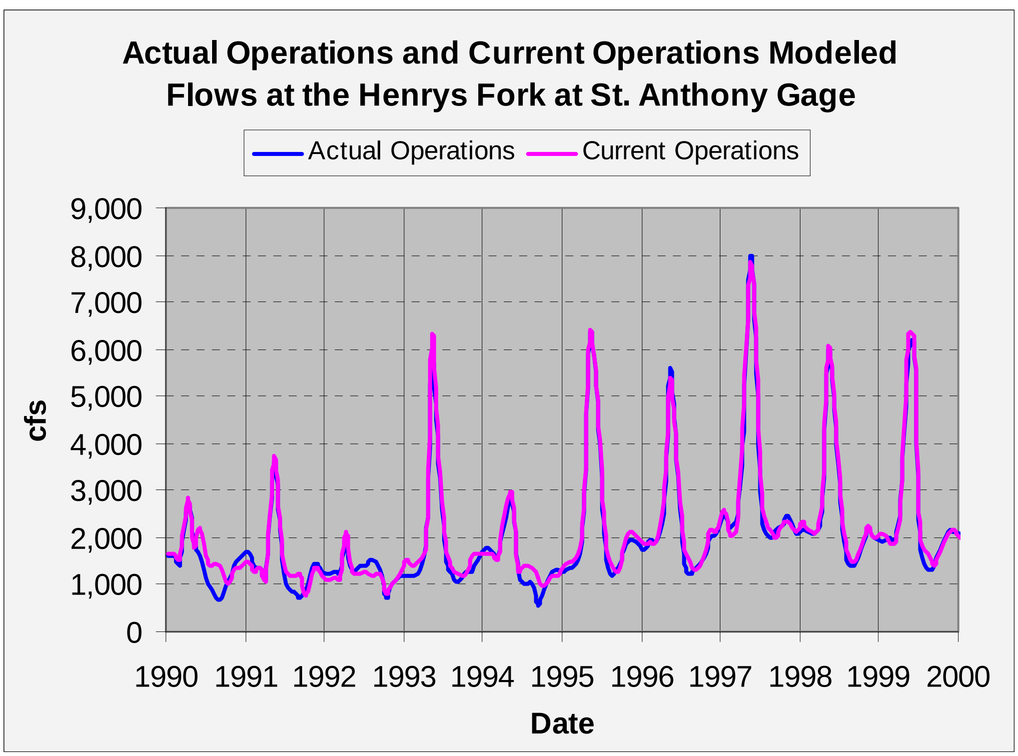
E.5 Modeling Intangibles

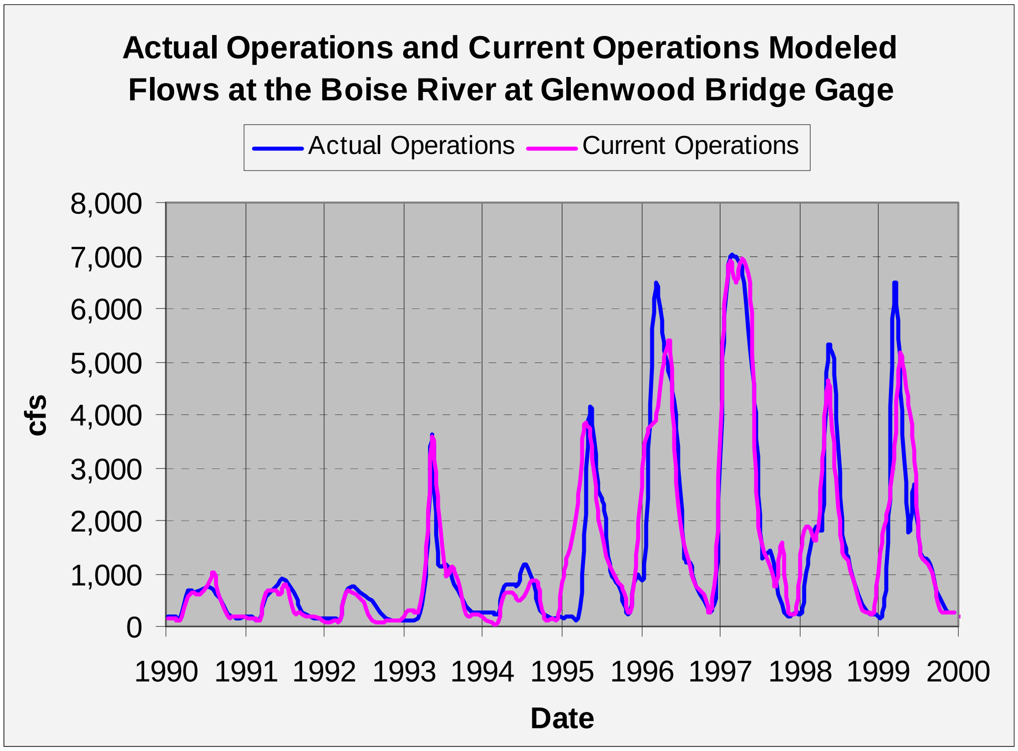
The MODSIM model used in the Snake River 2004 biological assessment attempts to predict near future operations based on the assumption that current practices will continue into the future. Such things as irrigation water demand, minimum flows, and the willingness of spaceholders to contribute to the rental pools can change with economic, political, and scientific conditions. In order to predict what happens in the future, one can attempt to quantify what has happened in the past and relate that to some measurable factor such as the dryness of the river basin or the volume of anticipated runoff. Diversion demand pattern, reservoir target content, flow objective level, and rent pool activity quantities can be dynamically determined in the MODSIM model based on the time step "Hydrologic State." At each time step, a table look-up is completed for any number of sub-basins (three are defined in the Snake River: Upper Snake, Boise, Payette) that determines the designation of water supply conditions (with 1 being very dry and 7 being very wet). There are 7 monthly rule curves defined for each reservoir that specify the desired end of month content based on the Hydrologic State computed for the given time step. Similarly, there are 7 annual diversion volumes (each with a temporal distribution pattern) for each irrigation demand; there are optionally, 7 rent limits for a storage contract. The demand level or rental activity limit is selected at each time step based on the derived Hydrologic State for that time step. Usually the Hydrologic State tables are based on a forecasted runoff at an operational forecast gage location (e.g., Heise, Lucky Peak, or Horseshoe Bend). The forecast may or may not be combined with simulated reservoir contents at specified dams as the basis for the table look-up factors. The Snake River 2004 biological assessment data set uses historical unregulated residual runoff flows January through September for the "forecasted runoff" values. Runoff after June is usually inconsequential to defining the water supply conditions; so values for hydrologic state in July through December are held at values computed for June of a given year.

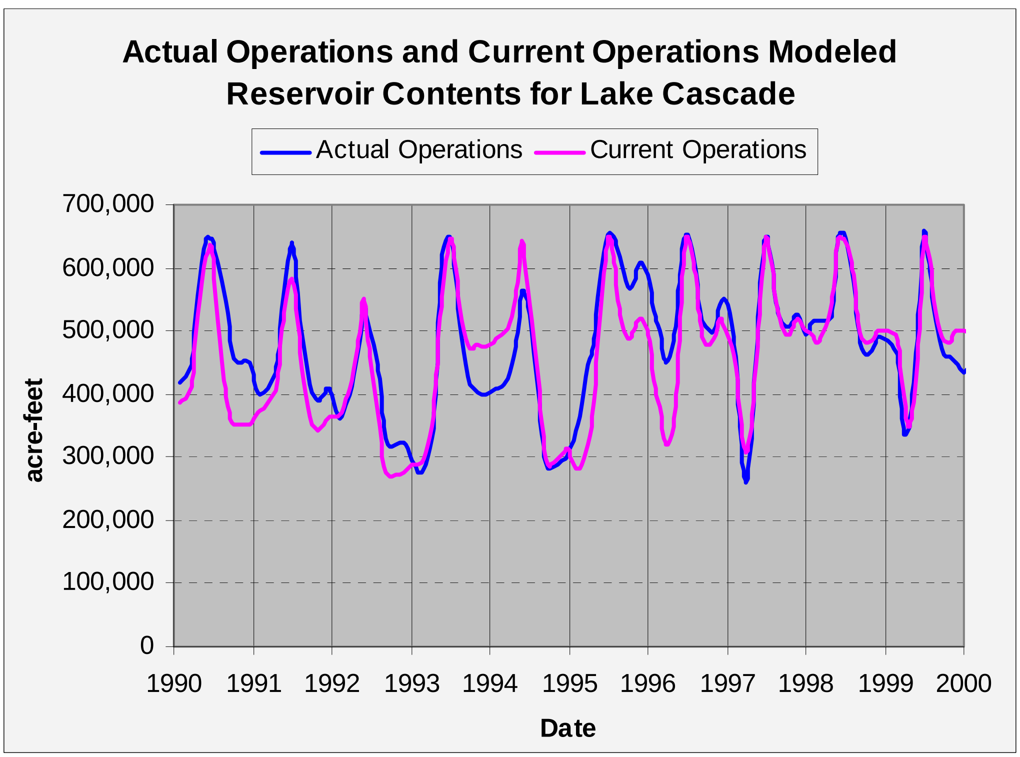
E.6 Validating the Model

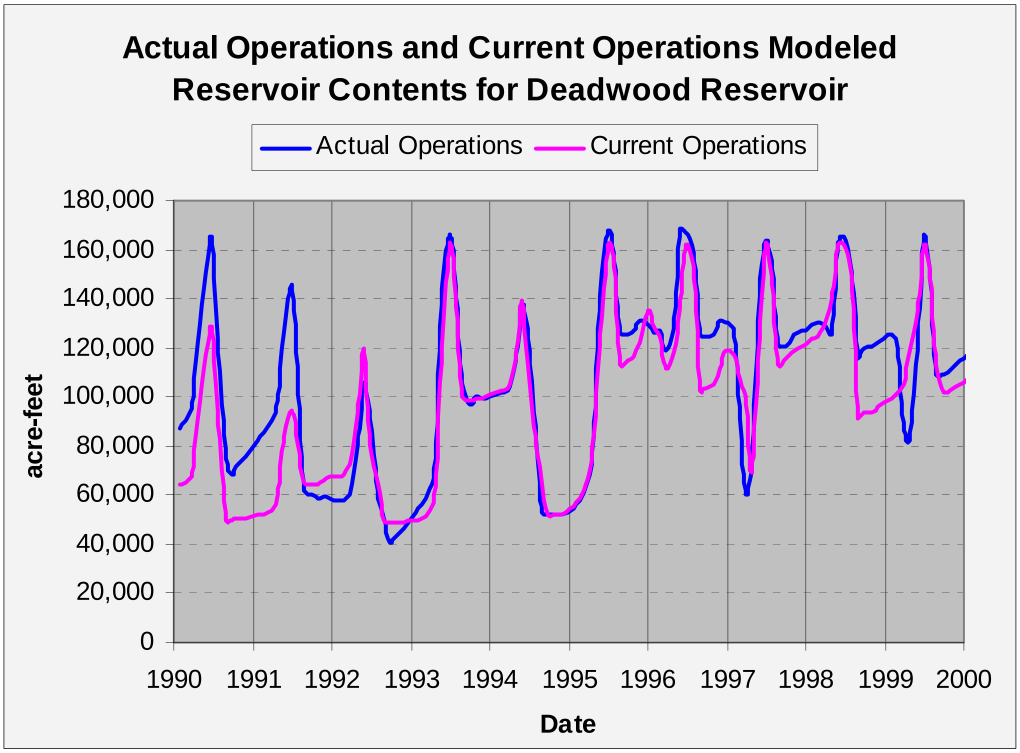
One way to validate the modeling analysis is visually compare modeled results to a period when similar conditions existed. River system features and the historical operational objectives in the mid- and late 1990s in the modeled 2000 Current Operations scenario were very similar to the conditions that existed at the time. In those years (except 1993 and 1994) Reclamation attempted to provide 427,000 acre-feet of flow augmentation without the use of powerhead. The following graphs show historical monthly data as compared to modeled data for the current conditions. Note the similarity except in 1993 and 1994 when powerhead was used to firm up the 427,000 acre-feet. Regressions were completed at three selected locations (Palisades outflow, American Falls Content, and Boise River at Glenwood flow) between historical recorded and simulated values. F test statistics show that the historical and simulated samples for monthly values between 1991 and 2000 are statistically from the same population with over 95 percent confidence. These results are documented in the spreadsheet SelectedRegressions.xls, available from Reclamation's Pacific Northwest Regional Office.

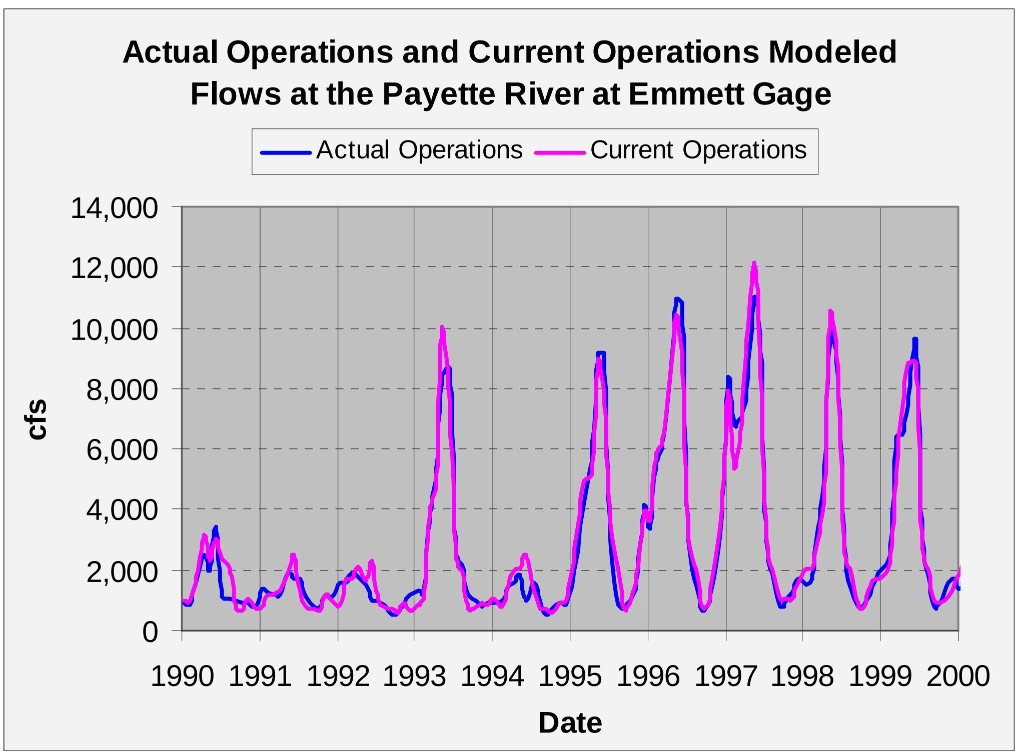


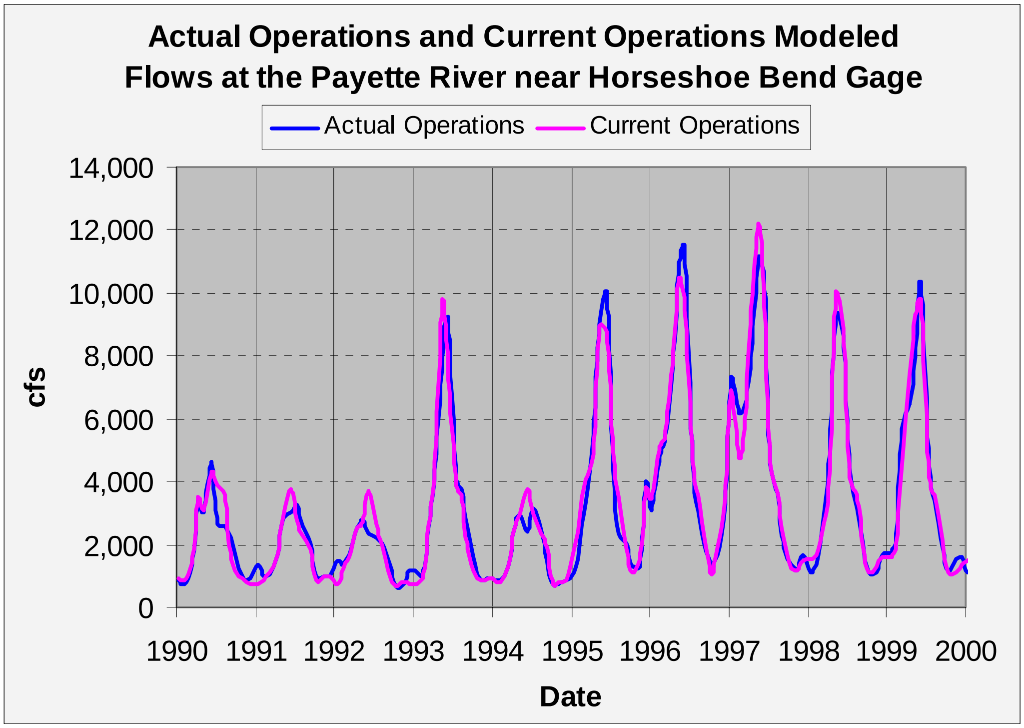


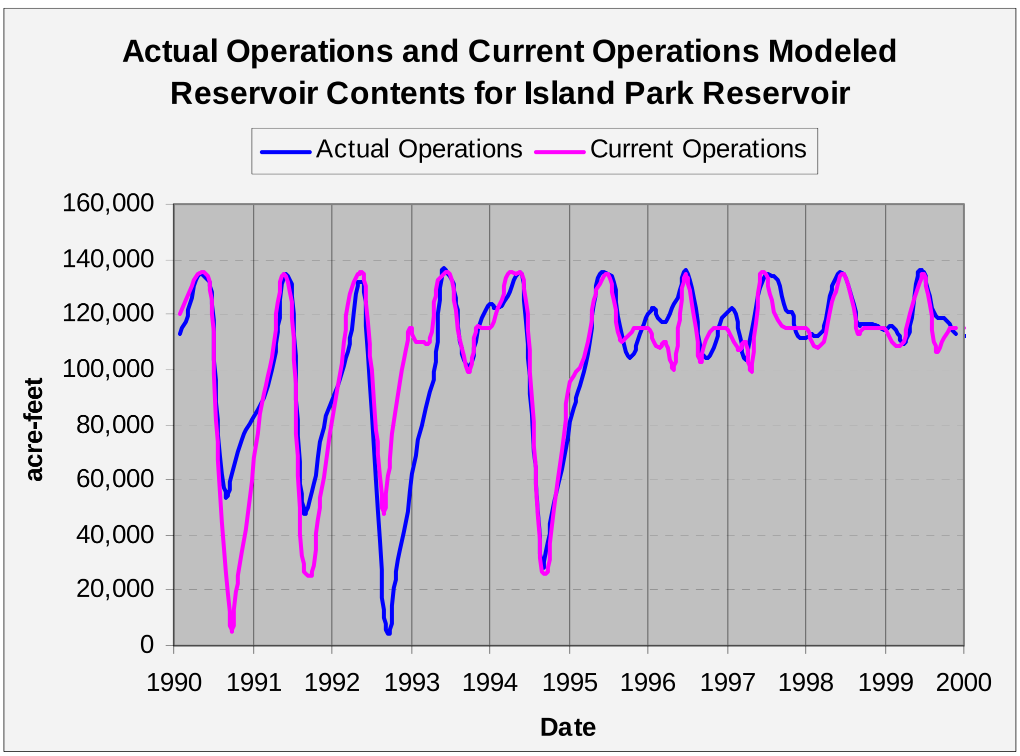

Actual Operations and Current Operations Modeled
Flows at the Boise River at Glenwood Bridge Gage
Actual Operations
Current Operations
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
cfs
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
Date

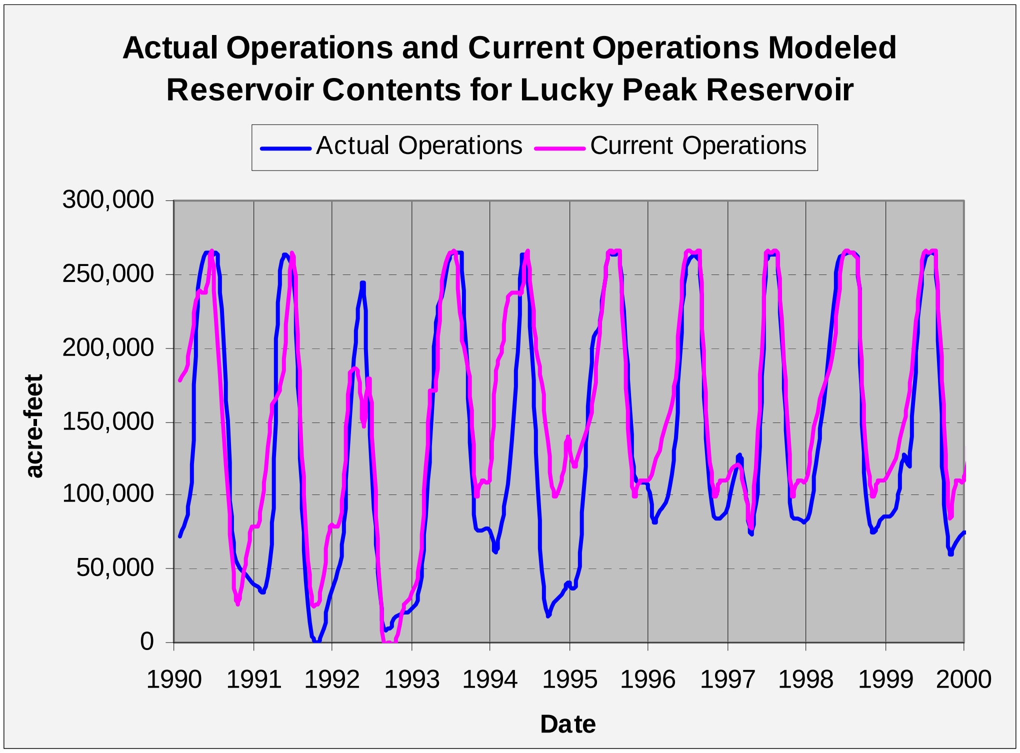

Actual Operations and Current Operations Modeled
Reservoir Contents for Lake Cascade
Actual Operations
Current Operations
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
acre-feet
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
Date

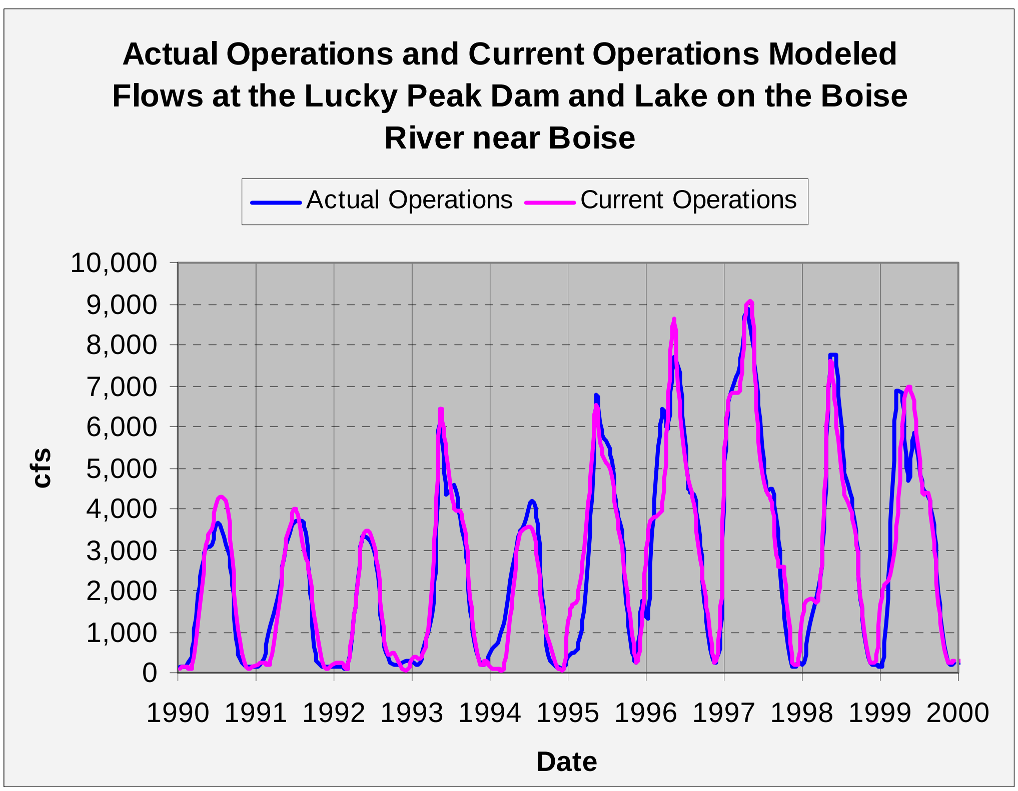

Actual Operations and Current Operations Modeled
Reservoir Contents for Deadwood Reservoir
Actual Operations
Current Operations
acre-feet
180,000
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
Date

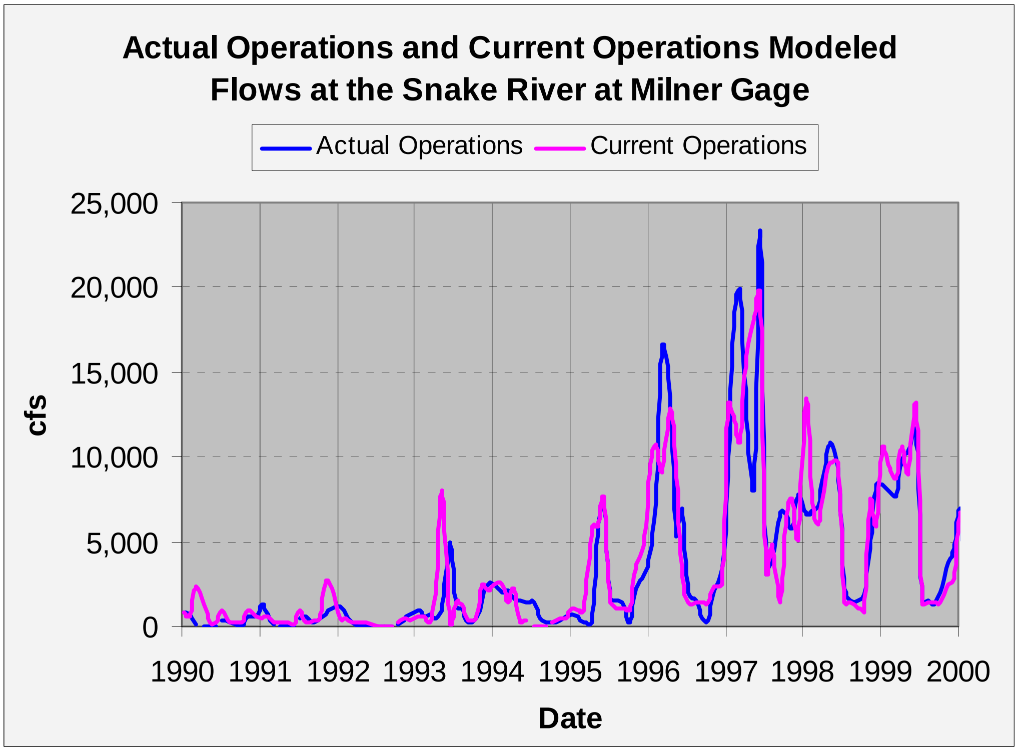

Actual Operations and Current Operations Modeled
Flows at the Payette River at Emmett Gage
Actual Operations
Current Operations
cfs
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
Date

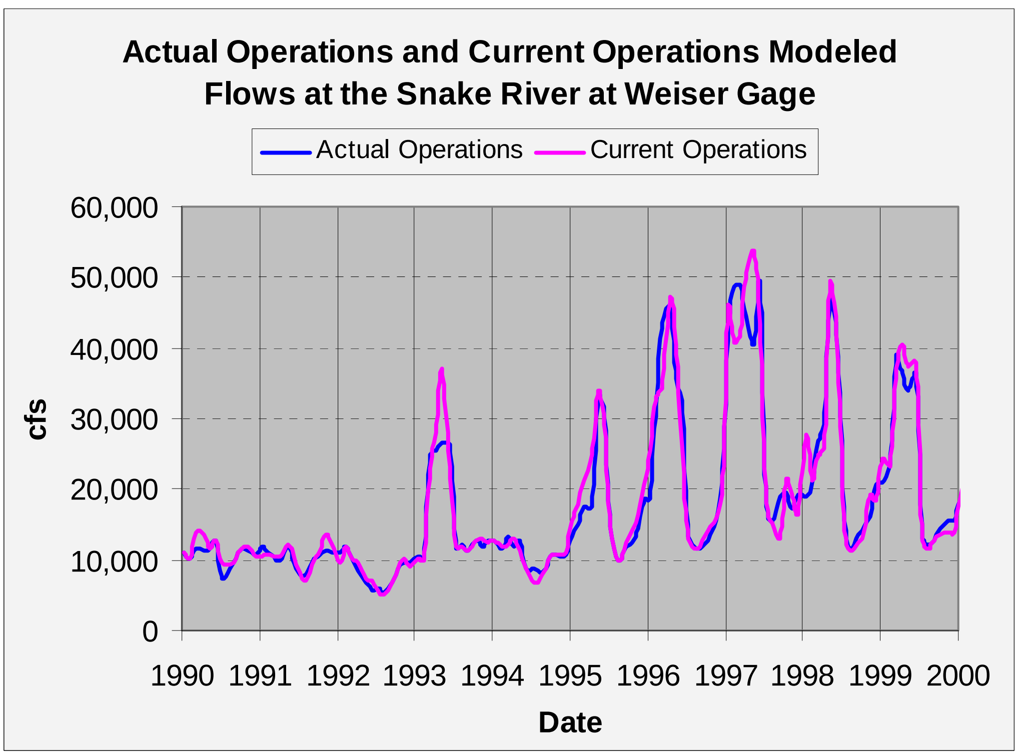

Actual Operations and Current Operations Modeled
Flows at the Payette River near Horseshoe Bend Gage
Actual Operations
Current Operations
cfs
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
Date

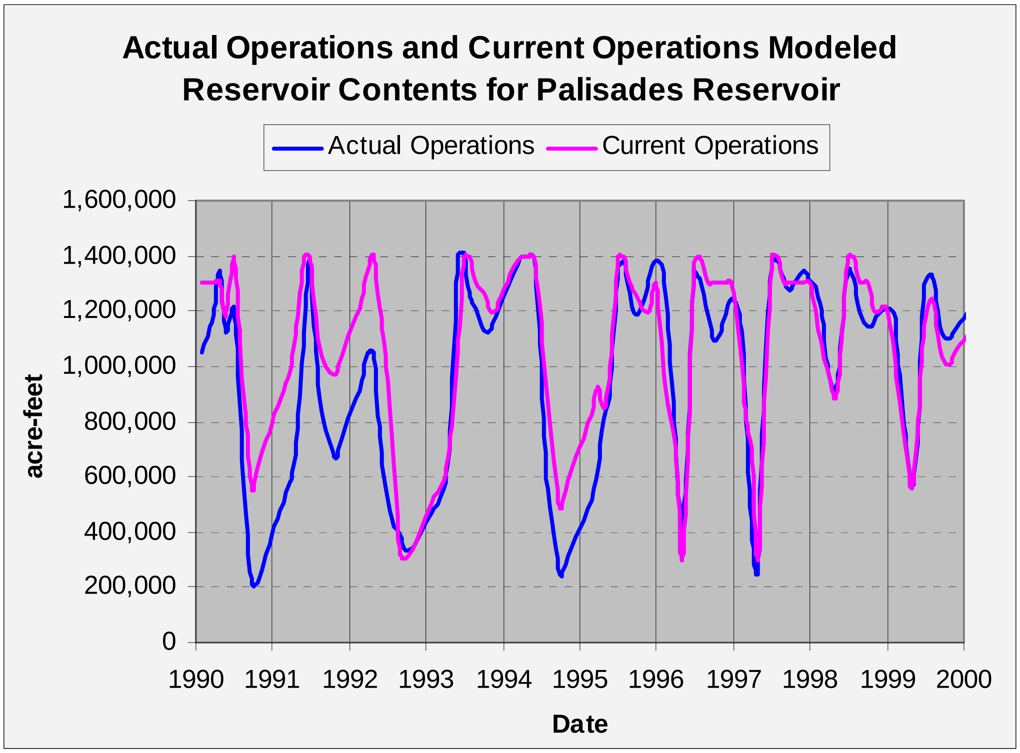

Actual Operations and Current Operations Modeled
Reservoir Contents for Island Park Reservoir
Actual Operations
Current Operations
acre-feet
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
Date

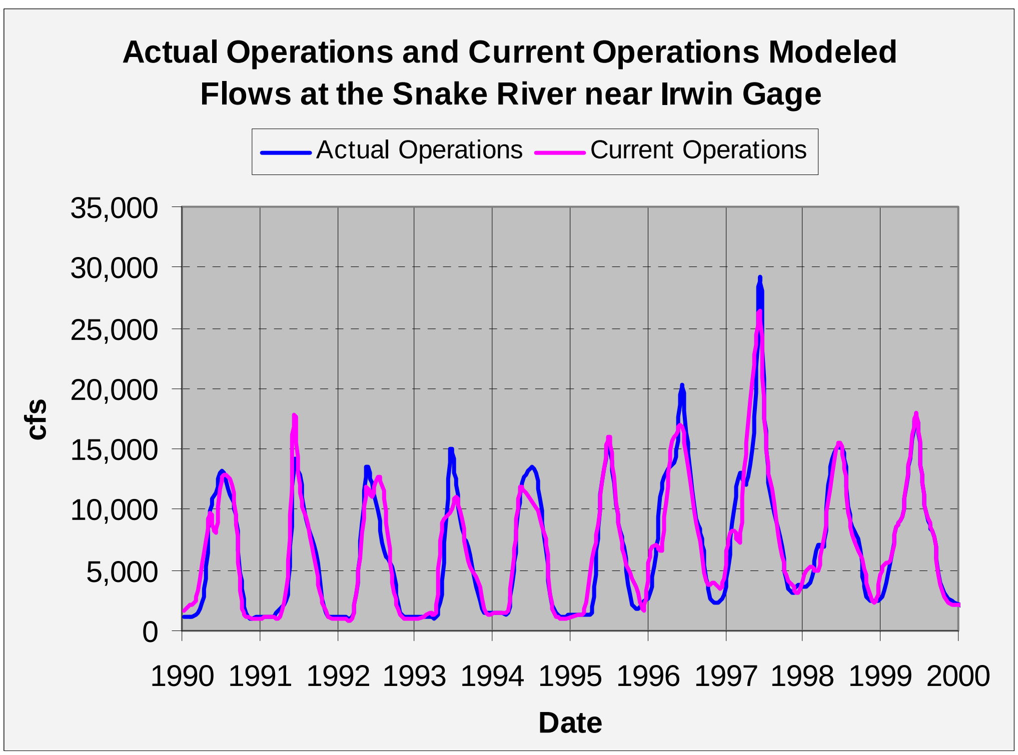

Actual Operations and Current Operations Modeled
Reservoir Contents for Lucky Peak Reservoir
Actual Operations
Current Operations
acre-feet
300,000
250,000
200,000
150,000
100,000
50,000
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
Date

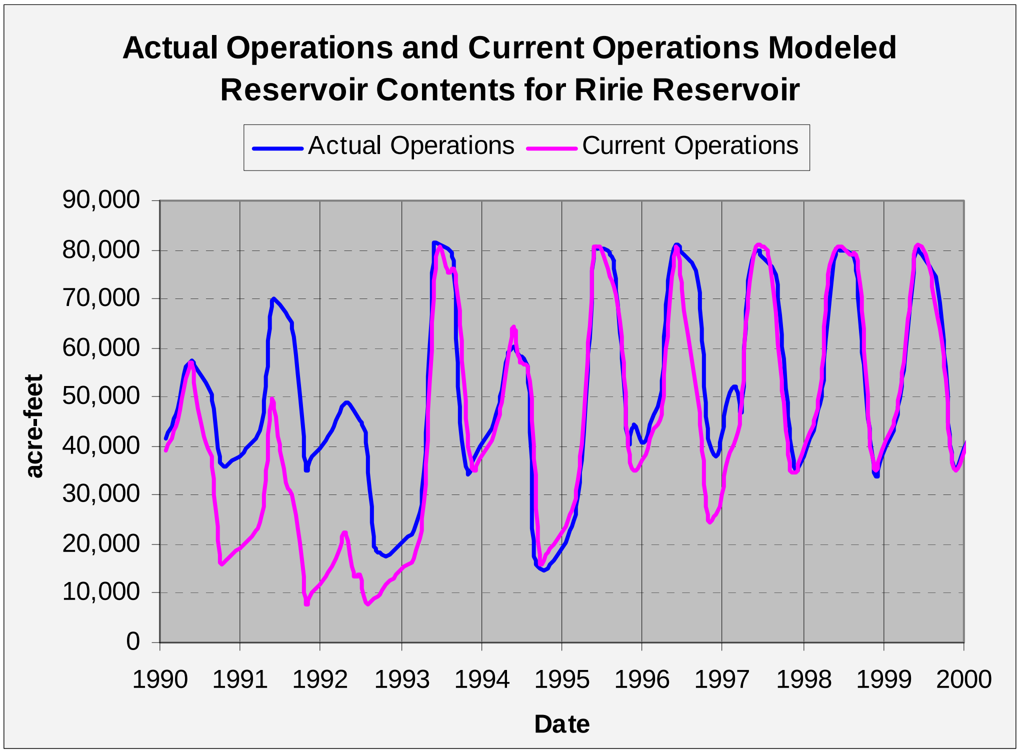

Actual Operations and Current Operations Modeled
Flows at the Lucky Peak Dam and Lake on the Boise
River near Boise
Actual Operations
Current Operations
cfs
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
Date

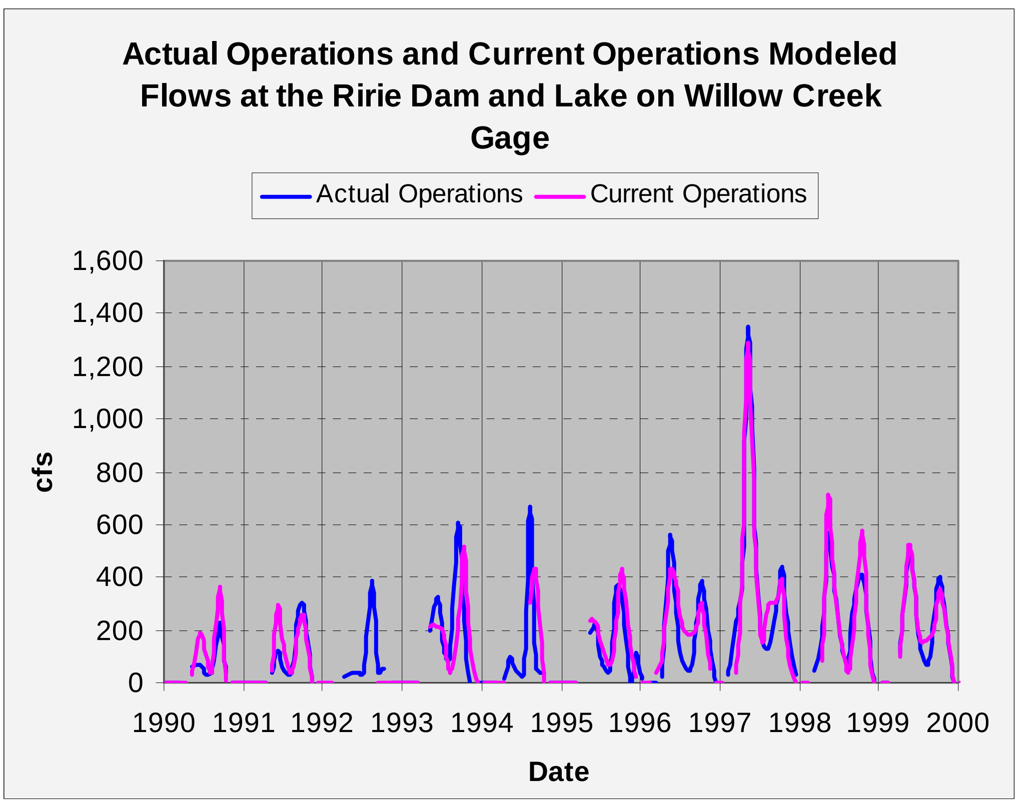

Actual Operations and Current Operations Modeled
Flows at the Snake River at Milner Gage
Actual Operations
Current Operations
25,000
20,000
15,000
10,000
5,000
0
cfs
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
Date


Actual Operations and Current Operations Modeled
Flows at the Snake River at Weiser Gage
Actual Operations
Current Operations
60,000
50,000
40,000
30,000
20,000
10,000
0
cfs
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
Date


Actual Operations and Current Operations Modeled
Reservoir Contents for Palisades Reservoir
Actual Operations
Current Operations
acre-feet
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
Date


Actual Operations and Current Operations Modeled
Flows at the Snake River near Irwin Gage
Actual Operations
Current Operations
cfs
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
Date


Actual Operations and Current Operations Modeled
Reservoir Contents for Ririe Reservoir
Actual Operations
Current Operations
acre-feet
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
Date


Actual Operations and Current Operations Modeled
Flows at the Ririe Dam and Lake on Willow Creek
Gage
Actual Operations
Current Operations
cfs
1,600
1,400
1,200
1,000
800
600
400
200
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
Date

E.7 Literature Cited

Parenthetical Reference	Bibliographic Information
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Garabedian 1992	Garabedian, S.P. 1992. Hydrogeology and Digital Simulation of the Regional Aquifer System, Eastern Snake River Plain, Idaho. U.S. Geological Survey Professional Paper 1408-F.
Robertson and Sutter 1989	Robertson, A.C. and R.J. Sutter. 1989. "Stream Flows in the Snake River Basin: 1989 Conditions of Use and Management." Idaho Department of Water Resources Open-File Report, Boise, Idaho.